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.

Chapter 1. Introduction

Awareness of human-induced change to marine environments has resulted in an increasing concern regarding the ecological impacts from multiple stressors (Grant *et al.,* 1995; Roberts *et al.,* 2003; Halpern *et al.,* 2008). Once thought to be an abundant, inexhaustible resource, the world's oceans face a significant loss of diversity. This loss is occurring at a rapid rate due to the combined effects of overfishing, habitat destruction, invasive species, pollution and profound environmental and biotic change caused by global climate change (Roberts *et al.,* 2003; White *et al.,* 2004; McArthur *et al.,* 2010). It has become apparent that many pressures on the marine environment threaten the survival of marine species (Halpern *et al.,* 2008). This loss of biodiversity, altered species composition, and subsequent loss of ecosystem functioning have been documented in marine habitats across the globe (Foley *et al.,* 2010).

Continuation of marine environments over the long term will require conservation of marine biodiversity, sustainable use of resources, remediation of degraded habitats, and amelioration of global climate change (ANZECC TFMPA, 1998; Howell, 2010). Through the goals and principles of ecologically sustainable development (ESD) Australia (ANZECC TFMPA, 1998) and many other countries (e.g. C GOV, 2013; CDFW, 2013; UK GOV, 2013) have committed to the protection of marine biodiversity and ecological integrity, and the sustainable use of marine resources. Marine protected areas (MPAs) are an effective method for protecting marine environments and their biodiversity, sustaining productivity of marine resources, and managing multiple uses in coastal and marine environments (Lindsay *et al.,* 2008). MPAs have been established to achieve three main conservation objectives: the maintenance of essential ecological processes, preservation of genetic diversity, and ensuring sustainable utilisation of species and ecosystems (Banks and Skilleter, 2010). MPAs also contribute to broader marine management objectives through habitat protection, the rebuilding of depleted fish stocks, the maintenance of species viability, productivity enhancement, and by providing insurance against fisheries management failure (Banks and Skilleter, 2010).

The establishment of a MPA frequently raises the profile of an area for marine tourism, broadens the local economic options and brings social benefits. This occurs by increasing fisheries stocks through the protection of habitats critical for commercially and recreationally important species and by protecting major tourist attractions (NSW Marine Parks Authority, 2001). Economic benefits also arise from the creation of employment through the sustainable harvest of resources, and the business generated from recreation and tourist activities (NSW Marine Parks Authority, 2001). MPAs also increase community awareness and understanding and provide sites for education (NSW Marine Parks Authority, 2001).

Although a primary goal of MPAs is biodiversity conservation, there are serious gaps in taxonomic, biogeographic, and ecological knowledge of marine biodiversity (Zacharias and Roff, 2000; Ponder *et al.,* 2002; Gladstone and Alexander, 2005; Banks and Skilleter, 2007). Obtaining such data over large areas is costly and time consuming (Banks and Skilleter, 2007). Recognising this issue, conservation planning, after the elucidation of aims and objectives, begins with the selection of a suite of surrogates that will make the process efficient and cost-effective. Conservation planning research is addressing the effectiveness and limitations of a range of potential surrogates (Ward *et al.*, 1999; Gladstone 2002; Mellin *et al.*, 2011). A further reason for improving the effectiveness of conservation planning is the need to minimise social costs (Voyer *et al.*, 2012). Testing the assumptions of surrogacy, and improvements in their effectiveness, will facilitate planning and improve conservation outcomes.

Identifying the location for an MPA requires quantitative measures of the relative importance, or conservation value, of candidate areas for the attainment of a conservation goal. Conservation value can be assessed by a raft of measures applicable to species (e.g. rarity, endemism, richness, conservation status, taxonomic distinctiveness) and areas (e.g. connectedness, irreplaceability, naturalness) (Brooks *et al.*, 2006). The marine environment is highly dynamic, and this is reflected in complex patterns of spatial and temporal variation in biodiversity. Scales of temporal variation in benthic fauna have been known for some time (e.g. Rainer, 1981; Morrisey *et al.,* 1992b). Temporal variation may arise from seasonal influences, short- or long-term environmental perturbations and ecological interactions (Thrush *et al.,* 1996), and from anthropogenic stressors (Roberts *et al.,* 2003). The inherent temporal variability in estuarine biodiversity should be a critical consideration for conservation planning of estuaries, especially in regards to temporal stability in the relative conservation priority of candidate areas. A potential consequence of temporal variation in the biodiversity of estuaries is that the conservation value of candidate sites may vary, depending on the time they were assessed, potentially compromising the long-term achievement of conservation goals (Margules *et al.,* 1994; Rodrigues *et al.,* 2000). Research in other non-marine ecosystems has shown considerable temporal variation in conservation value (Jeffries, 2006; Hassall *et al.*, 2012). There is very limited understanding of the implications of this variation in marine ecosystems for conservation planning.

Polychaetes play an important role in the functioning of benthic ecosystems and have been shown to be good indicators of species richness and community patterns in benthic invertebrate assemblages (Olsgard and Somerfield, 2000; Van Hoey *et al.,* 2004). With significant gaps in knowledge of Australian biota, there remains hundreds of thousands of species still not described and named (Just, 1998; Appletans *et al.,* 2012; ABRS, 2013). The total number of accepted described species in the world is estimated to be close to 1 900 000 (Chapman, 2009). In 2006 it was estimated at 1 786 000. Worldwide, about 18 000 new species are being described each year (Chapman, 2009). Estimates of Australia’s biological diversity vary dramatically (see ABRS, 2013). Contributions to the identification and naming of Australia’s taxa will assist biodiversity conservation. Marine conservation focuses on genes, species, habitats, ecosystems, and ecological processes (Ward *et al.,* 1999) and advances in taxonomy will contribute to marine conservation by improving species inventories and eliminating some of the uncertainties associated with surrogate approaches. Polychaetes form the focal group of organism used to answer the research questions posed in this thesis. For the purpose of this thesis the term biodiversity is used in regard to taxonomic and ecosystem diversity.

Therefore, the aims of this study are:

1. To investigate the suitability of habitat as a species diversity surrogate. This was done by testing the relevance, for polychaete biodiversity, of the habitat classification scheme used in the Port Stephens-Great Lakes Marine Park, in New South Wales, Australia. This was also investigated by testing whether a recently discovered and rare stretch of soft coral (*Dendronepthyia australis*) habitat was a distinctive habitat for polychaetes within the Port Stephens estuary.
2. To determine the temporal consistency of measures of conservation value typically used in conservation planning for the Port Stephens-Great Lakes Marine Park.
3. To improve the taxonomic knowledge of the polychaetes in the Port Stephens-Great Lakes Marine Park and assess species endemicity.

This dissertation comprises 6 other chapters. Chapter 2 provides the background to the study, in the form of a review of polychaete biology and ecology, and of the evidence for their value as indicator taxa for describing environmental variation and as surrogates for other taxa in conservation planning. The review also discusses the necessity and purpose of MPAs and the critical use of habitat surrogacy in determining conservation zoning of MPAs. Chapter 3 describes a test of the usefulness of habitats as a surrogate for the distribution of polychaete biodiversity using the habitat classification scheme of the Port Stephens-Great Lakes Marine Park (PSGLMP). Chapter 4 examines further the importance of habitats for polychaete biodiversity, by testing the relationship between polychaete biodiversity and a unique ecosystem engineer within the PSGLMP, the soft coral *Dendronepthyia australis*. Chapter 5 describes a test of the temporal stability of several measures of ‘conservation value’, tested by determining species turnover at the same sites over two temporal scales (months, years) and by testing for correlations in several measures of conservation value over the same time scales. Chapter 6 describes three new species of the polychaete family Nephtyidae found within eastern Australian coastal waters. Chapter 7 provides general conclusions and suggested future research. The chapters in this thesis have been formatted for submission as papers to international journals. There is, as a result, some repetition of the background information reviewed in Chapter 2 in the introductions to each of the chapters as they are written to be stand-alone publications.

Chapter 2. Polychaete biodiversity: relationship to environmental variation and conservation needs

2.1 Background

The research described in this thesis tested hypotheses related to the value of habitat-based biodiversity surrogates, and the assessment of conservation value, and used polychaetes (Annelida) as the test group of organisms. As background, this chapter reviews the literature on the roles of marine protected areas, and the quantification of conservation value, in achieving the goals of marine conservation. This chapter also reviews the literature on the contribution of polychaetes to macrobenthic assemblages (including the current status of polychaete taxonomy), their roles in ecological functions, and their significance as indicators of ecosystem condition.

2.2 Conservation of marine invertebrates

Australia is one of only 12 megadiverse countries with an estimated 10% of the world's species (Just, 1998). This high diversity also displays unusually high levels of micro-endemism (species with small range distributions), reaching well over 80% in flowering plants, mammals, reptiles and frogs, and a number of invertebrate groups (Just, 1998). Australia's marine domain covering more than 11 million km^2 of seafloor in three oceans and extending from cool temperate seas in the south to tropical seas in the north, also has one of the most diverse biotas on the planet (Last *et al.,* 2010). Taxonomic revisions of several families of polychaetes (Aphroditidae, Nephtyidae, Nereididae, Onuphidae, Sabellariidae, Sigalionidae, Spionidae, Terebellidae and Trichobranchidae) in Australian waters have identified a high degree of geographic endemism, particularly in southern Australia (Glasby *et al.,* 2000). The unique diversity of Australia's seas provide vital social and economic benefits as Australians utilise marine resources in a myriad of ways relating to income, employment, food, and recreation. For example, approximately 95% of Australia's booming aquaculture production and businesses are situated in marine coastal areas and estuaries along the Australian coastline (AAAT, 2001; Gaspar *et al.,* 2011).

The ultimate goal of biodiversity conservation is to conserve diversity at three levels: ecosystem, species and genetic diversity (Banks and Skilleter, 2002; Chapman *et al.,* 2009). Marine assemblages are typically characterized by a large diversity of small, often cryptic species, with patchy, over-dispersed distributions (Chapman *et al.,* 2009). Restoring or maintaining native species diversity, composition, and functional redundancy (e.g. the degree to which multiple species perform similar ecological functions) is essential for sustaining productive and resilient ecosystems (Foley *et al.,* 2010). Species diversity can affect multiple ecosystem functions including maintenance of productivity, resistance, resilience, capacity to maintain functional redundancies within an ecosystem, and stable food web dynamics (Foley *et al.,* 2010). A key argument for conserving biodiversity as closely as possible to its natural state is our lack of understanding of the complex interactions between species which form the basis of marine ecosystems. This can also be said for the "ecosystem services" that they provide (Glasby *et al.* 2000; Ponder *et al.,* 2002; Foley *et al.,* 2010; McArthur *et al.,* 2010). By conserving biodiversity as close to its natural state as possible these complex interactions will be captured and maintained.

2.2.1 Issues for macrobenthic biodiversity

The marine environment, as a global common resource, has become over-exploited by many parties with little or no accountability for continuing degradation (Banks and Skilleter, 2010). The highest trophic levels from marine food webs are systematically being depleted resulting in disruption to the composition and functioning of marine communities and ecosystems (Roberts *et al.,* 2003; McArthur *et al.,* 2010). The nature of overfishing of marine invertebrates ranges from the perception of overfishing because of competition by user groups for a common property resource, to extensive overfishing, and even near extinction through poaching by licensed or unlicensed fishers (Jamieson; 1993; Jackson, 2008; McArthur *et al.,* 2010). Species affected include oysters, mussels, crustaceans, commercial sponges and the black sea urchin *Diadema antillarum* (Jackson, 2008).

Marine invertebrates, including polychaetes, are vulnerable to the direct effects of human activities such as dredging, waste disposal, climate change, habitat loss, unsustainable collection and trawling, and the indirect effects of human activities such as altered hydrology and colonisation by invasive species (Ward and Hutchings, 1996; Hewitt *et al.,* 1999; Fraser *et al.*, 2006). Trawling has been compared to clear-felling (Watling and Norse, 1998) in which the seafloor is reduced to a muddy landscape with the 3-dimensionality removed (Hutchings, 1990). Bottom trawls crush benthic invertebrates in the path of the net and can cause mortality of those caught in the net (Malaquias *et al.*, 2006). Threats to macrobenthic assemblage structure also arise from nutrient loading into coastal watersheds and estuaries, which has intensified to unprecedented levels through agricultural, industrial and urban activities (Nixon, 1995). Nutrient loading, such as occurs through organic enrichment of the seabed, increases the activity of aerobic bacteria, which can lead to deoxygenation of the sediments. In addition, this can lead to the growth of anaerobic bacteria and the production of noxious gases and toxic substances such as hydrogen sulphide, methane, or their derivatives (Crawford *et al.,* 2002). These events can vary in extent, intensity and frequency, and may kill, decimate or damage organisms and alter habitats (Thrush *et al.*, 1996).

Habitat heterogeneity is often associated with high biodiversity (Thrush *et al.,* 2001). Loss of habitat within an ecosystem leads to loss of biodiversity, which contributes to a reduction in the functionality of ecosystem services that is evident in the rapid decline often observed at regional scales within ecosystems such as estuaries and coastal reefs (Worm *et al.,* 2006). Continued use of marine environments over the long term will require that marine biodiversity is conserved and resources used sustainably in order to ensure future optimal condition of this fragile environment (ANZECC TFMPA, 1998; Lindsay *et al.,* 2008; Howell, 2010).

Internationally, the white abalone (*Haliotis sorenseni*), historically found between Point Conception, CA (USA) and Punta Abreojos, Baja California (Mexico), in 2001 became the first marine invertebrate to be listed under the Endangered Species Act

(ESA) (Stierhoff *et al.,* 2012). At present there are 465 marine species listed as in danger of becoming extinct in Australia (EPBC Act, 2013). This list of species is proclaimed under s248 of the *Australian Federal Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act, 1999). In NSW the polychaete species *Hadrachaeta aspeta* (Terebellidae) is presumed extinct, in the opinion of the Fisheries Scientific Committee, established under Part 7A of the *Fisheries Management Act 1994*, as this species has not been recorded through targeted surveys in its known or expected habitat over a time frame appropriate to its life cycle (FSC, 2010; NSW DPI, 2013). The only published records of this species are Hutchings (1977) and Hutchings and Glasby (1988) from Patonga Creek, lower Hawkesbury River, Yamba, New South Wales and Serpentine Creek, Brisbane, Queensland. The species has not been collected since 1975 (FSC, 2010; NSW DPI, 2013).

2.2.2 Marine Protected Areas (MPAs)

Uncoordinated expansion of existing uses of the ocean and the addition of emerging uses, such as renewable energy and large-scale aquaculture, are likely to further aid the decline of marine ecosystem health. This is exacerbated by a rapidly growing coastal human population (Foley *et. al.*, 2010). Recognition of the dwindling condition of coastal regions and the increasing numbers of threatened species stimulated more integrated approaches to marine conservation. This led Australia, in 1994, to ratify the United Nations Convention on Biological Diversity (www.cbd.int/convention). Conservation of Australia's biodiversity is also a key goal of such strategies as *Australia's Biodiversity and Conservation Strategy 2010-2030* (NRMMC, 2010), the *Great Barrier Reef Biodiversity Conservation Strategy 2013* (GBRMP, 2013) and the *NSW Biodiversity Strategy* (Australian Government, 2013).

The primary goal for establishing a representative system of MPAs is to establish a comprehensive, adequate and representative system of MPAs that include a full range of marine biodiversity at ecosystem, habitat, and species levels (NSW Marine Parks Authority, 2001). Secondary goals of MPAs are to: protect areas of high conservation value; protect important habitat, threatened ecological communities and rare and threatened species; provide for ecologically sustainable use of marine resources within MPAs through management of human activities including recreation, tourism and fishing; provide opportunities for public appreciation, understanding and enjoyment, including recreational and cultural needs of Indigenous users; and, provide for educational and scientific research (NSW Marine Parks Authority, 2001). Article Eight of the Biodiversity Convention outlines the requirement of the conservation and sustainable use of threatened species, habitats, living marine resources and ecological processes by the establishment of marine protected areas (MPAs) (Post, 2008; Harris *et al.,* 2008). MPAs include multiple-use marine parks, aquatic reserves and marine components of national parks. The Convention's strategic plan set a target for the 2011-2020 timeframe of at least 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, to be conserved through effectively and equitably managed, ecologically representative and well-connected systems of MPAs (Harris *et al.,* 2008). The Australian Government, in order to meet its obligations under the Convention, has engaged in systematically establishing a comprehensive, adequate and representative network of MPAs to protect biodiversity and maintain ecological processes within Australia's costal marine environments (ANZECC TFMPA, 1998; Harris *et al.,* 2008; MPA, 2010). In order to fulfil the purpose of this integrated system and ensure its success, both the location of MPAs within a hierarchical spatial planning framework, and the placement of 'no-take' sanctuary zones within multiple-use MPAs are of critical importance (ANZECC TFMPA, 1998; Malcolm *et al.,* 2012). Zoning plans within multiple-use MPAs define the spatial placement of zones that allow or restrict different activities, and are the primary management mechanisms for protecting biodiversity (Malcolm *et al.,* 2012).

The state of New South Wales (NSW), Australia has adopted a multiple-use approach to achieve the goals of a representative network of MPAs (Banks and Skilleter, 2010). Marine parks are established under the Marine Parks Act 1997, which provides for the zoning of no-take sanctuary zones and habitat protection zones within the marine park (Voyer *et al.,* 2012). Biodiversity conservation is the primary goal of the multiple-use management approach in NSW. Six multiple-use marine parks have been established, containing 115 individual sanctuary zones that range in area from 0.01 to 6,580 ha and have an average area of 573 ha (Banks and Skilleter, 2010; NSW Marine Parks, 2013). However, if networks MPAs are to be successful in the goal of conserving biodiversity, managers need guidance on their placement that is firmly grounded in knowledge of the composition, distribution and function of marine biodiversity (Roberts *et al.,* 2003).

2.2.3 Selection of MPAs for biodiversity conservation

Knowledge of the composition of the biodiversity and patterns in its spatial and temporal variation is poor (Just, 1998; Snelgrove, 1999; Chapman *et al.,* 2009; Last *et al.,* 2010; Huang *et al.,* 2011). Worldwide taxonomic knowledge is sparse for many groups as there is a scarcity of taxonomists, taxonomic collections, and institutional facilities, rendering simple questions such as “how many species are there?” unanswerable – not even within an order of magnitude (Ponder *et al.,* 2002). There are huge gaps in our knowledge of the distributions and abundances of many marine organisms. Until more is known, an optimal strategy may be to conserve as much biological diversity as possible within the limits of socio-economic considerations.

Limited information on the distribution of biodiversity constrains the ability to systematically select and plan networks of marine reserves for conservation purposes (Gladstone, 2002; Hermoso *et al.,* 2013). The dilemma is that a detailed map of Australia’s biodiversity distribution does not exist (nor at the smaller spatial scales at which most marine conservation planning occurs) and it is not possible to make reliable predictions using the sparse biological information currently available (Harris *et al.,* 2008). An alternative approach is to use physical (i.e., geologic and oceanographic) indicators of the extent and diversity of benthic habitats and ecosystems as proxies for biological communities and species diversity (Harris *et al.* 2008; Kenchington and Hutchings, 2012; Hermoso *et al.,* 2013). In other words, the lack of knowledge of marine biodiversity has driven a shift in marine environmental planning and thinking over the past 20 years, from the conservation of species to the conservation of spaces (Zacharias and Roff, 2000; Huang *et al.,* 2011).

Surrogates are features chosen to represent biodiversity in conservation planning (Berger *et al.,* 2007). This is reflected in the design of MPAs where representation of all habitat types is a major criterion for selection of candidate areas, and the drawing of management boundaries is adopted (Stevens and Connolly, 2005). This is based on the theory that the identification of habitats defined by abiotic (physical and chemical) attributes should allow the identification and monitoring of the biotic components of the system. A major rationale for using broad habitat types to aid planning for the creation of MPAs and their zoning is a lack of systematically surveyed biological data, and the observed association of distinct biotic assemblages with distinct habitats (Ward *et al.,* 1999; Gladstone, 2002; Newton *et al.,* 2007; Olsgard *et al.,* 2008; Banks and Skilleter, 2010). Furthermore, the prohibitive cost of directly sampling marine biota over large areas, and the time required, renders physical environmental parameters faster and cheaper to measure (Zacharias and Roff, 2000; Huang *et al.,* 2011). A large number of sites from different research projects were studied by Van Hoey *et al.* (2004) to understand the macrobenthic assemblage structure of soft-bottom sediments on the Belgian continental shelf between 1994 and 2000. These samples covered a diverse range of habitats: from the sandy beaches to the open sea, gullies between the sandbanks to the tops of the sandbanks, and from clay to coarse sandy sediments. Using several multivariate techniques, 10 sample groups with similar macrobenthic assemblage structure were distinguished. It was concluded that the distribution and diversity patterns were linked to the habitat type, distinguished by median grain size and mud content.

Surrogacy research involves determining which easily measured characteristics best describe the spatial and temporal variation in assemblages of species. These characteristics act as predictors for the occurrence of species assemblages in habitats where species distributions remain unknown (Harris, 2012). Surrogates attempt to define a biophysical or ecological unit that provides an understanding of natural ecosystems and patterns of biodiversity (Banks and Skilleter, 2002).

In habitat mapping, the term "surrogacy" is used in reference to the biophysical variables that can be mapped with a quantifiable correspondence to the occurrence of benthic species and communities (Olsgard *et al.,* 2003; Harris, 2012). When implementing zoning of marine parks, habitat classification is the most frequently chosen surrogate for designing marine reserves (Ward *et al.,* 1999; Lindsay *et al.,* 2008; Hansen *et al.*, 2011). With the paucity of adequate biological data on distributions of many species, conservation planning can be based on representation of habitats as a surrogate for biological diversity as well as a surrogate for the ecological process that lead to the formation of habitats (Post, 2008; Chapman *et al.,* 2009; Banks and Skilleter, 2010; Huang *et al.,* 2011).

Unless validated, the use of habitat surrogates in marine conservation planning only *assumes* that protection of particular habitat types will lead to the protection of a larger suite of species whose conservation needs, distribution and abundance remains unknown (Banks and Skilleter, 2007; Post, 2008). For example, Ward *et al.* (1999) found for Jervis Bay, Australia, if given a target level of representation of ≥40% and a primary objective to protect species, a set of surrogates based on habitat categories could be used to define reserves efficiently, without the need to use extensive species-level data. On the other hand, a study of the utility of abiotic variables in predicting biological distributions at a local scale (10s of kilometres) was tested in a remote video survey of macrobenthos in Moreton Bay, Australia, and found these had poor predictive capacity for individual taxa or indicators (Stevens and Connolly 2004). In this case abiotic variables did not discriminate sufficiently between different soft bottom communities to be a realistic basis for mapping. Another study also found that habitats were an inefficient criterion for prioritizing areas for inclusion in a network of marine reserves in an estuary (Shokri and Gladstone, 2013) also. Therefore, despite the widespread adoption of habitats as a surrogate for biodiversity, research findings indicated that it is questionable whether MPAs designed solely on the basis of habitat mapping can have measurable benefits for conservation. This is a question that needs to be answered in order to ensure conservation efforts are effective and productive. There also needs to be an effective and efficient monitoring program to ensure this is the case.

While it is documented that basing conservation planning decisions on indicator groups that are taxonomically and ecologically well known, are easily surveyed, and have a known distribution is effective as a surrogacy strategy (Gladstone, 2002; Shokri *et al.,* 2009; Mellin *et al.,* 2011), their effectiveness in representing marine biodiversity has been questioned (Post *et al.,* 2006; Lindsay *et al.,* 2008). It is therefore likely that, under most circumstances, habitats will be the most frequently adopted surrogate for biodiversity in marine conservation planning. Throughout the marine planning process, however, it has been acknowledged that further testing of biological and physical surrogates is required to better define ecosystems and habitats at the scale of management zones (Post, 2008; Anderson *et al.,* 2011; Hutchings, 2012).

2.3 Conservation value

Decisions on the location and extent of MPAs require the elucidation of a conservation goal, and the formulation of criteria to assess the relative contribution of areas to the achievement of the conservation goal (Margules and Pressey, 2000). A large number of schemes have been developed to evaluate candidate sites for inclusion in a network of MPAs (reviewed by Roberts *et al.*, 2003). Conservation goals often include the representation of samples of the range of biodiversity, or suitable surrogates, in reserves. This requires a measure of the relative value of available places, in a planning area, towards achieving the conservation goal. Prioritising areas for conservation based on species richness only at particular sites (alpha diversity) might result in a selection of species-rich sites containing similar subsets of species. This could result in rare species, or those only present in species-poor sites, being excluded from protection (Margules and Pressey, 2000; Pressey *et al.,* 2007). This can be avoided by more comprehensive schemes for quantifying the 'conservation value' of available places in a planning area. Criteria for evaluating conservation value of species include such features as richness, rarity, endemism, diversity, size and conservation status, and criteria for evaluating the conservation value of places include degree of naturalness, importance for biological processes (such as spawning sites and juvenile nursery areas), connectedness, and occurrence of unique and/or representative assemblages (Margules, 1986; Gladstone, 2002).

A study undertaken in the Port Stephens-Great Lakes Marine Park investigated spatial and temporal patterns of variability in ascidian assemblages (Newton *et al.*, 2007). The study found that ascidian assemblages were highly variable between reef sites, reef exposures and between *depth* zones within each reef surveyed. In this study, however, temporal variation was only observed for a few ascidian species. It was discussed that for effective management of biological conservation a broad understanding of the spatial and temporal scales of variation in species assemblages was needed to guarantee that species diversity was properly represented within MPAs (Newton *et al.*, 2007). The study concluded that if the aim of the Port Stephens-Great Lakes Marine Park was to adequately represent the entire array of marine biodiversity in the area then numerous subtidal reefs may need to be protected within the marine park. Given this inherent temporal variability in biodiversity (as shown by the example presented), a critical consideration for conservation planning is the temporal stability in the relative conservation priority of candidate areas. This is particularly true within a unique and/or representative estuarine environment (Hutchings and Jacoby, 1994).

2.4 Macrobenthic biodiversity

Marine invertebrates represent 95-99% of marine biodiversity (Ponder *et al.,* 2002). Macrobenthic infauna are the invertebrate fauna which are visible by the naked eye and can be retained with a 1 mm sieve (e.g. polychaetes, molluscs, crustaceans, nemertine worms) (Simpson *et al.*, 2005). Marine invertebrates predominately live in or use sediments (Simpson *et al.*, 2005). In terms of diversity, size and numeric dominance, the major groups of macrobenthic invertebrates are the crustaceans, molluscs, and polychaetes. Information about Australian marine invertebrates occurs in many sources and there are no recent comprehensive reviews of Australian representatives (Environment Australia, 2002). Even for the relatively well-studied dominant macrofaunal groups (i.e. larger, highly visible, relatively common, or commercially important taxa), there remain numerous gaps in the understanding of their taxonomy, biology and ecology. For example, Porifera (sponges) contain approximately 5000-6000 described species worldwide, although three times this number may exist (Hooper and Wiedenmayer, 1994).

Macrobenthic invertebrates provide economic and social benefits to the world's aquaculture industry. Marine aquaculture (mariculture) is the fastest growing sector of the world food economy (White *et al.,* 2004). The industry has played a critical role in providing employment and income to regions throughout the world. In Australia, aquaculture has become well established with over 40 species being produced commercially. Macrobenthic invertebrates dominate this industry, making up three of the five main taxa (pearls, oysters, prawns, salmon and tuna) that account for over 85% of the gross value of production (AFMA, 2013). The mariculture industry in Australia employs producers, processors, marketers and support services (e.g. equipment manufacturers, suppliers, feed manufacturers). Macrobenthic species also have the potential through genetic variability to provide possible sources of pharmaceutically active compounds (Jones, 1994; Vo *et al.* 2011). The marine environment provides a source of compounds that show pharmacological activities and are helpful for the discovery and invention of bioactive compounds, used in the treatment of deadly diseases such as cancer and acquired immuno-deficiency syndrome (AIDS) (Jha and Zi-rong 2004). For example, marine organisms such as algae, sponges, tunicates, echinoderms, molluscs, shrimp, bacteria, and fungus provide promising anti- Herpes simplex virus agents (Vo *et al.,* 2011).

2.4.1 Macrobenthic assemblage structure and its relationship with physico-chemical parameters

The assemblage structure of macrobenthic infauna is a sensitive and reliable measure of sediment condition. This is because of the relationship between physico-chemical parameters of the benthic environment and the composition of the associated infaunal assemblages (Crawford *et al.*, 2002; Dernie *et al.,* 2003; Barnes *et al.,* 2006). A study undertaken by Post *et al.* (2006) tested this link between physical and biological datasets for the southern Gulf of Carpentaria, Australia. The study investigated a range of physical factors, including the sediment composition (grain size and carbonate content), sediment mobility, water depth and organic carbon flux, and the relationship of these variables to the distribution and diversity of benthic macrofauna. The results revealed the importance of process-based indices and concluded that patterns of diversity reveal the importance of physical processes such as sediment mobility in defining benthic habitats.

The diversity of macrobenthic species is a result of niche partitioning of the habitat. The extent of niche partitioning in turn is dependent on characteristics of the sediment, and the frequency of disturbance (Dernie *et al.*, 2003). Codling *et al.* (1995) concluded that evaluation of benthic infauna was a direct and ecologically relevant measure of environmental impact in their investigation of techniques used for environmental monitoring.

In unstressed marine environments benthic macrofaunal communities break down organic matter deposited on the seabed (Pearson and Rosenberg, 1978; Crawford *et al.,* 2002). In the case of organic oxidation, the oxic layer becomes shallower and the macrofauna, which require oxygen to survive, are driven towards the surface. As the oxygen level in the sediment declines further, many macrobenthic species are eliminated and may be replaced by others more tolerant of a low oxygen environment (Crawford *et al.,* 2002). The hypoxic sediments characteristic of organic enrichment are utilised by opportunistic or pioneer species (Grant *et al.,* 1995). Opportunistic species are "species whose reproductive and growth characteristics fit them to take immediate advantage of a sudden environmental change providing them with a favourable unexploited niche" (Pearson and Rosenberg, 1978).

2.5 Polychaetes

Polychaetes, or more commonly "bristle worms", "sand worms", and "tube worms", are multi-segmented marine invertebrate worms. Morphologically they typically exhibit segmental parapodia and chaetae (bristles) arranged in distinct bundles (Glasby *et al.*, 2000; Rouse and Pleijel, 2001). Species vary in sizes from less than 1 mm for some interstitial species to over 3 metres for some Australian beach worms (Onuphidae) (Glasby *et al.,* 2000). Although a number of species have successfully invaded freshwater, polychaetes are mostly marine (Hutchings, 1998). In the marine environment, they occur in all types of habitat and substrata and are found from the intertidal zone to abyssal depths of the ocean, and in brackish waters (Glasby *et al.,* 2000; Ponder *et al.,* 2002; Hutchings, 2003).

2.5.1 Polychaete biodiversity

The Polychaetes are a diverse group of macrobenthic invertebrates, with currently 81 families and about 13,000 species recognized, although only 8,000 of these are considered valid (Glasby *et al.,* 2000; Rouse and Pleijel, 2001; Hutchings, 2003;

Read and Fauchald, 2013). Most known polychaete families have been recorded from Australian waters; of the 81 families recorded worldwide, 67 are found in the Australasian region (Ponder *et al.,* 2002). Approximately 1,140 species are known from Australian waters however another 20-30% remain to be described (especially from Northern Australia and in deep waters) (Glasby *et al.,* 2000). There have been several reviews of Australia's polychaete taxonomy. Day and Hutchings (1979) completed a catalogue of the Australian fauna and listed more than 1,000 species, including new species still to be formally named (Hutchings and Johnson, 2001). This list has subsequently been made available through the Australian Biological Resources Study (ABRS) (see ABRS, 2013). General reviews of polychaetes by Beesley *et al.* (2000) and Rouse and Pleijel (2001) and comprehensive reviews of polychaete families (e.g. Hutchings and Turvey, 1982, Hutchings and Murray, 1984; Paxton, 1986; Hutchings and Glasby, 1986; Hutchings and Glasby, 1987; Hutchings and Glasby, 1988; Warren *et al.,* 1994; Hutchings and Peart, 2000; Ford and Hutchings, 2005; Capa, 2008; San Martin *et al.,* 2009; Glasby and Hutchings, 2010; Lattig *et al.,* 2010) have been undertaken which have identified many new Australian species. In an effort to encourage ecological studies to identify this diverse and important group and further enhance comparative biological studies, a CD-based interactive key to polychaete families and genera, and Australian species by Wilson *et al.* (2003) and internet keys such as POLiKEY for the ABRS (Glasby and Fauchald, 2003) have been developed (Hutchings, 2003). Polychaete species and family diagnostics have been made available on the internet through the World Register of Marine Species (WoRMS) and polychaete workers are employed in State Museums that have extensive collections (Read and Fauchald, 2013). However, despite the relatively recent upsurge in polychaete taxonomic studies, the number of marine taxa yet to be discovered is still thought to be very high (Last *et al.,* 2010). The largest number of undescribed taxa in Australia is likely to be found offshore, in remote areas away from the centres of major populations and therefore less well studied than areas close to urban centres, within undersampled cryptic habitats of the intertidal zone, in deep water, and in Northern Australia.

2.5.2 Ecological functions and significance of polychaetes

Polychaetes are a critical component of benthic marine ecosystems as they are numerous and speciose, and because they are the numerically dominant macrobenthic taxon and contain diverse trophic positions (Fauchald and Jumars, 1979; Pocklington and Wells, 1992; Hutchings, 1998; Giangrande *et al.,* 2005; Cardoso *et al.,* 2007). Polychaetes are also relatively sedentary, can be quantitatively sampled, contain a range of life spans (see Olive and Clark, 1978 and Olive, 1984), occupy a variety of ecological niches, and display a range of life histories (See Appendix A) (Simpson *et al.,* 2005; Surugiu, 2005). Functional groups of polychaetes can be formed by determining guilds based on features such as reproductive behaviours (e.g. contain species that are short to long lived rendering productivity importatnt), degrees of opportunism and morphology and feeding behaviour (Fauchald and Jumars, 1979; Hutchings, 2003). Polychaetes, which include active predators, scavengers and grazers of algae, are also eaten by other polychaetes, other marine invertebrates, fish and wading birds (Glasby *et al.,* 2000). They therefore play an important role in trophic ecology by occupying several levels within the food web (Fauchald and Jumars, 1979; Glasby *et al.*, 2000).

Polychaetes also alter the physical and chemical condition of the sediment and sediment-water interface by cycling nutrients and other chemicals between the sediments and the water column (Simpson *et al.* 2005, Surugiu 2005, Hutchings 1998). They influence surface productivity and transfer energy to higher trophic levels by consuming and excreting sediment particles (Giangrande *et al.,* 2005; Simpson *et al.,* 2005). This enables the activity of aerobic bacteria and the decomposition of organic substances from the sediments (Surugiu, 2005). This is especially true for soft-bottom habitats, where the distribution of species is predominantly linked to the sediment particle size and organic content (Giangrande *et al.,* 2005).

Polychaetes also play an important role in the functioning of benthic communities as the species collectively utilize sediments in a multitude of ways. This is primarily through their diverse feeding modes and trophic positions (Fauchald and Jumars, 1979; Pocklington and Wells, 1992; Hutchings, 1998; Giangrande *et al.,* 2005; Cardoso *et al.,* 2007). For example, deposit-feeding polychaete families, such as capitellids and maldanids, swallow mud and sand particles and feed on algae attached to particles (Fauchald and Jumars, 1979; Glasby *et al.*, 2000). By swallowing sediment, polychaetes obtain nutrients from the algae, bacteria, etc., that coat the surface of the particles. Many surface deposit-feeding polychaetes such as spionids, ampharetids, terebellids, and some nereidids reduce the amount of organic matter accumulated in the sediment with the organic detritus being strongly transformed and incorporated as their own biomass. In this way polychaetes hasten the circulation of organic matter from the water column and the sediments into their food chain, without being mineralised (Surugiu, 2005). The within-sediment feeding polychaetes such as pectinariids and capitellids ingest large amounts of mud or sand, which then passes through their digestive tract and ultimately leads to the aeration of the sediments. This makes possible the activity of aerobic bacteria and contributes strongly to the decomposition of organic substances from the sediments (Surugiu, 2005). Suspension-feeding sabellids filter suspended particles from large amounts of seawater, naturally purifying the water. Through this action, suspension-feeding polychaetes cycle nutrients and other chemicals between the water column and sediments (Surugiu, 2005) and burrowing polychaetes greatly influence the oxic conditions of surface sediments, by transporting oxygen down into otherwise anoxic zones. Such activities have been shown to stimulate nitrogen removal due to an enhanced, coupled nitrification-denitrification activity (Christensen *et al.,* 2003).

Polychaetes are also economically significant as they are used as bait by fishers the world over. In Australia, several companies are experimenting with breeding species of beach worms for this purpose (Glasby *et al.,* 2000). In Britain, *Neanthes virens* (Nereididae) is farmed and air freighted around Northern Europe (Olive, 1999). In the wild this species spawns once a year, but under the influence of species-specific reproductive hormones in a farm environment, they spawn year round. These hormones have been isolated, commercially synthesised and sold under franchise in Northern Europe (Hébert-Chatelain *et al.,* 2008). Polychaetes are also proposed to be used in wastewater treatment at mariculture facilities. Medium bedding sand and nereidid polychaetes (*Perinereis nuntia* and *P. helleri*) from Moreton Bay in southeast Queensland were combined and studied in down-flow sand filtration beds (Palmer, 2010). The activities of the polychaetes were found to help prevent sand filters from blocking. Organic debris and their biomass also offered a valuable by-product. This combination appears to provide a new option for brackish wastewater treatment for contemporary seafood farming systems.

2.5.3 Polychaete relationships with the abiotic environment

Benthic assemblages and environmental variables can vary significantly across a range of spatial and temporal scales (Grant *et al.,* 1995; Simpson *et al.*, 2005). Typically, benthic biota in soft sediments have extremely patchy distributions, with a large proportion of variability in diversity and abundances occurring at scales from centimetres to metres (Bergström *et al.*, 2002). This small-scale spatial variation has also been exhibited repeatedly in marine community studies (e.g. Morrisey *et al.*, 1992a; Bergström *et al.*, 2002; Barnes and Ellwood, 2012). Potential driving forces behind this include variation in food availability, habitat structural complexity, and recruitment (Morrisey *et al.*, 1992a; Barnes and Ellwood, 2012).

Polychaetes inhabit an extensive range of habitats from the intertidal to the deepest depths of the ocean, and at all latitudes (Hutchings, 2003). Species can be pelagic, borers or crevice-dwellers in hard substrates, encrusting, and some drift the oceans attached to pumice or driftwood (Glasby *et al.*, 2000). The distribution of benthic polychaete species is determined by habitat and by sediment characteristics such as particle size and organic content (Pocklington and Wells, 1992; Hutchings, 1998; Giangrande *et al.,* 2005; Surugiu, 2005; Wildsmith *et al.*, 2005). Sediment structure is important in determining species composition as polychaete assemblages are composed of species that utilize sediments in a multitude of ways (Papageorgiou *et al.,* 2006; Labrune *et al.,* 2007). Salinity is frequently invoked as the ultimate cause of upstream-downstream variation in estuarine macrobenthic assemblages (e.g. Nanami *et al.*, 2005). Within an estuarine environment some species occur in the more saline sections of the estuary, and others tolerate the lower, fluctuating salinities found further upstream. Polychaete larvae are far more susceptible to lower salinities (Nanami *et al.*, 2005). Major weather events such as flood and drought have aso been shown to impact temporal patterns in macrobenthic species (e.g. Jones 1989). Depth is also a source of variation in marine biodiversity (Gray, 2001; McArthur *et al.,* 2010). This trend is supported by studies of depth-related variation in polychaete biodiversity (Platell and Potter, 1996; Mackie *et al.*, 1997; Mutlu *et al.*, 2010). Water depth can act as a proxy for factors of direct influence, such as temperature, light penetration, wave activity, currents, sedimentation, pressure, and nutrient availability (McArthur *et al.,* 2010), and can be a source of variation in ecological processes, such as competition (Shima, 2001).

2.5.4 Polychaetes as an indicator of environmental impacts

Polychaetes exist in a range of habitats and under considerable environmental variation (Glasby *et al.,* 2000). Stresses on polychaete populations have been observed to generate some of the following responses: an increase in production mainly where eutrophication processes are found (Pearson and Rosenberg, 1978; Giangrande *et al.,* 2005); a shift to opportunistic species and a reduction in diversity in hypoxic sediments generated by organic enrichment (Crawford *et al.,* 2002); an increase in the number of individuals with a decrease in species in habitats under environmental disturbance (Pearson and Rosenberg, 1978; Giangrande *et al.,* 2005). This is seen in the study by Samuelson (2001) where sources of environmental disturbance included a sewage lagoon, dump sites and an area of the tidal flat that was scraped with bulldozers every spring. Since opportunistic forms are typically small-sized species with short life cycles, a decrease in biomass has also been observed (Pearson and Rosenberg, 1978; Warwick and Clarke, 1994).

The presence or absence of specific polychaetes in marine ecosystems provides an indication of the condition of the benthic environment as they contain tolerant and intolerant species (Pocklington and Wells, 1992). The polychaete family Syllidae is a very useful indicator taxon in hard substrata as they are highly sensitive to pollution and disturbances, decreasing in numbers of species and individuals or completely disappearing in adverse conditions (Giangrande *et al.,* 2005). Several species have been found to be indicative of organic loadings, most notably the opportunistic polychaete *Capitella capitata* complex (Pearson and Rosenberg, 1978; Crawford *et al.,* 2002; Stigebrandt *et al.*, 2004). This species complex has been found globally in areas of organic enrichment (Crawford *et al.*, 2002). In undisturbed areas polychaete assemblages consist of species with a greater range of trophic and reproductive strategies than other groups of invertebrates (Olsgard and Somerfield, 2000).

Polychaete composition and abundance is a sensitive indicator of environmental impacts resulting from environmental contaminants, such as organic enrichment of the sediment ecosystem (Pearson and Rosenberg, 1978; Dauer, 1984; Hutchings, 1998; Crawford *et al.*, 2002; Cardoso *et al.* 2007). Indirect effects on polychaete assemblages arise from changes in fecundity, alterations to food webs, and the cascading effects caused by the loss or increased prevalence of certain taxa (Simpson *et al.,* 2005; Malaquias, 2006). It is their ecological relevance and response to environmental contaminants that make polychaete assemblages an important and viable tool for sediment quality assessment (Giangrande *et al.,* 2005; Simpson *et al.,* 2005). Samuelson (2001) analysed polychaetes along gradients of environmental disturbance resulting from human activity on subarctic tidal flats near the town of Iqualuit, Baffin Island. The environmental disturbances were a sewage lagoon, dump sites and an area of the tidal flat that was scraped with bulldozers every spring. Polychaete communities could be categorised into four zones depending on distance from the disturbance. The heavily disturbed zone was devoid of polychaetes and the disturbed zone contained increased densities of opportunistic species, such as *Capitella capitata* complex. At the moderately disturbed zone, there was increased species diversity resulting from organic enrichment from the disturbances. The undisturbed zone contained moderate levels of diversity in comparison to all other zones, thus indicating polychaetes respond to anthropogenic disturbances. Another study used polychaetes as surrogates for benthic assemblages to assess the state of recovery at sites dredged for aggregate material more than 10 years previously in Botany Bay, NSW (Fraser *et al.,* 2006). This study utilised data from a study conducted by the Australian Museum at the same sites in the 2 years following cessation of dredging. Abundance, species richness and evenness of polychaetes, as well as overall polychaete assemblage structure, were compared between localities over time. Findings indicated that in one year polychaete abundances at the impact localities attained, and remained at, the abundances at the reference locality. The authors suggested that long-term (years to decades) changes can vary substantially from short-term (months to years) changes in both the physical environment and the structure of polychaete assemblages and that aggregate dredging in marine sedimentary environments can affect benthic assemblages both in the short- and the long-term. By using polychates as a surrogate for the benthic assemblage, Fraser *et al.* (2006) concluded that such studies provide important information on the state of recovery of faunal assemblages.

Polychaete assemblages are able to act as indicators of disturbance for the broader macrobenthic assemblage because they play an integral role in the functioning of benthic communities (Cardoso *et al.,* 2007; Giangrande *et al.,* 2005). For this reason, polychaete assemblages have been advocated as an appropriate indicator group for the assessment of overall change in macrobenthic fauna (Cardoso *et al.,* 2007). For example, species richness of polychaetes has been shown to be significantly correlated with the total species richness of other macrobenthic organisms, off the coast of Norway, the inner Oslofjord, and the Irish Sea (Olsgard *et al.,* 2003). Spatial patterns in species richness, assemblage variation and total abundance of annelids were found to be significantly correlated with the spatial patterns and total abundances of other species in a Southeast Australian estuary (Shokri *et al.,* 2009b). Similarly, in a study predicting benthic response (both diversity and distributional patterns) to a natural disturbance gradient produced by glacial sedimentation in an Arctic fjord, the results showed that polychaetes analyzed separately from the dataset were good predictors of variability throughout the macrobenthic community (Włodarska-Kowalczuk and Kędra, 2007).

2.6 Improved taxonomic understanding

Conservation is pivotal in ensuring we maintain species diversity and abundance both on land and in our oceans. However, the world's inventory of the living species is largely unsatisfactory, both regarding taxonomic *completeness* and taxonomic *accuracy* (Dubois, 2003). It is estimated there are hundreds of thousands of species all around us still not described and named (Just, 1998). A significant percentage of the earth's biodiversity will unavoidably become extinct in the coming decades, and a large portion of it will not even have been scientifically inventoried (May, 1988; Just, 1998). As a consequence of the crisis of biodiversity, it is imperative to revalue the importance of taxonomic activities (Dubois, 2003) and expand on our taxonomic knowledge base (Just, 1998).

Within Australia, knowledge of the large-scale structure and distribution of biota is either patchy or lacking. Estimates of Australia's biological diversity vary dramatically whilst most taxonomists have numbers of undescribed species on their shelves waiting for time and funding required to be formally named. A key argument for the use of habitat surrogates in marine reserve planning and the placement of conservation boundaries is the inadequate knowledge of the biological diversity and the marine environment. Marine conservation focuses on genes, species, habitats, ecosystems, and ecological processes (Ward *et al.,* 1999). Contributions to the identification and naming of Australia's taxa will assist in the management of biodiversity conservation by adding to the knowledge of species inventories and the ecological roles they contribute to the functioning of ecosystems.

2.6.1 Improved taxonomic understanding of Australia's polychaete geographic endemism

Another argument for increasing taxonomic knowledge is to reliably evaluate the extent of endemism, and potentially ecological specialisation of Australia's species. For some time many polychaete species were regarded as being 'cosmopolitan' or having wide (often discontinuous) distributions, however subsequent revisions have proven this inaccurate (Glasby *et al.,* 2000; Ford and Hutchings, 2005). Species previously described as European species are frequently found to be new species endemic to Australia. For example, of the 32 species of terebellids recorded from Australia up until 1979, probably only one is potentially a valid record – the rest, and many more, have been described as new species (Hutchings and Glasby, 1991). Another study examined populations of *Owenia* (Oweniidae) from Australia and found three major groups of *Owenia* were new species based on morphometrics (Ford and Hutchings, 2005). The study also provided further supporting evidence that the so called 'cosmopolitan species' *O. fusiformis* delle Chiaje, 1841 does not occur in Australian waters. Similarly, Hutchings and Peart (2000) debunked the belief that the 'cosmitolitan' *Terebellides stroemii* Sars, 1835 (Trichobranchidae), originally described from Norway, was widely distributed throughout Australian waters. This species was shown not to occur in Australia and material previously identified as *T. stroemii* was actually four new species (Hutchings and Peart, 2000). Determining the identity of species endemic to Australia will facilitate the assessment of the true conservation value of ecosystems and improve the likelihood of achieving biodiversity conservation.

2.7 Conclusions

Polychaetes play an integral role in the functioning of macrobenthic communities, however, due to exploitation of our marine ecosystems Australia faces a significant loss of essential diversity. Marine parks are being established along Australia's coastal regions, which provides for the zoning of no-take sanctuary zones and habitat protection zones within the marine park. Multiple-use management approach in NSW employs biodiversity conservation as the primary goal, but limited information on the distribution of biodiversity constrains the ability to systematically select and plan conservation networks. The use of physical surrogates in marine conservation planning is gaining momentum and has become heavily relied upon for various reasons such as cost-effectiveness. While there is enormous potential for using physical variables as surrogates to predict biological patterns, it is critical that the correlation between physical variables and biological pattern be assessed. The effectiveness of marine resource management practices depends largely on the complexity and knowledge of a region and the strategies employed. The question remains: How can an environment be conserved when the components that support it are undefined?

This chapter has highlighted the necessity of establishing a network of marine conservation zones to protect Australia's unique biodiversity. It has also illustrated the inconsistencies in the validity of habitat classifications acting as a surrogate for the distribution of marine species and the many taxonomic holes in Australia's species inventory. The need for further research to help fill these holes and ensure MPAs are successful in adequately representing the unique and not wholly understood Australian biota is paramount to ensure the survival of Australia's diverse, distinctive, and environmentally and potentially economically significant marine species.

Chapter 3. Effectiveness of habitat classes as surrogates for biodiversity in marine reserve planning[1]

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[1] Chapter 3 is currently in press:

Dixon-Bridges, K., Hutchings, P. and Gladstone, W. In press. Effectiveness of habitat classes as surrogates for biodiversity in marine reserve planning. *Aquatic Conservation: Marine and Freshwater Ecosystems*, DOI: 10.1002/aqc.2377

Abstract

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 used as they can comprise over one-third of species of benthic infaunal assemblages, they are the most frequent and abundant marine macrofaunal metazoans in benthic environments, and they are a reliable surrogate for other macrobenthic taxa. 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 determinant of assemblage variation than the habitat classes. Using these predictors, an alternative bio-geomorphic scheme to that currently utilised in marine park planning is proposed. This study demonstrates the critical importance of testing assumptions about surrogacy and an approach for refining surrogates.

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Dixon-Bridges, K., Hutchings, P. and Gladstone, W. 2014. Effectiveness of habitat classes as surrogates for biodiversity in marine reserve planning. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **24**: 463-477.
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Chapter 4. The conservation value of soft coral (*Dendronephthya australis*) beds on unvegetated seabed[2]

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[2] Chapter 4 has been written for submission to the journal Hydrobiologia

Abstract

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 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 od *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 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 and uncolonised habitats, and therefore has a high conservation value.

4.1 Introduction

The term ‘ecosystem engineer’ in ecology refers to organisms that create or modify a habitat either structurally, chemically, or ecologically (Berke, 2010; Miller *et al.,* 2012; Passarelli *et al.,* 2012). Epibenthic bivalves, corals and seagrasses are known to be ecosystem engineers (Jones *et al.,* 1997) because their presence enriches and transforms the associated benthic community (Crooks and Khim, 1999; Borthagaray and Carranza, 2007). The occurrence of an ecosystem engineer has the potential to promote or hinder the presence and distribution of other species (e.g. by potentially modifying both habitat and access to resources for other organisms), or their biological activity (e.g. through light penetration/filtration, bioturbation, sediment chemistry) (Zuhlke *et al.,* 1998; Borthagaray and Carranza, 2007; Berke, 2010; Meadows *et al.,* 2012). Transformation in faunal assemblage composition may occur as a direct consequence of the structure created directly by the ecosystem engineer, known as ‘autogenic’ ecosystem engineers, and/or by the structures’ modulation of biotic or abiotic factors, known as ‘allogenic’ ecosystem engineers (Passarelli *et al.,* 2012). The presence of structural ecosystem engineers increases total species richness in an ecosystem by increasing habitat diversity (Borthagaray and Carranza, 2007). This can only be achieved under two conditions: firstly, the engineer species must provide conditions not present elsewhere in the landscape, and secondly, some species must be able to live only in the engineered patches (Wright *et al.,* 2002; Borthagaray and Carranza, 2007). Only if the engineer-created patches are sufficiently different from the surroundings will the addition of an engineer increase species richness at the landscape scale via an increase in habitat diversity (Wright *et al.,* 2002).

Physical properties altered directly by the presence of structural engineers include sediment stratification, currents, and light penetration. Structural engineers act indirectly by altering rates of encounters between predators and prey (via their provision of shelter), topographic relief from currents for invertebrates created by the engineers structure and topographic complexity generated by their structure in an otherwise potentially barren sea floor that provides a unique habitat (Idjadi and Edmunds, 2006; Berke, 2010). Hermatypic corals are archetypical examples of structural ecosystem engineers, forming massive reefs in shallow tropical waters that support upwards of 30% of described marine species (Miller *et al.,* 2012). In two of the largest sea canyons in the world, Zhemchug and Pribilof of the Bering Sea, beds of gorgonian and pennatulacean corals and sponges enhance surface productivity, benthic currents and seafloor topography relative to adjacent bare substrate (Miller *et al.,* 2012). Their presence promotes higher abundances of rockfishes, such as Pacific Ocean perch, sculpins, poachers and pleuronectid flounders. Fishes associated with these biotic structures utilise them as a source of vertical relief and these structures provide prey with shelter from predators. Scleractinian corals on a Caribbean reef harbour a unique diversity of reef associated invertebrates by providing topographic relief from diverse morphologies generated from the coral skeleton (Idjadi and Edmunds, 2006). Generally soft corals are not reef builders but species of the genus *Sinularia* modify their associated environment by laying down a hard skeleton composed of masses of calcite spicules bound together by aragonitic cements that form three-dimensional structures. The enhanced seafloor topographical complexity created by these species supports a unique biodiversity in the sediments surrounding the soft coral (Konishi, 1981; Cornish and DiDonato, 2004). This species therefore acts as an autogenic ecosystem engineer as it modifies the habitat through its physical presence (Konishi, 1981; Cornish and DiDonato, 2004; Miller *et al.,* 2012). Ecosystem engineers therefore increase the conservation value of areas because of their roles in enhancing biodiversity and associated ecological functions (Crain and Bertness, 2006).

In order to establish a relationship between potential ecosystem engineers and their associated biota, studies have employed the method of testing the potential ecosystems influence on all benthic components and testing how the related ecosystem services may be modified. Artificial mimics of polychaete tubes have been used *in situ* to investigate purely physical impacts of the structures to test their potential as a structural engineer (Passarelli *et al.,* 2012). To establish a relationship between an ecosystem engineer and abundance and distribution of invertebrate assemblages, studies have compared the invertebrate assemblage within engineered habitats with locations not so influenced (e.g. Idjadi and Edmunds, 2006). Such studies have demonstrated that variation in benthic diversity can be explained by the presence of an ecosystem engineer (e.g. Idjadi and Edmunds, 2006).

Octocorals (soft corals) occur in almost all marine environments. They are found in all oceans, from the tropics to the poles, from brackish muddy areas to crystal clear marine environments, and from intertidal waters (van Ofwegen, 2005). The region encompassing Indonesia, the Philippines, Malaysia and New Guinea, is assumed to host the greatest species richness of octocorals (van Ofwegen, 2005). The family Nephtheidae currently contains 18 genera, mostly described as bushy, globe-shaped or arborescent in appearance (van Ofwegen, 2012). The nephtheid genus *Dendronephthya* forms colonies which are branched or bushy and usually have a rough or prickly feel from the sclerites. They are usually around 0.2 m high, but can grow up to 2 m (Fabricius and Alderslade, 2001). *Dendronephthya* species are common at depths below 20 m in areas with fast currents, and can also grow in muddy estuaries and deep oceanic waters (Fabricius and Alderslade, 2001). The temperate species *Dendronephthya australis* Kukenthal, 1905, the focus of this study (Fig. 4.1), was initially described from Port Jackson and Port Hacking, Sydney, Australia and was later re-described in more detail with material from Port Stephens, Australia (Verselveldt and Alderslade, 1982).

Figure 4.1: *Dendronephthya australis* habitat, Port Stephens, Australia. Images supplied by David Harasti.

This study was undertaken in a bed of *Dendronephthya australis* within the Port Stephens estuary in the Port Stephens-Great Lakes Marine Park (PSGLMP), New South Wales (NSW), Australia. Here *D. australis* occurs only in areas of strong current, and shallow depths (range 4.5-18 m) close to the shoreline on coarser sediment (Poulos *et al.*, in press). Zoning of marine parks in NSW to represent biological diversity is based on habitat classification schemes. The approach assumes that if a representative sample of all habitat classes present in the planning area is protected within conservation zones, then the biodiversity associated with those habitat classes will also be protected (Ward *et al.,* 1999; Lindsay *et al.,* 2008). The PSGLMP is a 'multiple-use' park where human uses are managed through a zoning plan that came into effect on 1 April 2007. The extensive bed of *D. australis* occurs within a General Purpose Zone (GPZ), within close proximity to a marina, and is at risk from anthropogenic activity such as anchor damage, fishing line entanglement, potential fuel leakage contamination and possibly aquarium collection. A GPZ allows multiple use, including fishing from a boat and trawling, as long as they are ecologically sustainable, however Sanctuary Zones allow for total protection of marine animals, plants and habitat. This is possible by prohibiting any activity such as fishing from a boat, motorised water sports and commercial or private collection that may involve harming any animal, plant or habitat (NSW Marine Parks

Authority, 2001; MPA NSW, 2013). Evidence that the bed of *D. australis* is a distinctive habitat for biodiversity would therefore be useful in future revisions of the zoning plan that attempt to improve protection of biodiversity.

The aims of this study were to determine whether the area occupied by *Dendronephthya australis* contained a distinctive biodiversity and could therefore be classified as a new habitat within the PSGLMP. The approach taken by this study involved a comparison of polychaetes biodiversity and physical environment in the *D. australis* bed with a range of similar, but uncolonised, sedimentary habitats. Polychaetes are a suitable group for testing hypotheses about ecosystem engineers in benthic environments because of their diverse ecological roles. Their assemblages are a critical component of benthic marine ecosystems as they are the numerically dominant macrobenthic taxon, highly speciose and exhibit a diversity of feeding modes and thus trophic positions (Fauchald and Jumars, 1979; Hutchings, 1998; Giangrande *et al.,* 2005; Cardoso *et al.,* 2007). This is especially true for soft-bottom habitats, where the distribution of species is predominantly linked to the sediment particle size and organic content (Giangrande *et al.,* 2005). In comparison to other marine fauna polychaetes are relatively sedentary, can be quantitatively sampled, contain a range of life spans (see Olive and Clark, 1978; Olive, 1984), and represent a variety of niches and life-cycles (Simpson *et al.,* 2005; Surugiu, 2005). Polychaetes also influence surface productivity, transfer energy to higher trophic levels (Giangrande *et al.,* 2005; Simpson *et al.,* 2005) and they are an effective taxonomic surrogate for other groups of benthic fauna (Shokri *et al.,* 2009).

4.2 Methods

4.2.1 Study Area

This study was undertaken in the Port Stephens estuary in the PSGLMP (Fig. 4.2). The putative *Dendronephthya australis* ‘habitat’ covered an area of 800 m^2, in an area otherwise classified as unvegetated sand habitat, and in a depth of 8.2-11.3 m. Three other predetermined unvegetated and uncolonised habitats were sampled. These included subtidal sand (<10% mud, >90% sand at 2–12.6 m depth), mud (>90% mud, <10% sand at 0.8–7.4 m), and muddy/sand (>50% mud, <50% sand at 0.9–4.2 m) (see Roy, 1983). The distributions of the other habitats had been previously mapped as part of the PSGLMP planning process (NSW Marine Parks Authority, 2009). However, at the time of the initial marine park planning the existence of the *D. australis* habitat was unknown.

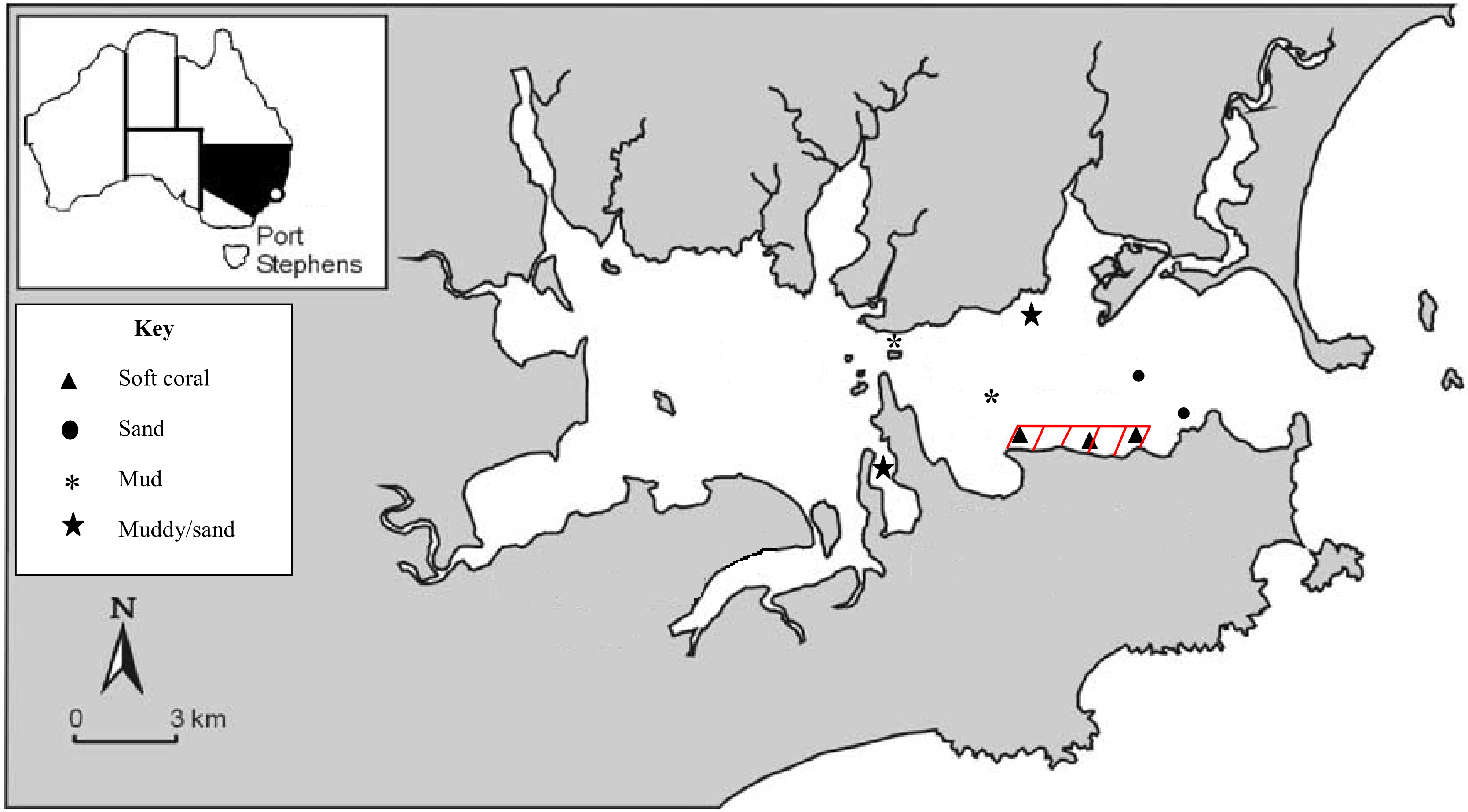


Figure 4.2: Location of study sites within each habitat in the Port Stephens estuary, Port Stephens–Great Lakes Marine Park, NSW, Australia (see Appendix B for site numbers). The area in red indicates the location of *Dendronephthya australis* habitat in the Port Stephens estuary (area of *D. australis* habitat from Poulos *et al.* 2013).

4.2.2 Sampling design and field methods

The hypothesis that the putative *Dendronephthya australis* habitat contained a distinctive assemblage of polychaetes was tested by haphazardly sampling at three replicate sites in the *D. australis* habitat and at two replicate sites within each of the other predetermined habitats (Appendix B) (Roy, 1983; NSW Marine Parks Authority, 2001). Sites were approximately 5 x 5 m, and replicate sites within each habitat were separated by at least 200 m. Sampling occurred on 2 occasions, in February and October 2011 (Appendix C and D). Five replicate samples of sediment were taken from each site using a 0.005 m^3 Van-Veen grab to collect benthic macrofauna (Appendix G). In the case of a misfire where a sample was not to capacity the sample was discarded and another taken to ensure uniformity between each sample and each habitat. A diver was used in the soft coral sites to help guide the grab and avoid damage to the soft corals. This method also ensured that the grabs were deployed away from the edges of the habitat to avoid possible edge effects. Mesh bags of 1 mm mesh size were used to retain and sieve each sample. The biological specimens retained in the bag after sieving were fixed in 5% formalin (buffered with 35 ppt seawater) containing Rose Bengal stain. Although unvegetated and uncolonised habitats were predetermined, the hypothesis that the physical features of the putative unvegetated *D. australis* habitat differed from the unvegetated and uncolonised habitats was tested by collecting an additional sediment sample from each site for analysis of current sediment physico-chemical properties during the October sampling period (Appendix G). Note that vegetated habitats were moderately dense but did contain small patches of unvegetated sediment. Sediment samples were frozen and stored at −20◦C prior to analysis. The depth in the mid-point of each site (to the nearest 0.1 m) was also recorded.

4.2.3 Laboratory analyses

Polychaetes were separated and transferred to 70% ethanol and identified to species where possible and deposited in the Australian Museum (see Appendices E and F).

The total organic matter (% total sample weight) and carbonate (% total sample weight) content of sediment were determined using the sequential loss on ignition method (See Appendix G) (Dean, 1974). The proportions of different sediment grain sizes present at each site were determined by sieving sediment samples (after drying at 60^0C for 72 h) through an agitated stack of Endecott sieves (apertures of 6.3 mm, 4.75 mm, 3.35 mm, 2 mm, 1 mm, 0.6 mm, 212 μm, 63 μm, <63 μm) and weighing (to the nearest 0.01 g) the sample retained on each sieve (See Appendix G) (Australian Standard, 1977).

4.2.4 Statistical analyses

Three-factor non-parametric multivariate analysis of variance (PERMANOVA) (Anderson, 2001; McArdle and Anderson, 2001) was used to test the hypothesis relating to the structure of the polychaete assemblage in the putative *Dendronephthya australis* habitat using the following model: habitat was treated as a fixed, orthogonal factor with 4 levels (the putative *D. australis* habitat and the 3 unvegetated habitats); site was treated as a random factor nested in habitat; and time was treated as a fixed, orthogonal factor. Analyses were undertaken with PRIMER 6 and PERMANOVA+ software (Primer-E). The 3-factor PERMANOVA was based on a Bray–Curtis similarity matrix of square-root transformed abundance data. Seven samples contained no polychaetes, and these came from one site of the mud habitat in the first sampling period (n=3), one site from the muddy sand habitat in the first sampling period (n=3), and from one site in the sand habitat in the second sampling period (n=1). These samples were eliminated from the data set for the assemblage analyses because they represented a small proportion (7.8%) of the total number of samples and occurred in different habitats and different times (Clarke and Gorley, 2006). PERMANOVA is sensitive to differences in the variability of groups of samples and so the PERMDISP routine was used to investigate the relative variability of groups of samples for factors that were significantly different.

Non-metric multidimensional scaling (nMDS) ordination plots (based on the average abundance of each polychaete species in each site) were used to visualise the relative dissimilarity of assemblages. Species responsible for dissimilarity in the assemblage structure of polychaetes were determined with the similarity percentages routine (SIMPER) in PRIMER. Two criteria were used to determine species that were underlying significant dissimilarity between 2 groups: (1) species with large values (i.e. >1) of the ratio δ_i/SD(δ_i) (where δ_i is the average contribution of the *i*th species to the overall dissimilarity [δ] between 2 groups and SD is standard deviation) (Clark 1993), and (2) species with δ_i >5% (Terlizzi *et al.,* 2005).

The same 3-factor model in PERMANOVA was also used to test the hypothesis for the number of polychaete species and total abundance of polychaetes. Homogeneity of variance of both variables was tested prior to PERMANOVA (Anderson, 2001) by Cochran's C-test. Euclidean distance was used as the measure of similarity.

The hypothesis relating to the physical features of the putative *Dendronephtya australis* habitat and the 3 unvegetated habitats was tested by 1-factor PERMANOVA. The factor habitat was analysed as a fixed factor with four levels (the putative *D. australis* habitat and the 3 unvegetated habitats). The single samples of sediment collected in each site were pooled to give n=3 samples in the *D. australis* habitat and n=2 samples in the other habitats. Data for the 12 variables (9 sediment fractions (expressed as a % total sample weight), total organic (%) content, carbonate (%) content, and depth (in metres) were log(X+1) transformed, then normalised, and used to construct a Euclidean distance matrix.

4.3 Results

4.3.1 Polychaete diversity

A total of 1143 polychaetes were collected, including 582 in the first sampling period and 561 in the second (See Appendices D and E). A total of 110 species were recorded, including 69 species (29 families) in the first sampling period and 87 species (33 families) in the second sampling period. Sampling in February 2011 (first sampling period) recorded 73 species in *Dendronephthya australis* habitat, 35 species in sand habitat, 21 species in mud habitat and 19 species in muddy/sand habitat (three replicate sites of the *D. australis* habitat, and two replicate sites of the other habitats, were sampled). October 2011 (second sampling period) contained 72 species in *D. australis* habitat, 36 species in sand habitat, 36 species in mud habitat and 45 species in muddy/sand habitat. Spionidae was the most speciose family, with 8 and 15 species recorded in the first and second sampling periods respectively. Spionidae was also the most numerically abundant family in the *D. australis* habitat, particularly *Spio pacifica* with 201 and 74 total individuals collected in the first and second sampling periods respectively. The family Poecilochaetidae was only recorded in the *D. australis* habitat during both sampling periods. The families Goniadidae and Polynoidae were absent from the soft coral habitat, and present in all other habitats, in both sampling periods.

4.3.2 Polychaete assemblage variation

Polychaete assemblages of the *Dendronephthya australis* habitat differed significantly from other habitats in both the February 2011 sampling and October 2011 sampling periods, and assemblages of the other habitats did not differ (Table 4.1, Fig. 4.3). Habitats clustered into distinct groups on the nMDS ordination based on similarity in the structure of polychaete assemblages: mud and muddy/sand habitats were distributed to the right, the *D. australis* habitat occurred in the centre, and the sand habitat occurred on the left of the ordination plot (Fig. 4.3).

Table 4.1: Summary of: a) PERMANOVA results testing for differences in polychaete assemblages among habitats, sites within habitats, and at different times (*P*-values were calculated from permutation of residuals under a reduced model, n=9999 permutations); b) pairwise *t*-tests among habitats.

a)

Source of variation	df	MS	Pseudo-*F*	*P*(perm)
Time	1	15437	2.42	0.05
Habitat	3	15419	2.15	0.01
Site (Habitat)	5	7349.4	2.85	<0.001
TimexHabitat	3	7829.6	1.21	0.28
TimexSite (Habitat)	5	6597	2.56	<0.001
Residual	66	2574.9		

b)

Groups	*t*	*P*(perm)
D. australis, Sand	1.50	0.04
D. australis, Mud	1.51	0.02
D. australis, Muddy/Sand	1.60	0.01
Sand, Mud	1.46	0.07
Sand, Muddy/Sand	1.57	0.05
Mud, Muddy/Sand	0.83	0.75

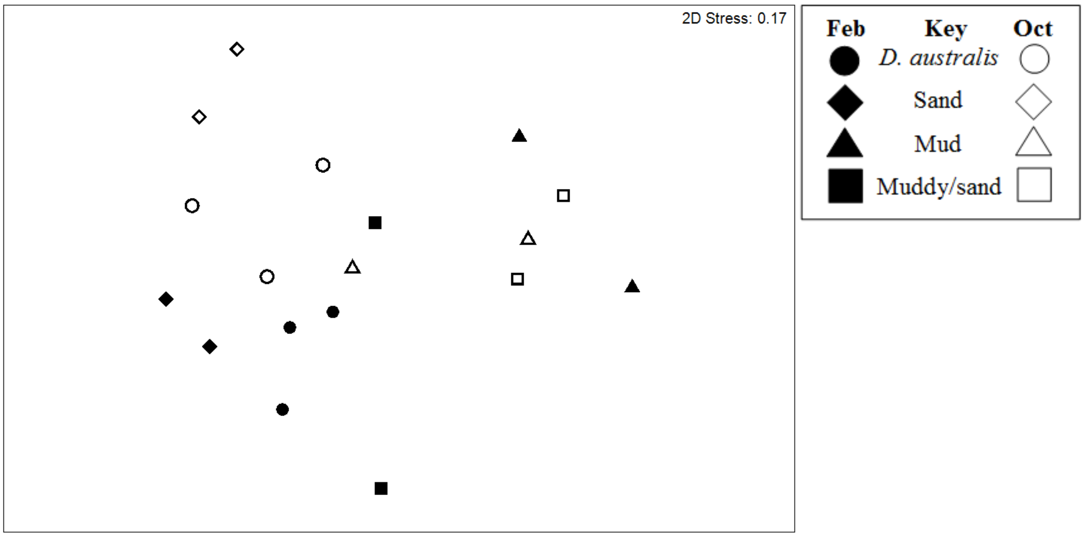


Figure 4.3: MDS ordination plot depicting variation in polychaete assemblages among sites (depicted by the replicate symbols) within four habitats in the Port Stephens estuary, Port Stephens-Great Lakes Marine Park in February and October 2011. Ordination based on data of mean abundance of each species in each site.

Habitats differed significantly in their variability (PERMDISP $F_{3,80}$=5.23, P_{perm}=0.008). This was caused by the assemblages of the sand habitat being significantly more variable than *Dendronephthya australis* (t=2.22, P_{perm}=0.04), mud (t=3.70, P_{perm}=0.001), and muddy sand (t=3.47, P_{perm}=0.001).

The significant TimexSite (Habitat) interaction occurred because assemblages in some sites in some habitats (but not all) varied significantly between sampling periods. Assemblages at two sites in the *Dendronephthya australis* habitat, both sites in the sand habitat, one site in the mud habitat, and both sites in the muddy/sand habitat differed between the two sampling periods (Fig. 4.3).

SIMPER analysis found that differences in the abundance of four species were responsible for differences in the polychaete assemblages of the *Dendronephthya australis* habitat and other habitats (Table 4.2). Differences in the abundance of *Spio pacifica* (Spionidae) were responsible for differences in the assemblage structure of *D. australis* and all other habitats, with this species occurring in higher abundance in *D. australis* habitat. Also *Mediomastus australiensis* (Capitellidae) influenced differences in polychaete assemblage structure, occurring at greater abundance in *D. australis* habitat compared to mud habitat, and at a reduced abundance in *D. australis* habitat compared to muddy/sand habitat. *Lumbrineris* cf *latreilli* (Lumbrineridae) was also responsible for differences in the polychaete assemblage structure of *D. australis* compared to sand (Table 4.2), occurring at a greater abundance in sand habitat.

Table 4.2: Summary of SIMPER results showing the five most influential species responsible for dissimilarity in assemblage structure of polychaetes between the *Dendronephthya australis* soft coral habitat and other habitats.

Comparison	**Overall av. dissimilarity**	**Most influential species**	**Av. dissimilarity**	**Av. contribution /SD**	**% contribution**	**Av. abundance in *D. australis* habitat**	**Av. abundance in compared habitat**
D. australis vs. sand	85.8	*Lumbrineris* cf *latreilli*	10.38	1.09	12.1	0.29	2.11
		Spio pacifica	8.35	1.15	9.73	1.87	1.33
D. australis vs. mud	91.57	*Spio pacifica*	9.02	1.09	9.84	1.87	0.24
		Mediomastus australiensis	5.75	0.93	6.28	0.86	0.84
D. australis vs. muddy/sand	92.67	*Spio pacifica*	9.54	1.07	10.3	1.87	0.18
		Mediomastus australiensis	6.86	0.95	7.4	0.86	1.01

4.3.3 Species richness and total abundance of polychaetes

Average polychaete total abundance and average species richness did not differ between the *Dendronepthya australis* habitat and other habitats (Table 4.3, Fig. 4.4). The significant TimexSite (Habitat) interaction occurred for both polychaete abundance and richness because these variables changed significantly between the two sampling periods in some sites in some habitats (but not all). Polychaete abundance changed significantly between sampling periods in one site of *D.*

australis habitat, whereas species richness did not change significantly in any site. Total abundance of polychaetes changed significantly in one site within the sand habitat, whereas both sites in the sand habitat did not vary in species richness. Total abundance, but not species richness, changed significantly in both sites in the mud habitat. One site in the muddy/sand habitat differed between the two sampling periods in both polychaete abundance and richness (Table 4.3, Fig. 4.4).

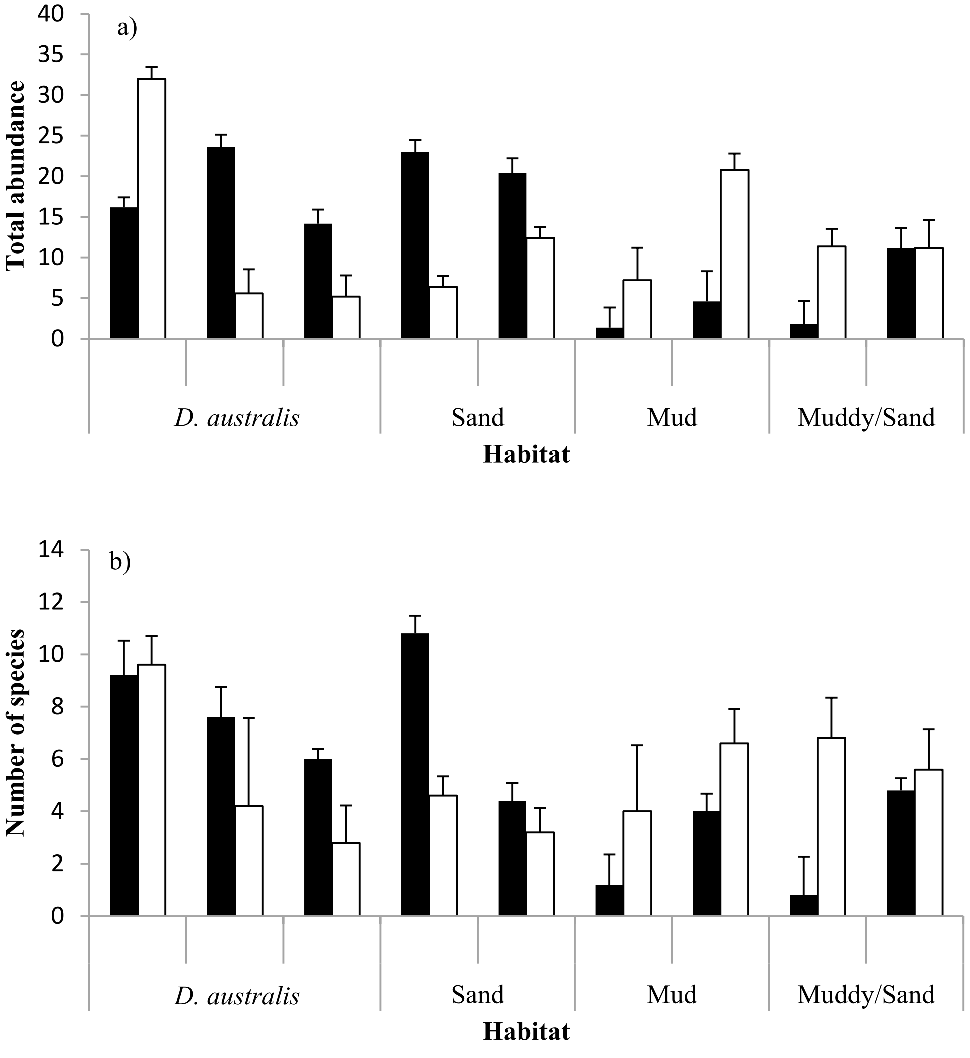


Figure 4.4: Total abundance (a) and species richness (b) of polychaetes in replicate sites within the *Dendronephthya australis* and other habitats in the Port Stephens estuary, Port Stephens-Great Lakes Marine Park. Values for each site are mean+standard error (n=5). Sampling occurred in February 2010 (black) and October 2010 (white).

Table 4.3: a) Summary of PERMANOVA results testing for differences among habitats, sites within habitats, and at different times, in total polychaete species richness and polychaete abundance. *P*-values were calculated from permutation of residuals under a reduced model (n=9999 permutations). Analyses were done on untransformed data (results of Cochran's *C* test are shown; b) results of pairwise *t*-tests for the time x site(habitat) interaction for differences in total abundance and species richness of sites (habitats) between the two sampling periods.

a)

		Abundance (*C*=0.16, *P*>0.16)			Richness (*C*=0.14, *P*>0.05)		
Source of variation	df	MS	Pseudo-*F*	*P*(perm)	MS	Pseudo-*F*	*P*(perm)
Time	1	44.82	0.07	0.81	82.26	3.43	0.13
Habitat	3	802.46	1.33	0.38	54.59	0.70	0.59
Site (Habitat)	5	604.43	5.54	<0.001	77.80	7.95	<0.001
TimexHabitat	3	538.02	0.78	0.55	40.59	1.69	0.28
TimexSite (Habitat)	5	688.67	6.31	<0.001	23.96	2.45	0.04
Residual	72	109.06			9.78		

b)

		Abundance		Richness	
Habitat	Site	*t*	*P*(perm)	*t*	*P*(perm)
D. australis	1	4.94	0.01	2.26	0.07
D. australis	2	2.32	0.05	0.82	0.50
D. australis	3	1.41	0.23	1.01	0.40
Sand	1	3.09	0.02	1.19	0.32
Sand	2	0.39	0.68	1.09	0.45
Mud	1	2.98	0.03	3.52	0.05
Mud	2	3.72	0.02	2.54	0.05
Muddy/sand	1	2.02	0.03	3.14	0.02
Muddy/sand	2	0.05	0.98	1.71	0.16

4.3.4 Physical attributes of habitats

The multivariate set of physical variables did not differ among the four habitats (Pseudo-$F_{3,5}$=2.58, P=0.06). The nMDS ordination plot shows that habitats were not consistently separated and there was considerable variation within habitats in their physical attributes (Figs. 4.5 and 4.6). There was considerable variation in the physical attributes of sand and muddy/sand (as shown by the distances between replicate samples) and similarity between some replicates of mud and muddy/sand, and of *Dendronephthya australis* and muddy/sand (as shown by the proximity of some replicates from each habitat).

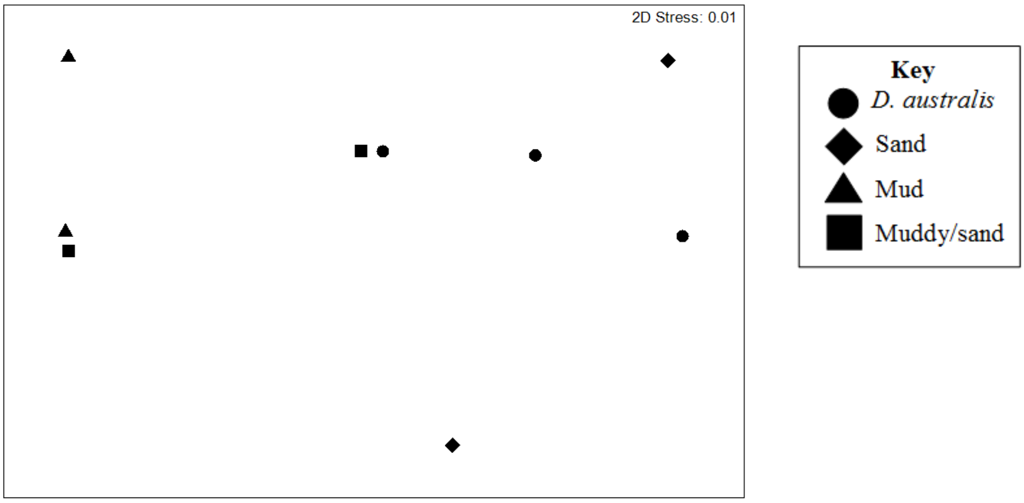


Figure 4.5: MDS ordination plot depicting variation in multivariate composition of the physical characteristics of habitats (depicted by the replicate symbols) within the Port Stephens estuary, Port Stephens-Great Lakes Marine Park.

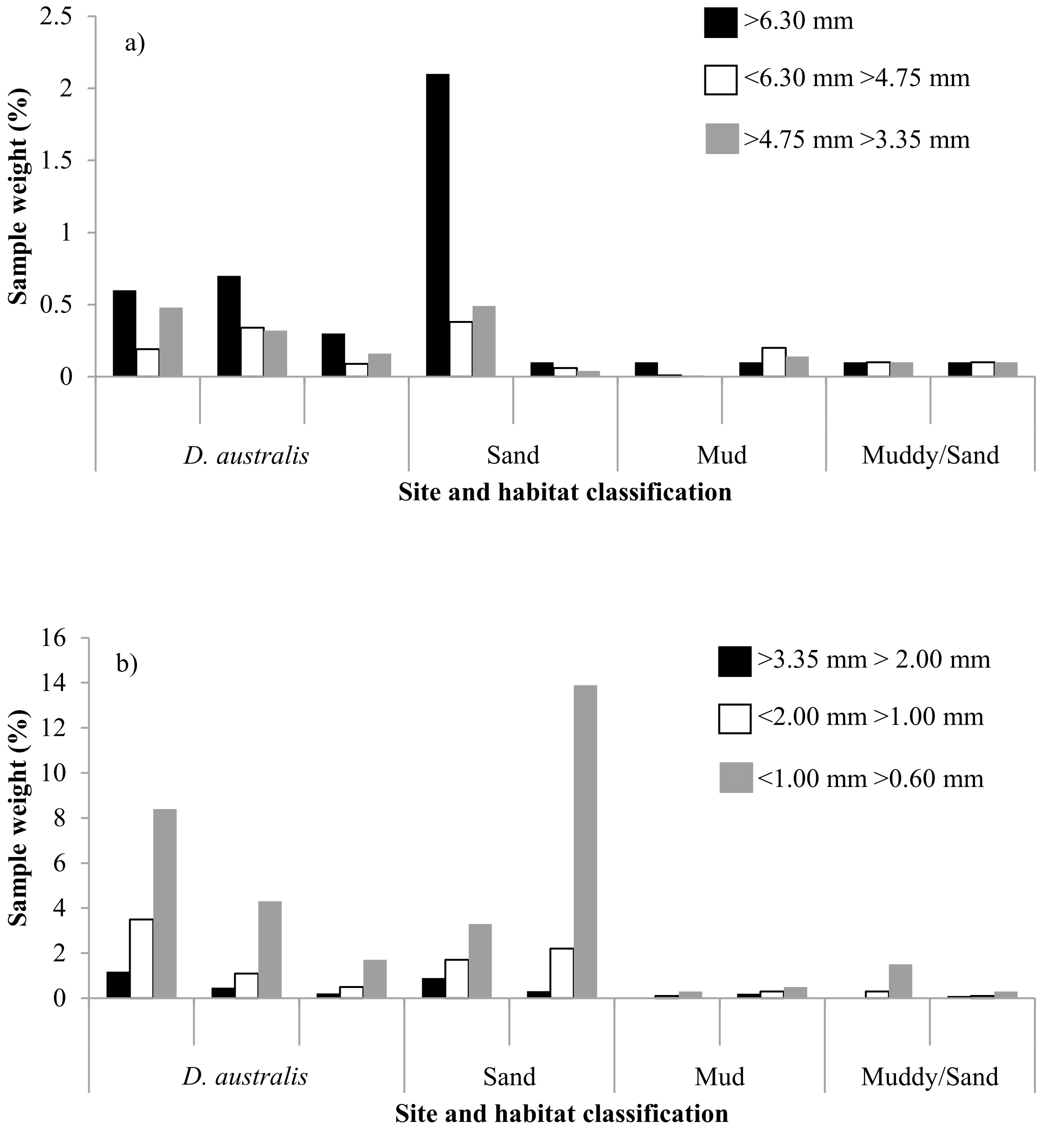
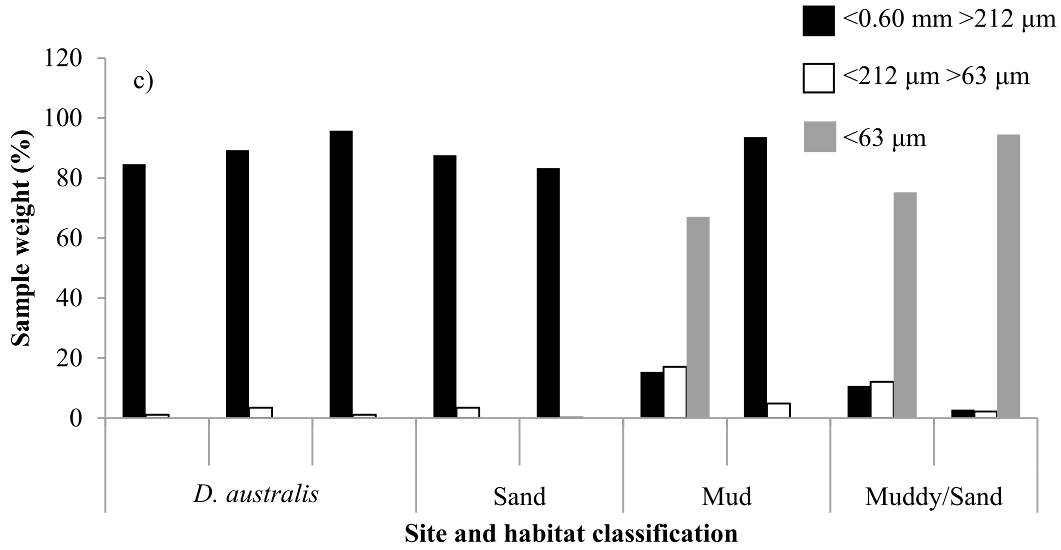


Figure 4.6: Comparison of the physical attributes of the *Dendronephthya australis* habitat and the current physical attributes of the other habitats tested in the Port Stephens estuary, Port Stephens-Great Lakes Marine Park from October 2011. The variables shown are: sediment particle size (a, b, c), $CaCO_3$ content (d), total organic carbon content (e) and depth (f).



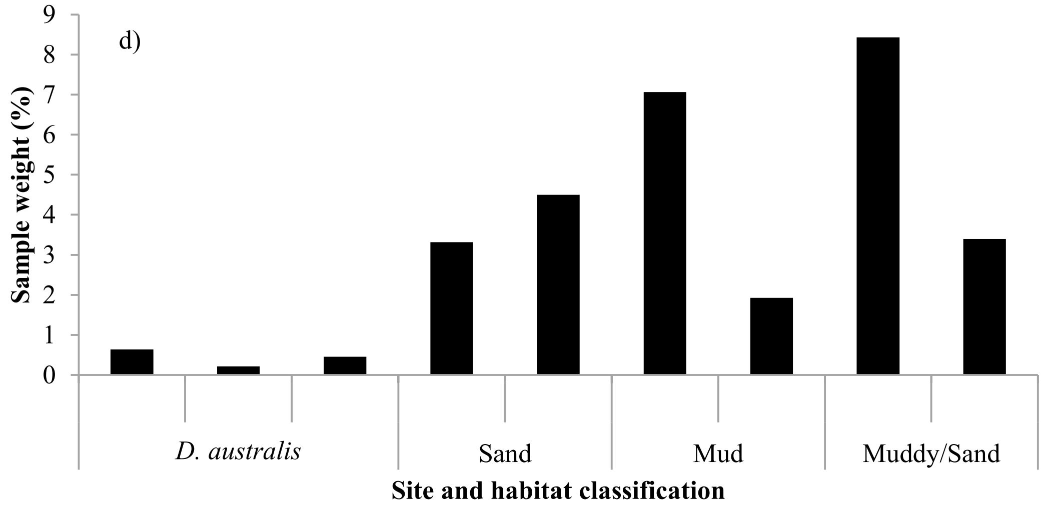
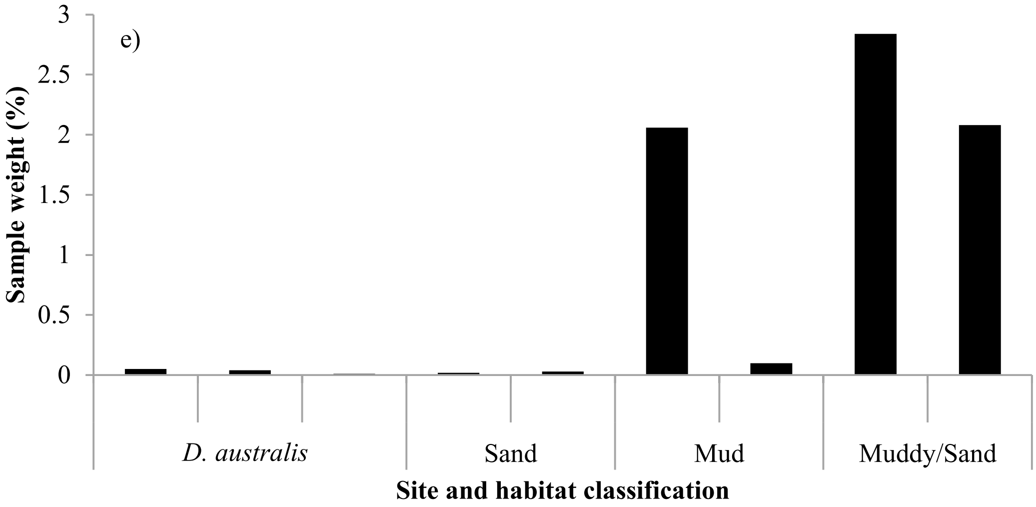


Figure 4.6 cont.: Comparison of the physical attributes of the *Dendronephthya australis* habitat the current physical attributes of the other habitats in the Port Stephens estuary, Port Stephens-Great Lakes Marine Park in October 2011. The variables shown are: sediment particle size (a, b, c), $CaCO_3$ content (d), total organic carbon content (e) and depth (f).



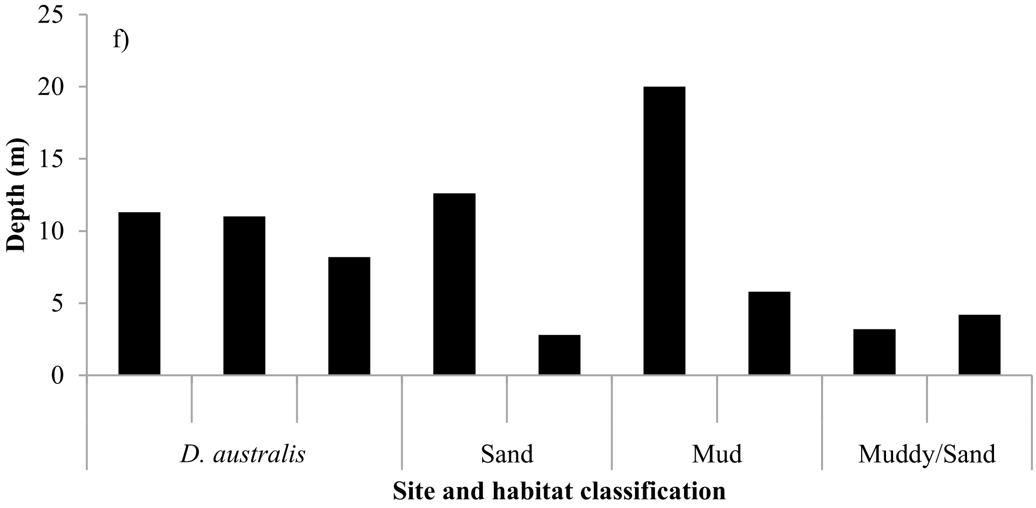


Figure 4.6 cont.: Comparison of the physical attributes of the *Dendronephthya australis* habitat and other habitats in the Port Stephens estuary, Port Stephens-Great Lakes Marine Park. The variables shown are: sediment particle size (a, b, c), $CaCO_3$ content (d), total organic carbon content (e) and depth (f).

4.4 Discussion

4.4.1 Dendronephthya australis as a distinctive habitat

Dendronephthya australis colonies occur along a narrow depth contour of the southern shoreline in the Port Stephens estuary between Fly Point and Corlette Point, covering a total area of 4.8 ha (see. Fig 4.1, Poulos *et al.,* 2013). This study has found that beds of this soft coral can be regarded as providing a distinctive habitat within the Port Stephens estuary (Bunce *et al.,* 2013). In the strict sense of the term, habitat is defined as a place where an organism lives (Syms and Kingsford, 2008) however there are several ecological influences at play when determining a habitat. Therefore habitat has often been defined as the spatial extent of a resource for a particular species; or a zone comprising a set of resources, consumables and utilities, for the maintenance of an organism (Bunce *et al.,* 2013).

The unvegetated *Dendronephthya australis* habitat contained a distinct assemblage of polychaetes compared to unvegetated and uncolonised habitat sampled within the Port Stephens estuary. Polychaete assemblage from *D. australis* habitat differed significantly from unvegetated and uncolonised habitats in both the February 2011 and October 2011 sampling periods, whereas polychaete assemblages of all the unvegetated and uncolonised habitats did not differ. Although richness varied, polychaete abundance did not vary between habitat classes tested in this study. This finding was also demonstrated in a previous study from 2009 testing all habitats within the Port Stephens estuary with the exception of the previously unknown *D. australis* habitat (see Dixon-Bridges *et al.,* 2013). A similar study was undertaken on the same *D. australis* habitat assessing fish and macroinvertebrate biodiversity associated with the *D. australis* habitat and sponge, seagrass and unvegetated sand habitats (Poulos *et al.,* 2013). Multivariate fish assemblages associated with soft corals were significantly different to those associated with nearby sponges, seagrass and sand habitats, with species richness of fishes and invertebrates significantly higher in soft coral and sponge habitats than seagrass (Poulos *et al.,* 2013). Both the results from Poulos *et al.* (2013) and this study support that *D. australis* is a unique habitat within the estuary. Polychaete abundance within each habitat tested varied significantly, whereas richness remained similar within *D. australis* and sand habitats. Species abundance is expected to vary greatly within habitats both spatially and temporally (Syms and Kingsford, 2008), whereas species richness remained similar within *D. australis* and sand habitats.

While this study shows that *Dendronephthya australis* is providing a unique habitat for polychaete species within Port Stephens, these findings are also likely to reflect other benthic invertebrate taxa (Olsgard *et al.,* 2003; Papageorgiou *et al.,* 2006; Cardoso *et al.,* 2007; Włodarska-Kowalczuk and Kędra, 2007; Shorkri *et al.,* 2009). This is because spatio-temporal patterns in measures of polychaete biodiversity co-vary with other benthic taxa (Papageorgiou *et al.,* 2006; Shorkri *et al.,* 2009). For example, spatial patterns in species richness, assemblage variation and total abundance of annelids were found to be significantly correlated with the spatial patterns and total abundances of other species in a Southeast Australian estuary (Shokri *et al.,* 2009b). However, community patterns in multivariate assemblages of polychaetes and other macrofauna was mainly spatial rather than temporal in the mid- and sublittoral ecosystems of microtidal Mediterranean sandy shores (Papageorgiou *et al.,* 2006). Differences between the two patterns were explained to have potentially arisen from the different responses that polychaetes may show to environmental stress arising from major disturbance from a winter storm relatively shortly before sampling was carried out.

4.4.2 Polychaetes of the Dendronephthya australis habitat

A total of 110 polychaete species representing 34 families were recorded during this study within the Port Stephens estuary. This study also provided the first insight into the polychaete fauna associated with the rare soft coral *Dendronephthya australis* habitat. The polychaete assemblage occurring in the *D. australis* habitat included the families Poecilochaetidae and Spionidae, with 8 and 15 species recorded from the latter family in each sampling period respectively. This is the first known record of the family Poecilochaetidae within Port Stephens according to records of the Australian Museum and this family has only been found in Port Stephens in conjunction with *D. australis.*

The *Dendronephthya australis* habitat contained the greatest abundance of the family Spionidae, with *Spio pacifica* consistently occurring in higher abundance within *D. australis* habitat compared to all other habitats, which contributed to a significantly different polychaete assemblage inhabiting the *D. australis* habitat. Differences in the abundances of *S. pacifica*, *Mediomastus australiensis* (Capitellidae) and *Lumbrineris* cf *latreilli* (Lumbrineridae) were shown by SIMPER analysis to be driving the dissimilarity between the *D. australis* habitat and all other habitats. *Mediomastus australiensis* (Maldanidae) occurred at a greater abundance in *D. australis* habitat compared to mud habitat, and at a reduced abundance in *D. australis* habitat compared to muddy/sand habitat and *L. latreilli* was more abundant in sand. Polychaete assemblages are composed of species that utilize sediments in a multitude of ways. Maldanids are mostly non-selective deposit-feeders (Glasby *et al.,* 2000) and lumbrinerids have been reported to include herbivores, carnivores and deposit-feeders (Fauchald and Jumars, 1979). In both sampling periods spionids dominated polychaete numbers within the *D. australis* sites, and were shown to be significantly higher in abundance compared to all other habitats. Many surface deposit-feeding polychaetes such as spionids, reduce the amount of the organic matter accumulated in the sediment with the organic detritus being strongly transformed and incorporated as their own biomass. In this way polychaetes hasten the circulation of the organic matter from the water column and the sediments into their food chain, without being mineralised (Surugiu, 2005). Some species of spionids are known to alternate between two modes of feeding, deposit- and suspension-feeding, depending on environmental conditions (Glasby *et al.,* 2000). A study using spionids investigated the influence of palp size on particle contact in particle size selection (Hentschel, 1996). It was found that juvenile spionids spent more time suspension feeding relative to deposit feeding to increase diet quality and overcome the combined digestive and deposit-feeding constraints imposed by small gut and palp size (Hentschel, 1996).

Whilst the *Dendronephthya australis* habitat differed principally in quantitative ways to the other habitats, four individuals of the polychaete family Poecilochaetidae were also *only* found within the *D. australis* habitat during both sampling periods. Very little is known on this family, particularly in Australia, but it is presumed that both suspension- and deposit-feeding occurs in the family; the grooved palps that are normally held above the sediment are used for both methods of feeding (Glasby *et al.* 2000). Conversely, the polychaete families Goniadidae and Polynoidae were absent from *D. australis* habitat and present in all other habitats. These families are considered to be carnivorous (Fauchald and Jumars, 1979; Glasby *et al.*, 2000). Further investigation is required to determine the reasons *D. australis* formed a distinctive habitat for certain polychaete species, in particular the influence of this habitat on relevant ecological processes.

4.4.3 Dendronephthya australis as an Ecosystem Engineer

While there is little known of ecology of *Dendronephthya australis* (see Cornish and DiDonato, 2004), its presence provides habitat to a unique assemblage of polychaete species within the Port Stephens estuary. The multivariate set of physical variables did not differ among the four sampled habitats, indicating the difference in polychaete assemblage structure between the unvegetated and uncolonised habitats and the *D. australis* habitat cannot be attributed to variation in the measured sediment physico-chemical attributes and depth. The difference could therefore be due to the physical presence of the *D. australis* colonies, and/or some other unmeasured environmental attribute that is being modified by the soft corals. This is the action of an ecosystem engineer (Wright *et al.,* 2002). Although this study did not examine the presence of commensal species, it should be noted that polychaete species have previously been found to show complex relationships with ecosystem engineers. Examples of the influence of an ecosystem engineer on polychaetes species include the relationships between *Eunice norvegica* and *Harmothoe oculinarium* with coral polyps. These species are seldom found in other habitats and *E. norvegica* lives in a close relationship with the coral species *Lophelia pertusa* (Mortensen, 2001). The coral precipitates calcium carbonate around the parchment-like tube of the polychaete. After years of skeletal growth, the polychaete has a tube with several openings close to a polyp in order to collect food spills and removes organic particles from the corals surface (Mortensen, 2001). It also removes organisms invading or colonising its territory (Mortensen, 2001). *H. oculinarium* lives as a commensal inside the tube of *E. norvegica*.

Marine communities are structured by complex interactions among biotic and abiotic processes (Siebert and Branch, 2006). Autogenic and allogenic engineers can potentially provide living space, alter and ameliorate physical conditions, and affect biological interactions. These can enhance diversity and change patterns of species composition and dominance on local or landscape scales (Miller *et al.,* 2012). At a local scale, the morphology of organisms shape the environment by, for example, modifying hydrodynamics, providing shelter and microhabitats, and providing pockets with trapped particles and detritus for feeding (Buhl-Mortensen *et al.,* 2010). Porifera (sponges) play a key role in a host of ecological processes through their high diversity, large biomass, complex physiology and chemistry (Buhl-Mortensen *et al.,* 2010). Ecological processes influenced by sponges include space competition, habitat provision, predator-prey relationships, chemical defence, primary production, nutrient cycling, nitrification of sediments, food chain interactions, bioerosion, mineralisation, and cementation (Rützler, 2004). While other ecosystem engineers, such as sponges, are known to ameliorate physical conditions, variables tested in this study did not differ between the *D. australis* habitat and other habitats. Potentially, other unmeasured environmental variables driven by the presence of *D. australis* are causing this habitat to host a unique assemblage of polychaetes. The distribution of benthic polychaete species is associated not only with habitat, but also by depth, salinity and sediment characteristics such as particle size and organic content (Pocklington and Wells, 1992; Hutchings, 1998; Giangrande *et al.,* 2005; Surugiu, 2005). Salinity was not measured in this study; however all sites were relatively close together within the estuary.

Ecosystem engineers also affect biological interaction. For example, an autogenic engineer may modify the interactions between predator and prey species by providing shelter. Engineers may also facilitate the feeding of some species (Buhl-Mortensen *et al.,* 2010). For example, sea pens act as autogenic engineers. They grow to heights of 0.1-2 m above the sediment surface, providing an elevated position for particle collection by associated ophiuroids (Buhl-Mortensen *et al.,* 2010). Their presence also provides shelter against predation to prey species (Buhl-Mortensen *et al.,* 2010). Similar to this study, another study found this rare soft coral habitat of *D. australis* supported a distinctive biotic assemblage, and may be potentially providing a valuable source of food and shelter for fishes and invertebrates (Poulos *et al.*, 2013). As an autogenic engineer, the specialised structures of soft coral, known as sclerites, may provide support and protection for prey species and act as a deterrent against predators (Fabricius and Alderslade 2001).

4.4.4 Spatial and temporal variation in polychaete assemblages

Polychaete species richness and total abundance varied in complex ways that were unrelated to the presence of the *Dendronephthya australis* habitat, with both variables exhibiting significant Time x Site(Habitat) interactions. Similar to this study, small scale spatio-temporal variation has been demonstrated in other marine community studies (for example: Morrisey *et al.,* 1992a,b; Bergström *et al.,* 2002;

Barnes and Ellwood, 2012; Dixon-Bridges *et al.,* 2013). Smaller scale species interactions are considered to be most important within macrobenthic community dynamics (e.g. Pearson and Rosenberg, 1987; Thrush, 1991) as large proportions of the variability in diversity and abundances of soft sediment species occur at spatial scales ranging from centimetres to metres (Bergström *et al.,* 2002). Variability also occurs on a temporal scale, with benthic assemblage variation occurring over different time scales from days to weeks to decades to centuries (Morrisey *et al.,* 1992b; Bergström *et al.,* 2002). For example, seasonal variability driving environmental influences (e.g. precipitation patterns) is known to be important in causing variation within macrobenthic assemblages (e.g. Mesa *et al.,* 2009).

Patterns in ecological communities are often scale-dependent, with separate processes operating at different scales (Bergström *et al.,* 2002). Estuaries, as highly dynamic ecosystems, experience considerable temporal variation in their hydrological and biodiversity characteristics (Hutchings, 1999; Dauer *et al.,* 2008). The temporal variation of macrobenthos within estuaries has been related to changes in freshwater flow, salinity (related to tidal influences), anthropogenic activity, recruitment and seasonal biological and chemical fluctuations within the environment (Rozas *et al.,* 2005; Hourston *et al.,* 2011). For example, a ‘pulse’ event, or short-term disturbance such as a storm, can result in short-term faunal assemblage variation (Papageorgiou *et al.,* 2006) and a long-term or ‘press’ event such as an oyster farm can result in long-term faunal assemblage change (Crawford *et al.* 2003).

Habitat structural complexity within sites, food availability, settlement and recruitment are all mechanisms found to drive small-scale spatial variation in macrobenthic assemblages (Morrisey *et al.,* 1992a; Barnes and Ellwood, 2012). Local differences, on a scale of metres, in wave action resulted in site-specific colonisation of macrobenthic communities (Hewitt *et al.,* 2003). The strength and duration of the macrofaunal response to deposited sediment suggested that chronic small-scale (metres) patchy deposition of terrestrial sediment in the intertidal marine environment had a strong potential to alter both habitats and communities. Like the study by Hewill *et al.* (2003), results from spatial analysis of habitats from Port Stephens showed small scale variability, as sites sampled within habitats showed varying polychaete abundance and richness. On a scale of months, polychaete abundance varied in most habitats tested. This was also demonstrated in a study testing temporal variation on a scale of months on a nearshore benthic community in Southern Brazil (Paiva, 2001). Variation in these communities presented a complex pattern in benthic community parameters (e.g. abundance, diversity, evenness).

4.4.5 Conservation value of the Dendronephthya australis habitat

Biodiversity loss has been shown to contribute to a reduction in ecosystem services, and this is evident in the rapid decline often observed at regional scales within ecosystems such as estuaries and coastal reefs (Worm *et al.,* 2006). Marine protected areas (MPAs) are an effective method for protecting marine environments and biodiversity, sustaining productivity of marine resources, and managing conflicting uses (Edgar and Stuart-Smith, 2009; Lester *et al.,* 2009; Babcock *et al.,* 2010). A national system of MPAs, which include marine parks, aquatic reserves and marine components of national parks, is being established in Australia under the National Representative System of Marine Protected Areas to conserve representative examples of Australia’s marine biodiversity (Voyer *et al.,* 2012). Unfortunately, limited information on the distribution of biodiversity constrains the ability to systematically select and plan networks of marine reserves to conserve biodiversity (Gladstone, 2002; Hermoso *et al.,* 2013). In the design of MPAs, representation of all habitat types is a major criterion for selection of candidate areas, and the drawing of management boundaries is adopted (Stevens and Connolly, 2005). This is based on the theory that the identification of habitats defined by abiotic (physical and chemical) attributes should allow the identification and monitoring of the biotic components of the system.

The existence of the *Dendronephthya australis* habitat was unknown within the Port Stephens-Great Lakes Marine Park when it was declared on the 1st December 2005 (D. Harasti *pers. comm.*). As a result, this habitat was not included within the Park’s conservation zoning scheme and it is therefore currently categorized as general purpose. This means that a variety of activities, such as trawling, are allowed there. Trawling has been likened to clear felling (Watling and Norse, 1998) in which the seafloor is reduced to a muddy landscape with the 3-dimensionality removed (Hutchings, 1990). In the Great Barrier Reef the cumulative effects of frequent trawls over the same locality may be substantial, for example the faunal assemblage composition in frequently trawled locations is substantially altered (Pitcher *et al.*, 2000). This is because fauna vary in their ability to recover from disturbance, from being vulnerable to tolerant species. Differential vulnerability within assemblages in impacted localities will result in a shift to less vulnerable species and fauna with no capacity for recovery will eventually be completely removed from all trawled areas (Pitcher *et al.,* 2000).

Decisions on the location and extent of MPAs require the elucidation of a conservation goal, and criteria to assess the relative contribution of areas to the achievement of the conservation goal (Margules and Pressey, 2000). By quantifying the ‘conservation value’ of locations in a planning area it will improve determining the conservation significance of that location and help prioritise conservation zoning within a marine park. Criteria for conservation value include such features as rarity, endemism, diversity, representativeness, size, conservation status of species and naturalness (Margules, 1986; Gladstone, 2002). The presence of a unique habitat will provide invaluable information for management and add significantly to the conservation value of a location. This is largely attributed to the relationship between habitat-forming species with processes maintaining local and regional biodiversity (Borthagaray and Carranza, 2007). Currently the existence of *D. australis* is only confirmed in Port Stephens; however a specimen of this species from Maryborough, Queensland is located at Queensland Museum (ALA, 2014). This species has also been sighted in small colonies extending further south towards Sydney, such as Lake Macquarie, Brisbane Waters, Balmoral, and Manly (D. Harasti *pers. comm.*). Its presence was not noted in the 2009 habitat mapping of Port Jackson and Port Hacking (Creese *et al.,* 2009). While this species occurs in Port Stephens at relatively high densities, it is much more spatially restricted and occurs at lower densities in these other locations. This species could therefore potentially be close to extinction. Within Port Stephens the *D. australis* habitat occurs in the vicinity of a popular marina and so it is potentially threatened by boat anchors, fishing debris entanglement and sand inundation. Further increases in commercial and recreational uses of the area in the future have the potential to impact on the biological values as the use of this area is likely to continue to increase as a result of growth in the region.

With development expanding and population growth, it is likely to result in greater pressure on the marine environment. Slow growing fragile corals are highly vulnerable to damage by physical contact with fishing gear (Miller *et al.,* 2012). Corals are extremely sensitive to disturbance, and consequently have questionable potential for recovery (Miller *et al.,* 2012). *Dendronephthya australis* is rare and endemic to NSW yet abundance data for *D. australis* is scarce to non-existent. This species merits increased scientific and conservation emphasis, because of the fundamental role that they play in shaping habitat and the presence of unique associated assemblages (Coleman and Williams, 2002). Loss of an ecosystem engineer could potentially remove oases of structural and biological diversity from the ocean floor that cannot be restored in any meaningful way (Coleman and Williams, 2002). Ultimately the loss of this species could potentially affect the condition of the ecosystem. Additional conservation measures for *D. australis* include the establishment of a no-anchor zone in the locality of the *D. australis* habitat.

4.5 Conclusion

The present study is the first to provide an overview of polychaete fauna associated with the rare *Dendronephthya australis* habitat in Port Stephens. *Dendronephthya australis* beds are providing a unique habitat for macrobenthos within the Port Stephens estuary as it supports a unique polychaete assemblage compared to all other unvegetated and uncolonised habitats tested. While physical variables measured were not found to be causative, further investigation is required to explain the affect of *D. australis* on polychaete assemblages. *Dendronephthya australis* is rare and endemic to NSW and has been shown to play a fundamental role in shaping habitat and the presence of unique associated assemblages. This species merits increased scientific and conservation emphasis within the Port Stephens-Great Lakes Marine Park.

Chapter 5. Temporal variation in measures of conservation value within an estuarine environment[3]

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[3] Chapter 5 has been written for submission to the journal Biodiversity and Conservation

Abstract

A critical consideration for conservation planning is the temporal stability of the conservation priority of candidate priority 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. 2.5 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.

5.1 Introduction

Estuaries are transition zones between the land and the sea (Attrill and Rundle, 2002). Distinctive physical, chemical and ecological gradients are characteristic of estuarine systems, and these gradients exhibit change over smaller spatial scales in comparison to coastal and oceanic environments (Hutchings, 1999; Cognetti and Maltagliati, 2000; Neely and Zajac, 2008). As highly diverse and productive ecosystems influenced by oceanic and freshwater influences, estuaries host a unique biodiversity that provides ecosystem services of high economic and intrinsic value (Hutchings, 1999). For example, estuarine ecosystems are crucial for the sustainability of a number of marine fisheries (Kennish, 1990; Whitfield, 1998; França *et al.,* 2009; Hughes *et al.,* 2009) as habitats occurring within estuaries are nurseries for many commercially important fish and invertebrates (Pollard, 1984; West and Kink, 1996; Dolbeth *et al.,* 2008). Specific habitats within estuaries hold high conservation value, such as seagrasses, which are an important marine foundation species that house dependent fish and invertebrate communities, including species listed internationally as vulnerable or endangered (Hughes *et al.,* 2009; Shokri *et al.* 2009b).

Estuarine environments have experienced a long history of human uses such as shipping, fishing, recreation, waste dumping, and tourism (Dauer *et al.,* 2008; Neely and Zajac, 2008), which have led to associated impacts such as contamination, eutrophication, channel dredging and intense resource use and extraction (Neely and Zajac, 2008). Such saturated human activity has led estuaries to rank amongst the most degraded of the world's ecosystems (Edgar and Barrett, 2002; Neely and Zajac, 2008).

Human use of estuaries will continue, yet conservation of their unique biodiversity and ecological processes are necessary both to support the anthropogenic uses of estuaries and for their inherent values (ANZECC TFMPA, 1998). However, in an environment with intense human activity and complex spatial variation in both habitats and species' assemblages, conservation will require a different management approach that effectively addresses these unique characteristics of estuaries (Neely and Zajac, 2008). Integrating the complex socio-economic values of estuaries with the need for conservation will require a mix of approaches (Shokri *et al.,* 2009). Marine Protected Areas (MPAs) are considered to be one important marine ecosystem management tool (Kaplan *et al.*, 2010), which includes the implementation of conservation reserves (Shokri *et al.,* 2009). When implementing MPAs, information on the natural and social features of the planning area is essential to provide stakeholders with the understanding of the complexity and location of conservation features and consequences of human influences on ecosystems, habitats and species (Banks and Skilleter, 2010; Foley *et al.,* 2010; Malcolm *et al.,* 2012). Within MPAs, inclusion of 20-30% of the area within a planning area as conservation zones may be necessary to maximize the likelihood that a representative and viable selection of biodiversity is included (Gladstone, 2007).

Decision on the location and extent of MPAs require the elucidation of a conservation goal, and criteria to assess the relative contribution of areas to its achievement (Margules and Pressey, 2000). A large number of schemes have been developed to evaluate candidate sites for inclusion in a network of MPAs (reviewed by Roberts *et al.*, 2003). Biologically-based selection criteria for evaluating sites for MPAs typically focus on biodiversity (such as representation of species, assemblages and habitats, and endemics), and the processes that will lead to the long-term sustainability of biodiversity (such as the presence of vulnerable life stages, the extent of connectivity, the existence of links among habitats, importance for reproduction, and the likelihood of disturbance by natural disasters) (Ward *et al.*, 1999, Sala *et al.*, 2002, Roberts *et al.,* 2003). The selection criteria that have been used to evaluate the relative conservation value of estuaries, and areas within estuaries, are similar to the criteria used for MPAs and have included: representation of habitats, species richness and assemblage variation (Neely and Zajac, 2008); species richness and the existence of species with localised distributions (Edgar *et* *al.,* 2000); and total number of species, the number of rare or endemic species, and assemblage variation (Frojan *et al.,* 2009).

Estuaries, as highly dynamic ecosystems, experience considerable temporal variation in their hydrological and biodiversity characteristics (Hutchings, 1999; Dauer *et al.,* 2008). The temporal variation of macrobenthos within estuaries has been related to changes in freshwater flow, salinity (related to tidal influences), anthropogenic activity, recruitment and seasonal biological and chemical fluctuations within the environment (Rozas *et al.,* 2005; Hourston *et al.,* 2011). For example, macrofauna of sediments in Botany Bay, New South Wales showed significant variation at temporal scales from days to months. It was predicted that there would also be smaller and larger-scale temporal variation in the assemblages that would be related to influences from tidal cycles, migration and climatic changes over decades or centuries (Morrisey *et al.,* 1992b). Given this inherent temporal variability in estuarine biodiversity, a critical consideration for conservation planning of estuaries is the existence and magnitude of temporal variability in the relative conservation priorities of candidate areas. This study investigated temporal variation in some common measures of conservation value, using polychaetes as a case study group. The measures of conservation value assessed were species richness, abundance, assemblage structure, and irreplaceability value. Temporal variation was measured on short-term (between February and October 2011) and long-term (between May 2009 and October 2011) time scales. The study tested the null hypothesis that there was no temporal variation in any of the measures of conservation value.

The aim of this study was to investigate spatio-temporal variation in conservation value of sites across five habitats in the Port Stephens estuary of the Port Stephens-Great Lakes Marine Park (PSGLMP). Polychaete species were used as they are among the most numerous frequent, recurrent and abundant marine metazoans in benthic environments and regularly comprise over one-third the number of species of benthic infaunal assemblages (Hutchings, 1998; Glasby *et al.,* 2000; Olsgard *et al.,* 2003). They play an important role in the functioning of benthic communities not only because they are the numerically dominant macrobenthic taxon, but also because of the diversity of feeding modes and thus trophic positions they exhibit (Fauchald and Jumars, 1979; Hutchings, 1998; Giangrande *et al.,* 2005; Cardoso *et al.,* 2007). Shokri *et al.* (2009) concluded that annelids were effective surrogate taxa for identifying spatial variation in several measures of conservation value (species richness, abundance, assemblage variation) in estuaries. Polychaetes are also known to represent benthic taxa as spatio-temporal patterns in measures of polychaete biodiversity co-vary with other benthic invertebrate taxa (Papageorgiou *et al.*, 2006; Cardoso *et al.*, 2007; Shokri *et al.*, 2009) and networks of reserves selected to represent polychaete species in an estuary coincidentally included species of other taxa of benthic invertebrates at rates significantly greater than MPAs selected at random (Shokri *et al.*, 2009). This study tested for the existence of significant temporal variation in several measures of conservation value. The approach taken by this study was to repeatedly sample a number of sites and test for correlations through time in the measures of conservation value.

5.2 Methods

5.2.1 Study Area

This study was undertaken in Port Stephens estuary in the Port Stephens–Great Lakes Marine Park (PSGLMP), New South Wales, Australia (Figure 5.1). PSGLMP is located in the Manning Shelf marine bioregion and spans an area of 98,720 ha. The Karuah River is an arterial river in the Great Lakes region and flows into the Port Stephens estuary. PSGLMP is a ‘multiple-use’ park where human uses are managed through zoning (NSW Marine Parks Authority, 2006) with a zoning plan coming into effect on 1 April 2007. This study focused on five predetermined subtidal habitat classes: subtidal sand (<10% mud, >90% sand), mud (>90% mud, <10% sand), muddy sand (>50% mud, <50% sand) (Roy, 1983), *Posidonia australis* seagrass (hereafter referred to as *Posidonia*) and *Zostera muelleri* sub sp. *capricorni* seagrass (hereafter referred to as *Zostera*). The habitats were defined and mapped as part of the planning for the PSGLMP and cover approximately 98% of the subtidal extent of the estuary, with the remainder consisting of subtidal rocky reef (NSW Marine Parks Authority, 2001). Representation of all habitat types was the major criterion for selection of candidate areas, and the drawing of management boundaries when the PSGLMP was zoned.

5.2.2 Field sampling

Sampling occurred haphazardly at replicate sites within each predetermined habitat (Roy, 1983; NSW Marine Parks Authority, 2001). To test for long-term temporal variation in conservation value ten sites were sampled in May 2009 and October 2011 in the following arrangement: subtidal sand (n=2 sites), mud (n=2), muddy sand (n=2), *Posidonia* (n=2), and *Zostera* (n=2). Short term variation was investigated by sampling 13 sites in February 2011 and October 2011 in the following arrangement: subtidal sand (n=2 sites), mud (n=2), muddy sand (n=2), *Posidonia* (n=2), and *Zostera* (n=2). Sites were approximately 5 x 5 m, and replicate sites within each habitat were separated by at least 200 m. Samples were collected using a 0.005 m^3 Van-Veen grab. In the case of a misfire where a sample was not to capacity the sample was discarded and another taken to ensure uniformity between each sample and each habitat. Note that seagrass habitats were moderately dense, but did contain small patches of unvegetated sediment. Mesh bags of 1 mm mesh size were used to retain and sieve each sample and fixed in 5% formalin (buffered with 35 ppt seawater) containing Rose Bengal stain fixed the biological specimens.

5.2.3 Laboratory analyses

Polychaetes were separated and transferred to 70% ethanol and identified to species where possible (See Appendices B, D and E). Oligochaetes were recorded also. Specimens were deposited in the Australian Museum.

5.2.4 Turnover in species composition

Turnover in species composition from one sampling period to the next was measured using a species temporal turnover index (STT) (Peterson *et al.*, 2002; Albouy *et al.*, 2012), which is a modified Jaccard coefficient, where SST=(b+c)/(a+b+c). In this formula a is the number of species present in both sampling periods, b is the number of species present in the first sampling period but not the second, and c is the number of species present in the second sampling period but not the first sampling period. SST can range from 0 (no change in species composition from one sampling period to the next) to 1 (complete change in species composition from one sampling period to the next).

5.2.5 Species richness and total abundance

The species richness, and total abundance, of polychaetes at each site at each sampling period was calculated by combining the n=5 replicate samples.

5.2.6 Polychaete assemblages

Patterns of similarity among sites in the structure of their polychaete assemblages at each sampling period were quantified by Bray-Curtis similarity matrices, using PRIMER 6 software (Primer-E). The data set was the total abundance of each species in each site at each sampling period, and separate matrices were prepared using the untransformed, square-root transformed, and presence/absence transformed data. Transformation of multivariate data sets is done to reduce the overriding influence of a few very abundant and/or rare species (Clarke, 1993), and different transformations were compared because patterns of multivariate similarity are known to be sensitive to the type of data transformation (Olsgard *et al.,* 1997, 1998). Non-metric multidimensional scaling (nMDS) ordination plots, based on Bray–Curtis similarity matrices, were used to visualise the relative similarity of polychaete assemblages at each sampling period, for each type of data transformation.

Distinctive assemblages of polychaetes were defined from clusters of sites with at least 30% similarity in their assemblages.

5.2.7 Summed irreplaceability

Irreplaceability is defined as the likelihood that a given site will need to be selected to achieve a conservation goal or, conversely the extent to which options for achieving the goal are reduced if the site is not selected (Pressey *et al.,* 1994). Summed irreplaceability is the sum of the irreplaceabilities of a site, estimated separately for each of the species it contains (Pressey, 1998). The summed irreplaceability value of each site at each sampling period was determined for the conservation goal of each species being represented at least once in a reserve. The conservation planning software C-Plan (New South Wales National Parks and Wildlife service, Pressey, 1999) was used to determine summed irreplaceability values. C-Plan when compared to Marxan, another conservation-planning package, used higher relative targets and included no spatial constraints, and found conservation-value outputs to be similar (Carwardine *et al.*, 2007).

5.2.8 Reserve selection

A simulated reserve selection was undertaken for the data set from each sampling period in the short- and long-term data sets, for the conservation goal of each species being represented at least once in a reserve. A minimum-set algorithm in C-Plan was used to select sites to achieve the conservation goal according to the following rules: (1) select the site with the highest summed irreplaceability value, (2) recalculate the summed irreplaceability values of the remaining sites, (3) select the site with the highest summed irreplaceability value, (4) in the event of a tie between two sites at step (3) select the site with the highest initial summed irreplaceability value (i.e., prior to any selection), and (5) repeat steps 1–4 until the conservation goal has been achieved. After the selection process was completed, species accumulation curves were constructed to represent the % of species progressively included at each step of the selection process.

5.2.9 Statistical Analyses

The null hypothesis that mean turnover in species composition between the first and second sampling periods in the short-term data set would not differ from mean turnover in species composition between the first and second sampling periods in the long-term data set was tested by *t*-test. The null hypothesis that site rankings in successive sampling periods would not change, for species richness and total abundance, for both the short- and long-term data sets was tested by determining the magnitude and significance of Spearman rank correlation coefficients (using SPSS v 20 software). The null hypothesis that patterns of assemblage similarity in the first and second sampling periods, for both the short- and long-term data sets, would be uncorrelated was tested by matrix correlation, using the RELATE test in PRIMER 6, with n=9999 permutations used to test for significance.

The null hypothesis that site rankings in successive sampling periods for summed irreplaceability value would be correlated in both the short- and long-term data sets was tested by determining the magnitude and significance of Spearman rank correlation coefficients. The null hypothesis that the % species accumulated in the reserve selection process for each sampling period in the short-term data set, and in the long-term data set, would not differ was tested by the Wilcoxon matched-pairs signed ranks test (Sokal and Rohlf 1994; Norden *et al.*, 2004). The matched pairs were the % species accumulated, at each increment of % sites reserved, by the reserve selection process for each sampling period.

5.3 Results

5.3.1 Polychaete biodiversity

A total of 74, 63 and 86 species of polychaetes were sampled from the Port Stephens estuary in May 2009, February 2011 and October 2011 respectively (Table 5.1, Appendices B, D and E), with 139 species in total. Species represented 26, 29 and 33 families from May 2009, February 2011 and October 2011 respectively. Thirty-four species (46% species recorded), 31 species (49%), and 42 species (48%) were recorded in one site only in May 2009, February 2011 and October 2011 respectively. Twenty-six species (35% species recorded), 21 species (33%), and 25 species (29%) were recorded by one individual only in May 2009, February 2011 and October 2011 respectively. Family-level richness of polychaetes showed complex patterns of variation over the three sampling periods. Four families not sampled in May 2009, were present in February and October 2011: Chaetopteridae, Dorvellidae, Poecilochaetidae and Sigalionidae. This was also true for the Oligochaetes. Three families (Ampharetidae, Flabillegeridae, Oenoidae) were sampled in May 2009 and October 2011, but not February 2011. One family (Oweniidae) was sampled in May 2009 and February 2011, but not October 2011. Two families (Pisionidae, Saccocirridae) were sampled only in October 2011.

Mediomastus australiensis (Capitellidae) was the only species to be sampled consistently in both sites in one habitat (muddy/sand) over all sampling periods. No other species were recorded consistently in each site over all sampling periods in any other habitat. Over the long-term data set (May 2009-October 2011) *M. australiensis* was also the most consistently recorded species over all sites and habitats, followed by *Lumbrineris* cf *latreilli* (Lumbrineridae) and *Neanthes cricognatha* (Nereididae). In the short-term data set (February-October 2011) *Exogone (Exogone) africana* (Syllidae) was recorded from both sites of the *Posidonia* habitat in both sampling periods, *Exogone (Exogone) haswelli* (Syllidae) and *L. latreilli* was recorded in both sites of sand habitat in both sampling periods, and *S. pacifica* was recorded in both sites of *Zostera* habitat in both sampling periods. *Lumbrineris* cf *latreilli* was the most consistently present species, being the most consistently recorded species over the majority of all sites and habitats for all sampling periods. This was followed by *S. pacifica* and *M. australiensis*. Thirty-nine species (38%), from a total of 102 species, were recorded in only one site in the short-term data set. Forty-six species (36%), from a total of 127 species, were recorded in only one site in the long-term data set (note species may have been recorded a number of times from the site). Of the total of 139 species recorded in this study, 25 species (18%) were represented by one individual. The polychaete family Cossuridae was the only family recorded in the entire data set to be represented by a single individual.

Table 5.1: Total number of polychaete species sampled in each site within each habitat during May 2009, February 2011 and October 2011, and in the short-term (February-October 2011) and long-term (May 2009-October 2011) data sets.

Habitat	Site	May-09	Feb-11	Oct-11	Total species short-term	Total species long-term
Sand	1	21	27	20	40	38
	2	21	8	16	21	34
Total		33	29	28	48	54
Mud	1	15	6	16	18	31
	2	15	13	20	30	33
Total		25	17	30	38	50
Muddy/sand	1	26	2	25	26	47
	2	19	16	20	31	36
Total		34	17	34	44	60
Posidonia	1	15	20	18	29	31
	2	15	11	12	19	27
Total		26	26	27	41	50
Zostera	1	19	18	25	33	40
	2	13	12	11	17	22
Total		28	24	32	40	52
Grand total		74	63	86	102	127

5.3.2 Temporal turnover in species composition

Values of the STT index for sites in the short-term data set ranged from 0.65 to 0.96, with the lowest values occurring in one *Zostera* site and in one *Posidonia* site (Table 5.2). All sites in the long-term data set returned values of the STT index of 0.9 or higher, with one mud site and one *Posidonia* site experiencing complete replacement of species (STT=1) (Table 5.2). The mean STT index for the short-term data set (0.80±0.03) was significantly less than the mean STT index for the long-term data set (0.94±0.01) (t_{18}=-4.07, P=0.001). The null hypothesis that the mean STT indexes of the short- and long-term data sets would not be different is therefore rejected.

Table 5.2: Temporal turnover in species composition for the short-term (February-October 2011) and long-term (May 2009-October 2011) data sets. The value shown for each site is the species temporal turnover (STT) index.

Habitat	Site	February-October 2011	May 2009-October 2011
Sand	1	0.83	0.92
	2	0.86	0.91
Mud	1	0.78	1.00
	2	0.90	0.94
Muddy/sand	1	0.96	0.91
	2	0.84	0.92
Posidonia	1	0.69	0.94
	2	0.79	1.00
Zostera	1	0.70	0.90
	2	0.65	0.91

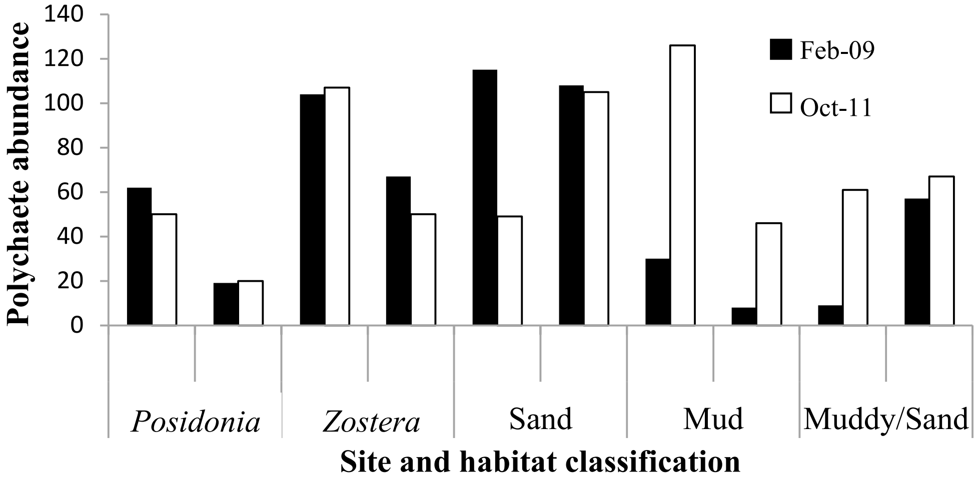
5.3.3 Species richness and abundance

Total polychaete abundance in each site varied over all sampling periods (Fig. 5.1). The rankings of some sites changed over the short-term, and long-term. For example, over the short-term a site of the sand habitat varied in species richness from eight species in February 2011 to 16 species in October 2011. Over the long-term there were 21 species recorded in this site in May 2009 and 16 species in October 2011.

The total abundance of polychaetes in a *Zostera* site varied over the long-term from 295 individuals in May 2009 to 107 individuals in October 2011. Over the short-term abundance varied only from 104 individuals in February 2011 to 107 individuals in October 2011 for the same site. Both sites in mud habitat had 30 and 8 individuals, respectively, in February 2011 and 126 and 46 individuals, respectively, in October 2011.

Site rankings for species richness in successive sampling periods were uncorrelated in the short-term data set, and correlated in the long-term data set (Fig. 5.2) Site rankings for total abundance of polychaetes in successive sampling periods were uncorrelated for both the short- and long-term data sets (Fig. 5.3). The null hypothesis that site rankings for species richness and total abundance would not change over both short and long terms was accepted for long-term species richness and rejected for short-term species richness, and for short- and long-term total abundance.

a)



b)

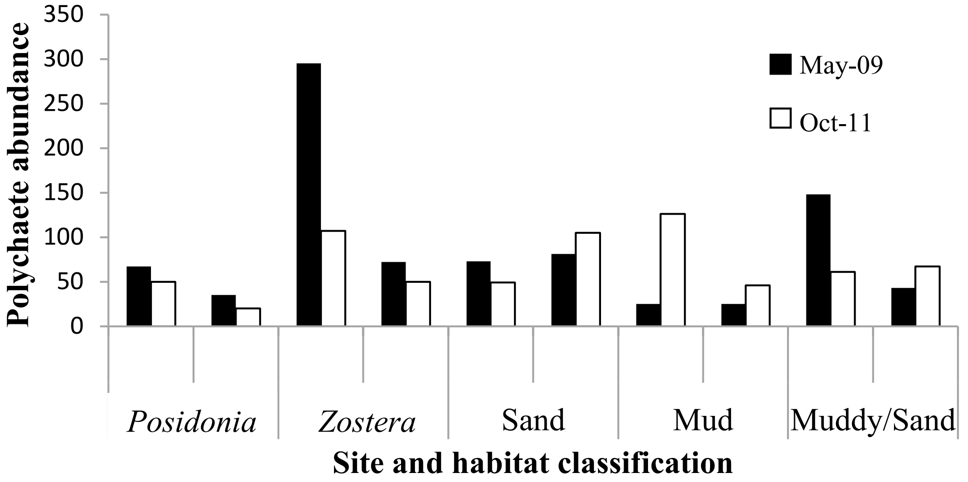


Figure 5.1: Total polychaete abundance of each site (from summing the abundance in n=5 replicate samples) in each habitat sampled in a) February 2011 and October 2011 and b) May 2009 and October 2011. The two bars in each habitat represent the two sites.

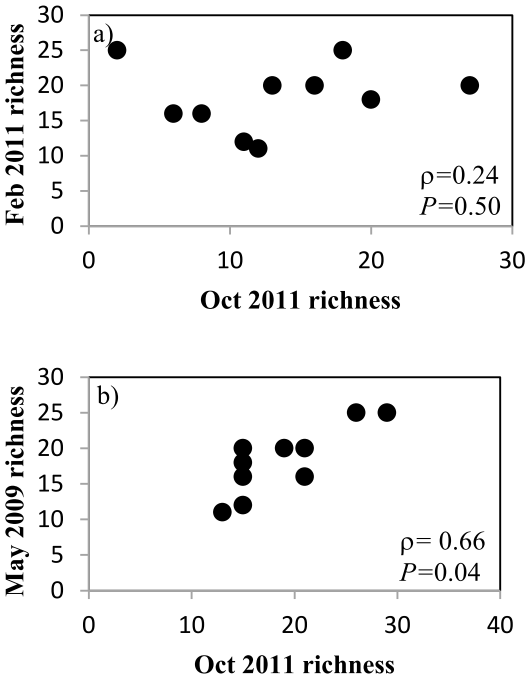


Figure 5.2: Pairwise scatterplots of species richness in (a) February and October 2011 (short-term data set), and (b) May 2009 and October 2011 (long-term data set). The values shown are the Spearman rank correlation coefficients (ρ) and their *P*-values.

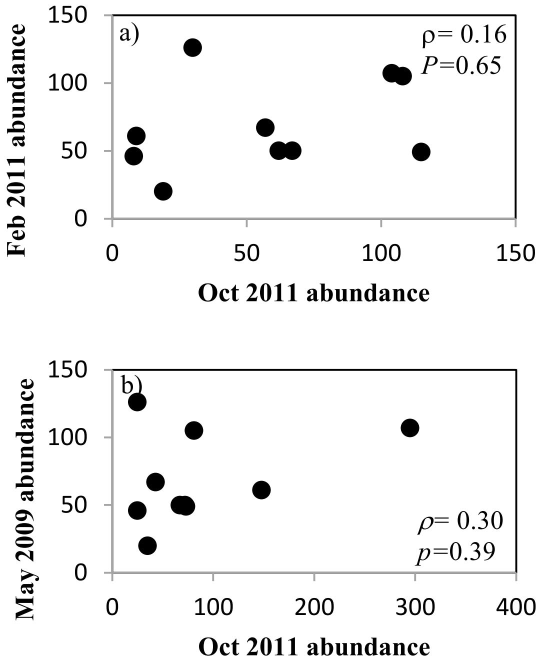


Figure 5.3: Pairwise scatterplots of total abundance of polychaetes in (a) February and October 2011 (short-term data set), and (b) May 2009 and October 2011 (long-term data set). The values shown are the Spearman rank correlation coefficients (ρ) and their *P*-values.

5.3.4 Assemblage variation

The number of polychaete assemblages, the identity of sites comprising each assemblage, and the number and composition of unique assemblages (i.e. occurring only at one site) varied over both the short- (Fig. 5.4) and long-terms (Fig. 5.5). Over the short-term, for the untransformed data, there were six assemblages in February and five in October 2011. Sites that were included in each assemblage between the two data sets varied (see Fig. 5.4a and d). For the square root-transformed data there were five assemblages in February 2011 and four assemblages in October 2011 (Fig. 5.4b and e). In February three assemblages were comprised of a single site (sites 29 and 30) whereas in October 2011 there was only one assemblage that was comprised of a single, different site (site 32). Changes were also observed in the presence-absence transformed data, however both data sets contained four distinct assemblages (Fig. 5.4c and f). The distinctive assemblage at site 32 (mud habitat) occurred for all data transformations in the October 2011 sampling period.

In the long-term data set (May 2009-October 2011), when the data were untransformed, there were seven polychaete assemblages in May 2009 and five assemblages in October 2011 (Fig. 5.5a, d). In the square root-transformed data there were four distinct assemblages in each sampling period (Fig. 5.5b and e). The composition of these assemblages was generally consistent in both sampling periods, with sites 32 and 1 switching positions. In the presence-absence transformed data there were three and four assemblages in the two sampling periods (Fig. 5.5c and f). One assemblage was consistently made up of sites 2 and 4.

Patterns of similarity among sites in their assemblage structure in the two sampling periods in the short-term data set were uncorrelated, for each data transformation (Table 5.3). Patterns of assemblage similarity among sites in their assemblage structure in the two sampling periods in the long-term data set were correlated when abundance data was untransformed and square-root transformed data, but not when data was transformed to presence-absence (Table 5.3). Therefore, the null hypothesis that patterns of assemblage similarity among sites would be unchanged is rejected for the short-term, and accepted for the long-term for two data transformations (untransformed, square-root).

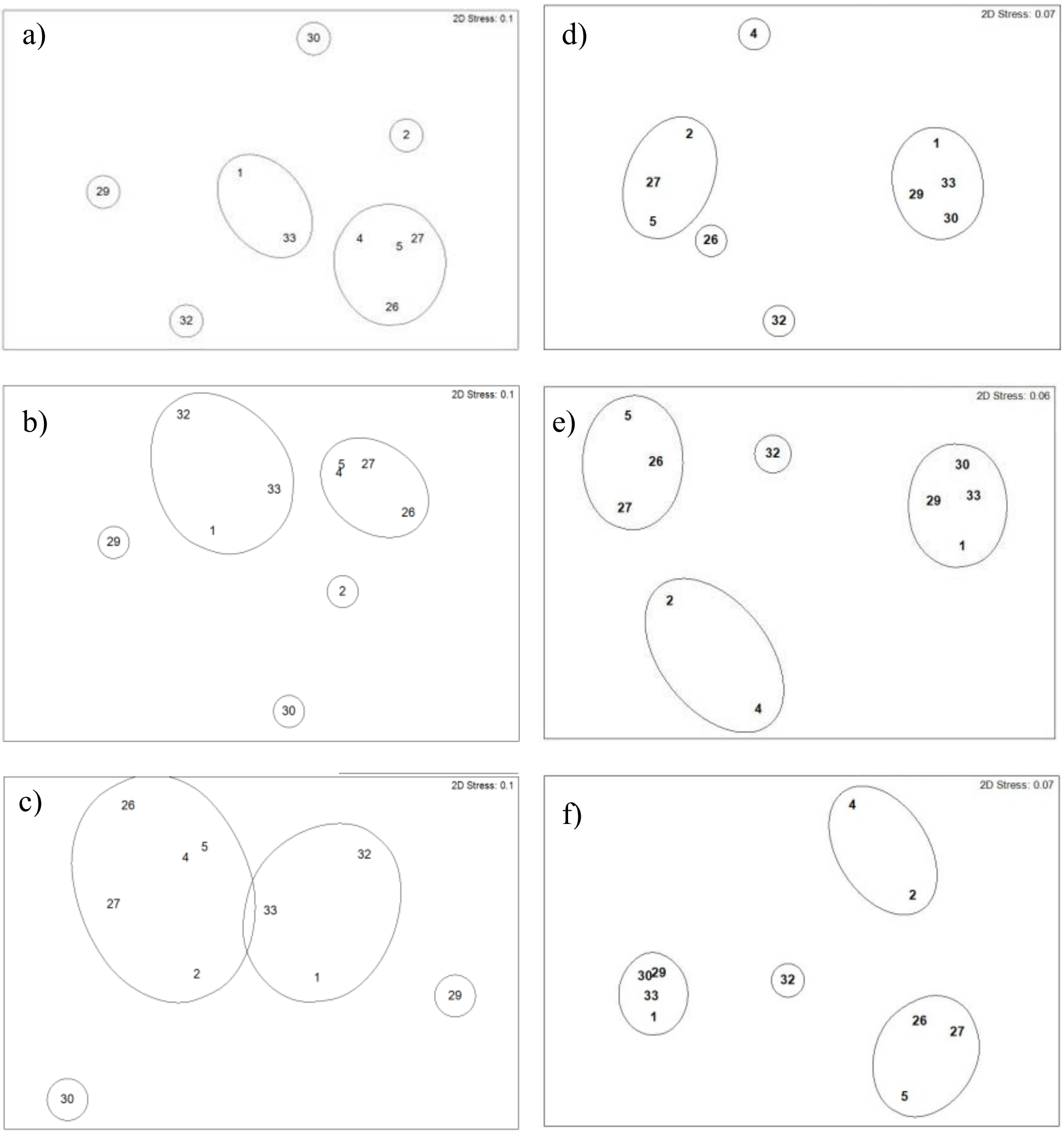


Figure 5.4: nMDS ordination plots depicting polychaete assemblages in Port Stephens estuary for the short-term data set, in February 2011 (upper panel), and October 2011 (lower panel). Clusters of sites that are at least 30% similar in their assemblage structure are enclosed by ellipses. Labels represent unique site identification codes, with sites representing the following habitats: 1 and 4 *Posidonia*; 2 and 5 *Zostera*; 26 and 27 Sand; 29 and 32 Mud; 30 and 33 Muddy/sand. Assemblages are based on total abundance of each species in each site with abundance data: untransformed (a, d); square-root transformed (b, e); and transformed to presence/absence (c, f).

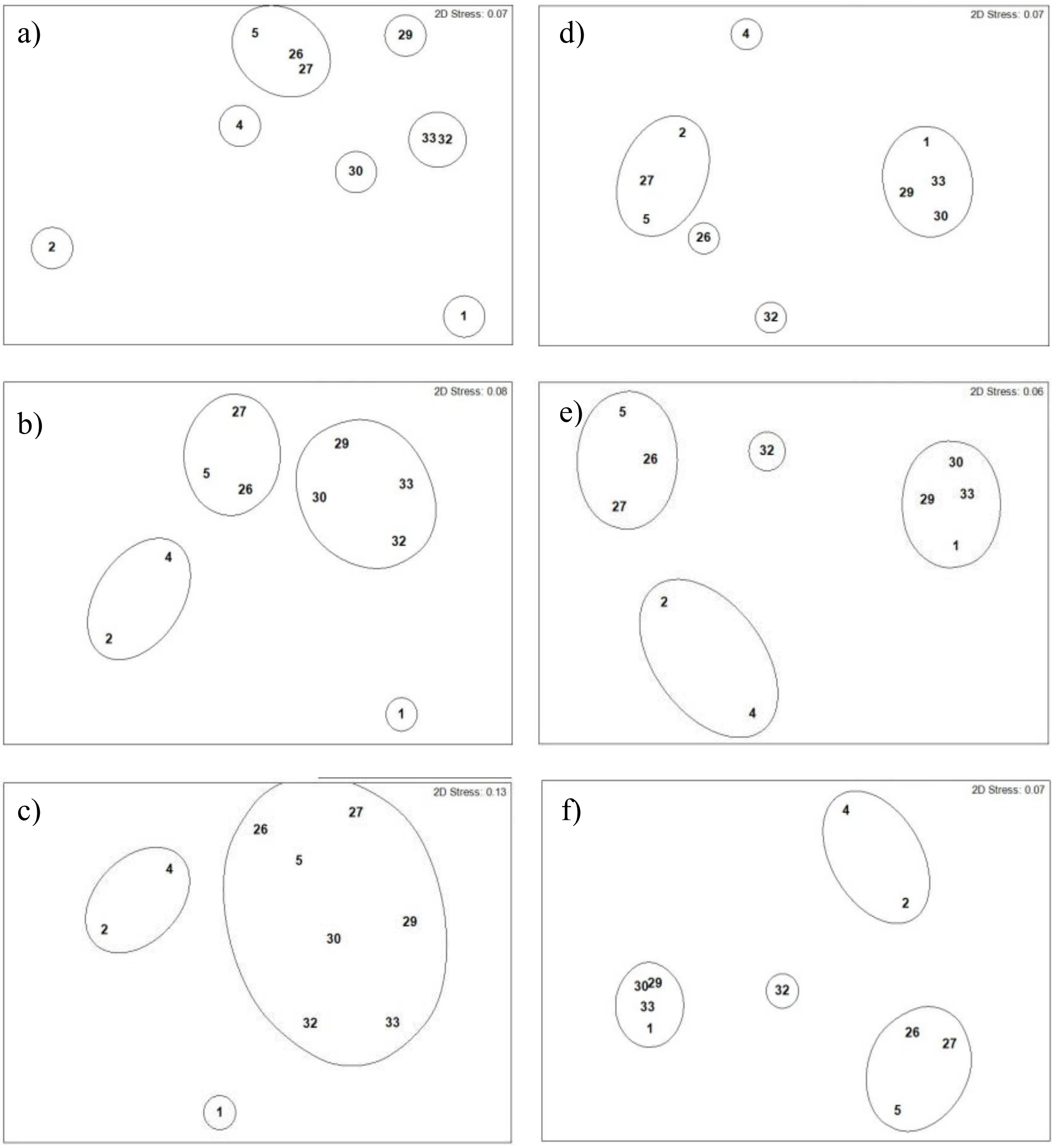


Figure 5.5: nMDS ordination plots depicting polychaete assemblages in Port Stephens estuary for the long-term data set, in May 2009 (upper panel), and October 2011 (lower panel). Clusters of sites that are at least 30% similar in their assemblage structure are enclosed by ellipses. Labels represent unique site identification codes, with sites representing the following habitats: 1 and 4 *Posidonia*; 2 and 5 *Zostera*; 26 and 27 Sand; 29 and 32 Mud; 30 and 33 Muddy/sand. Assemblages are based on total abundance of each species in each site with abundance data: untransformed (a, d); square-root transformed (b, e); and transformed to presence/absence (c, f).

Table 5.3: Results of the Relate test for the two Bray-Curtis similarity matrices in the short-term (February and October 2011) and long-term (May 2009 and October 2011) data sets. Values shown are Spearman rank correlation coefficients (ρ) and their *P*-values.

Comparison	Data transformation		
	Untransformed	Square-root	Presence-absence
February-October 2011	$\rho=0.07$ ($P=0.25$)	$\rho=0.10$ ($P=0.19$)	$\rho=0.10$ ($P=0.23$)
May 2009-October 2011	$\rho=0.23$ ($P=0.03$)	$\rho=0.24$ ($P=0.04$)	$\rho=0.17$ ($P=0.12$)

5.3.5 Summed irreplaceability

Summed irreplaceability is a measure of each site's contribution towards the achievement of the conservation goal. Over the short-term, there were changes in the summed irreplaceability values of sites (i.e. their relative conservation value). For example, site 1 in the Sand habitat and site 2 in the Muddy/sand habitat were the first and second ranked sites, respectively, in February 2011 (Table 5.4). In October 2011, site 1 in the Muddy/sand habitat and site 1 in the *Zostera* habitat were, respectively, the first and second ranked sites. Summed irreplaceability values of sites in the two sampling periods of the short-term data set were uncorrelated (Fig. 5.6). Site 1 in the Muddy/sand habitat had the lowest summed irreplaceability value in February 2011, having the least number of species that occurred there and nowhere else. The first and second ranked sites in the May 2009 and October 2011 sampling periods were the same: site 1 in the Muddy/sand habitat and site 1 in the *Zostera* habitat, respectively (Table 5.4). Summed irreplaceability values of sites in the two sampling periods of the long-term data set were significantly correlated (Fig. 5.6). Therefore, the null hypothesis that the summed irreplaceability values of sites would be correlated in successive sampling periods is rejected for the short-term data set and accepted for the long-term data set.

Table 5.4: Summed irreplaceability values of sites (for the conservation goal of each species being represented at least once in a reserve) based on data from the May 2009, February 2011, and October 2011 sampling periods.

Habitat	Site	May-09	Feb-11	Oct-11
Sand	1	12.27	16.80	11.36
	2	12.27	3.08	9.98
Mud	1	6.74	3.38	7.71
	2	7.80	7.52	10.08
Muddy/sand	1	13.56	0.36	16.29
	2	10.62	11.85	11.85
Posidonia	1	9.18	11.49	10.14
	2	8.51	2.97	5.93
Zostera	1	12.37	9.63	14.13
	2	6.11	4.70	5.91

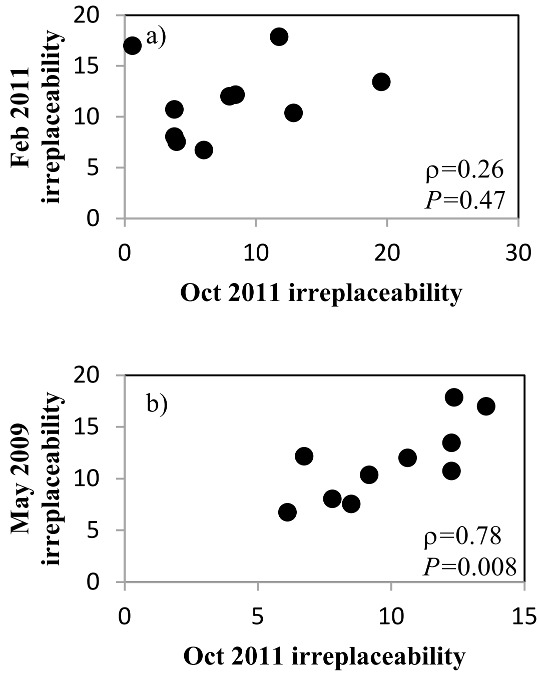


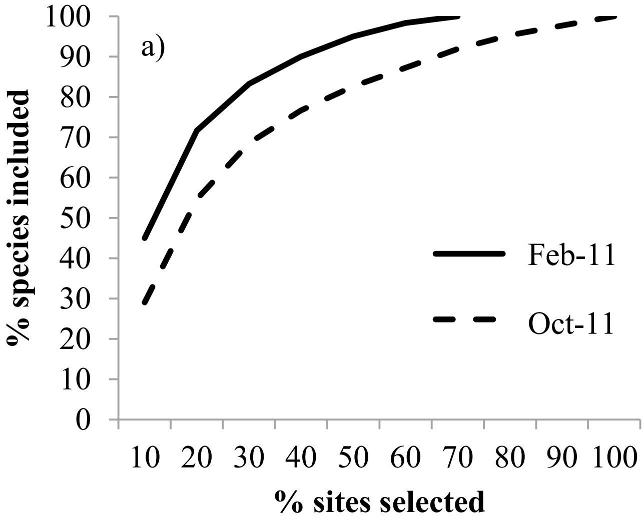
Figure 5.6: Pairwise scatterplots of summed irreplaceability values of sites in (a) February and October 2011 (short-term data set), and (b) May 2009 and October 2011 (long-term data set). Values shown are Spearman rank correlation coefficients (ρ) and their *P*-values.

5.3.6 Reserve selection

Seven sites were required to achieve the conservation goal, of each species being represented at least once in a reserve, in February 2011 and all 10 sites were required in October 2011 (Fig. 5.7). As a measure of the relative differences in the outcomes of reserve selection in each sampling period, 83% of species had been included after 30% sites had been selected from the February 2011 data set, and 64% of species had been included after 30% sites had been selected from the October 2011 data set. The % species accumulated at each step of the reserve selection processes in February and October 2011 differed significantly (W=45, $P<0.01$), with a greater % species being accumulated as sites were progressively added to the reserve network in February 2011 (Fig. 5.7a). Nine sites were required to achieve the conservation goal in May 2009 and all 10 were required in October 2011 (Fig. 5.7b). The reserve selection processes for each sampling period accumulated species at a similar rate:

after 30% sites had been reserved 65% species had been included from the May 2009 data set and 69% species had been included from the October 2011 data set. The % species accumulated at each step of the reserve selection process in May 2009 and October 2011 did not differ (W=6, *P*>0.05). Therefore, the null hypothesis that the % species accumulated in the reserve selection process for successive sampling periods would not differ is accepted for the long-term data set, and rejected for the short-term data set.

The locations of the top three sites selected as reserves in each sampling period differed marginally in the short-term data set (Fig. 5.8) and were identical in the long-term data set (Fig. 5.9). The difference in the short-term data set arose from the replacement of one site near the northern shoreline of the Port Stephens estuary, by a site in the middle of the estuary. Two sites, close to the sea entrance of Port Stephens estuary were ranked in the top three sites in all reserve selection processes.



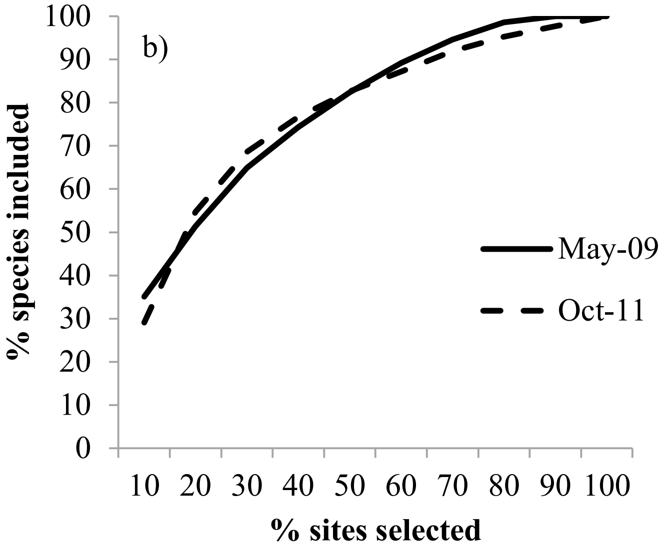
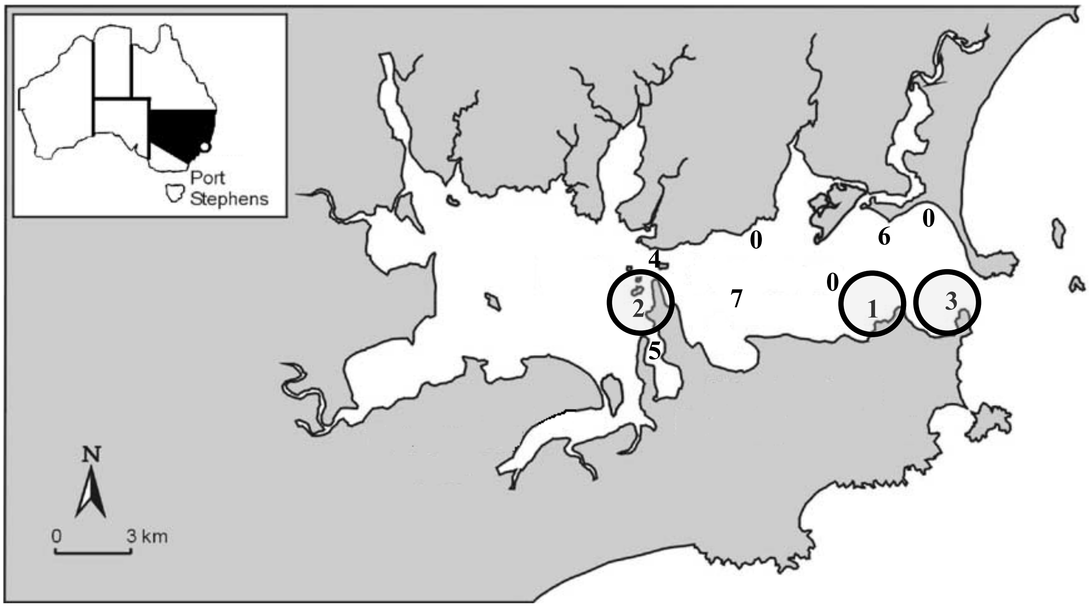


Figure 5.7: Results of the reserve selection process for each sampling period in (a) the short-term data set, and (b) the long-term data set. The graphs show the % species accumulated from the progressive reservation of sites, with the order of sites determined by the reserve selection process. All sites were not required to achieve the conservation goal in February 2011 and May 2009.

a)



b)

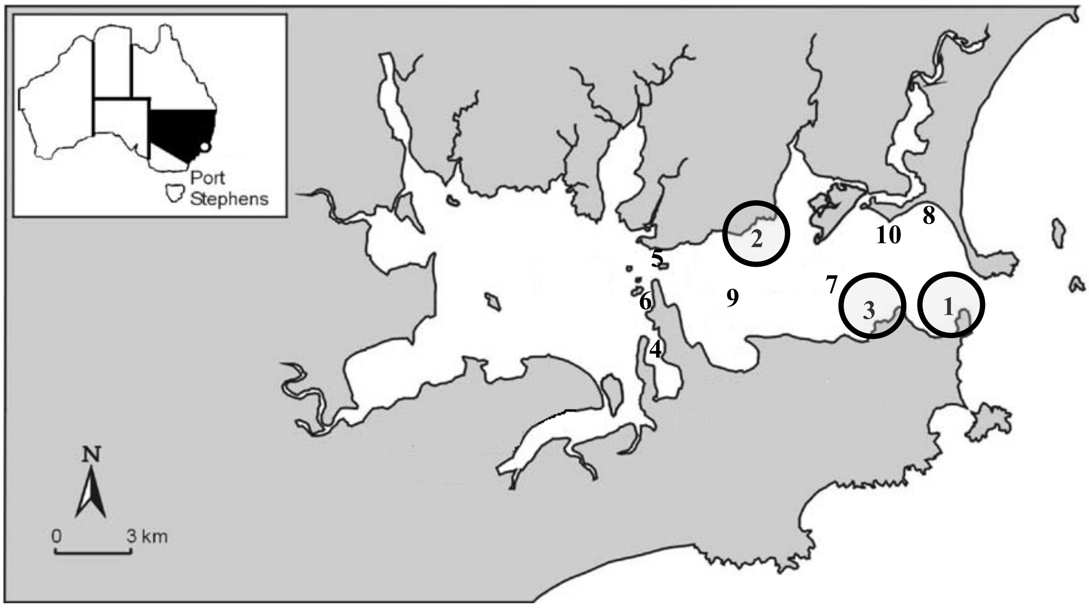


Figure 5.8: Maps showing the order in which sites were selected by a reserve selection process to achieve the conservation goal of each species being represented at least once in a reserve for: a) February 2011 sampling period; b) October 2011 sampling period. Sites labeled 0 were not required to achieve the conservation goal. The top-3 ranking sites are enclosed by circles.

a)

b)

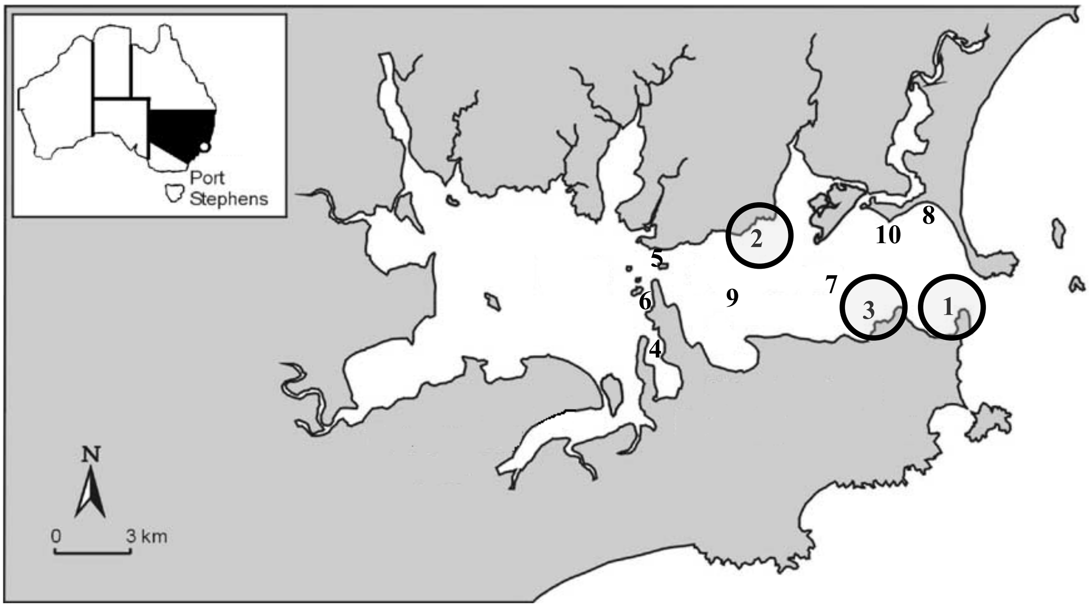


Figure 5.9: Maps showing the order in which sites were selected by a reserve selection process to achieve the conservation goal of each species being represented at least once in a reserve of conservation priority of each site using short term polychaete assemblage structure of each site for: a) May 2009 sampling period; and b) October 2011 sampling period. The site labeled 0 was not required to achieve the conservation goal. The top-3 ranking sites are enclosed by circles.

5.4 Discussion

This study has provided temporal analysis of polychaete assemblages within the Port Stephens estuary of the Port Stephens-Great Lakes Marine Park (PSGLMP) over both a short-term (months) and long-term (years) scale. Polychaete species present varied over each sampling period with 74, 63 and 86 species of polychaetes recorded from the Port Stephens estuary in May 2009, February 2011 and October 2011 respectively. Family-level richness of polychaetes also showed complex patterns of variation over the three sampling periods. Significant temporal variation in polychaete assemblages has been shown in previous studies bother over short- and longer-terms. Over a period of days and months complex patterns of temporal variation in total abundance of polychaetes was observed in Botany Bay, New South Wales, Australia. Significant variation occurred at one sampling plot and no significant temporal variation occurring at other sampling plots in the same environment (Morrisey *et al.*, 1992b). Over a 9-year period significant temporal variability was observed with deep-sea polychaete assemblages at the Porcupine Abyssal Plain Sustained Observatory, NE Atlantic. The study observed there was significant differences in polychaete abundance between sampling periods displayed, and that some polychaete families were recorded by a single individual. Also families not present in early data sets were present in later sampling (Soto *et al.,* 2010). Similar variation in polychaete biodiversity and spatial patterns has also been observed in other studies. Results of a study show 72% polychaete species were restricted to 1-2 sites out of a total of 10 sampled sites (Ellingsen *et al.*, 2007) and another study found that almost 20% of polychaete genera occurred as singletons, and that patterns of temporal variation differed in the replicate sampling sites (Musco *et al.*, 2011). Results of the present study are consistent with the findings of other studies. In the current study 34 species (46% species recorded), 31 species (49%), and 42 species (48%) were recorded in one site only in May 2009, February 2011 and October 2011 respectively. Twenty-six species (35% species recorded), 21 species (33%), and 25 species (29%) were recorded by one individual only in May 2009, February 2011 and October 2011 respectively.

The findings of the current study are likely applicable to other taxa of benthic invertebrates. Polychaetes are known to be suitable indicators of other benthic taxa as spatio-temporal patterns in measures of polychaete biodiversity co-vary with other benthic invertebrate taxa (Papageorgiou *et al.*, 2006; Cardoso *et al.*, 2007; Shokri *et al.*, 2009). This is reflected in a study of spatial and temporal variation in a study using polychaete assemblages as indicators of habitat recovery in the Mondego estuary, Portugal from eutrophication found polychaete assemblages showed similar patterns over time to the total macrobenthic assemblage (Cardoso *et al.*, 2007). Patterns between the two assemblages were even mirrored following the introduction of management for all the three study areas, with a decline in abundance and a marked increase in biomass. In a study testing the suitability of surrogate taxa, the species richness of annelids was significantly correlated with the species richness of non-annelid species (Shokri *et al.,* 2009). It can therefore be inferred that the other macrobenthic fauna of the Port Stephens estuary also exhibited complex patterns of spatial and temporal variation.

5.4.1 Temporal variation of polychaete richness and abundance

Species-based criteria for evaluating the conservation value of sites include features such as species richness and abundance (Margules, 1986; Gladstone, 2002). Maintaining species diversity and composition is essential for sustaining productive and resilient ecosystems (Worm *et al.,* 2006; Foley *et al.,* 2010); these features are therefore critical aspects of an ecosystem's structure. Species richness and abundance can affect multiple ecosystem functions including maintenance of productivity, resistance to and recovery from perturbations, capacity to maintain functional redundancies within an ecosystem, and food web dynamics (Foley *et al.,* 2010). High species richness is also a measure of genetic diversity, and more diverse and abundant assemblages support greater ecosystem function and in turn support a range of ecosystem services (Naeem, 2006; Palumbi *et al.,* 2009). A significant aim of MPAs is to conserve species diversity and abundance (Freitag *et al.,* 1997).

Despite the potential importance of species richness and abundance of organisms for assessing conservation value, this study found patterns in these two measures of conservation value were not consistently stable through time. Site rankings for species richness in successive sampling periods were uncorrelated in the short-term data set but were correlated in the long-term data set, while site rankings for total abundance of polychaetes were uncorrelated over both short- and long-term time scales.

Polychaete diversity and abundance can be driven by variation in food availability, habitat structural complexity, and recruitment (Morrisey *et al.*, 1992b; Barnes and Ellwood, 2012). Ecological processes that determine species' distribution and abundance can operate at local and regional scales (Dunning *et al.*, 1992). Sediment structure is important in determining species composition as polychaete assemblages are composed of species that utilize sediments in a multitude of ways (Papageorgiou *et al.,* 2006; Labrune *et al.,* 2007) and salinity is frequently invoked as the ultimate cause of upstream-downstream variation in estuarine macrobenthic assemblages (e.g. Jones, 1989; Nanami *et al.*, 2005). Within an estuarine environment, such as the Port Stephens estuary, some species occur in the more saline sections of the estuary, and others are physiologically able to tolerate the lower, fluctuating salinities found further upstream. This was also shown in the nearby Hawkesbury Estuary, New South Wales (see Jones, 1989). Polychaete larvae are far more susceptible to lower salinities (Nanami *et al.*, 2005). Depth is also a source of variation in marine biodiversity (Gray, 2001; McArthur *et al.,* 2010) with previous studies displaying depth-related variation in polychaete biodiversity (Platell and Potter, 1996; Mutlu *et al.*, 2010). Water depth can act as a proxy for factors of direct influence, such as temperature, light penetration, wave activity, currents, sedimentation, and nutrient availability (McArthur *et al.,* 2010), and can be a source of variation in ecological processes, such as competition (Shima, 2001). The lack of a consistent pattern of temporal variation in polychaete species richness and total abundance is therefore likely to reflect the different processes that determine each measure, and the different scales at which they operate.

5.4.2 Temporal variation of polychaete assemblages

A central theme of conservation biology is the representation of biodiversity in protected areas (Freitag *et al.,* 1997). Some species or populations have characteristics that render them of particular interest for conservation, such as species unique to particular location (endemics), and are of higher conservation priority than species that are more widespread (Roberts *et al.*, 2003). Conservation planning involves biologically-based selection criteria for evaluating sites for MPAs that typically focus on biodiversity (such as representation of species, assemblages and habitats, and endemics), and the processes that will lead to the long-term sustainability of biodiversity. It is therefore essential to identify assemblages within a location of conservation relevance to ensure each assemblage is adequately represented. The Port Stephens estuary of the PSGLMP showed variation through time in the number of polychaete assemblages, the identity of sites comprising each assemblage, and the number and composition of unique assemblages (i.e. comprised only of 1 site). With temporal variation in benthic assemblages, conservation will require a different management approach that effectively addresses temporal variability in order to conserve an optimal representation of benthic diversity.

Patterns of similarity among sites in their assemblage structure in the two sampling periods in the short-term data set were uncorrelated, for each data transformation. Patterns of assemblage similarity among sites in their assemblage structure in the two sampling periods in the long-term data set were correlated when abundance data were untransformed and square-root transformed, but not when data was transformed to presence-absence. The locations of unique assemblages also changed with data transformation. The effects of data transformation on spatial patterns of assemblage similarity have been reported in other studies (Olsgard *et al.*, 1997, 1998; Bertasi *et al.*, 2009). Assemblage variation is incorporated into spatial conservation planning (i.e. coarse-filter conservation, after Noss, 1987) by the protection of sites that host unique and/or representative examples of assemblages, as a complement or alternative to species-level planning (i.e. fine-filter conservation) (Noss 1987, Ward *et al.* 1999; Trakhtenbrot and Kadmon 2006). The temporal variation in spatial patterns of assemblage similarity, the variable consistency of these spatial patterns at different time scales, and the dependence of these patterns on the degree of data transformation suggests that planning based solely on representing assemblage variation in estuaries may not be effective.

It must be noted that this study did not investigate sudden disturbances experienced within estuaries, such as floods and droughts. Previous studied show that flood-associated changes in benthos exist (see Jones, 1989; Grilo *et al.,* 2011) and that droughts potentially reduce freshwater input into the estuarine system (Grilo *et al.,* 2011). This could have potential ramifications for management purposes.

5.4.3 Temporal variation and marine conservation planning

This study determined the summed irreplaceability value of sites by taking into account the occurrence of species in the planning area. In the Port Stephens estuary summed irreplaceability values of sites were uncorrelated over the short-term, but were significantly correlated over the long-term. Sites selected to achieve the conservation goal were therefore similar on a long-term scale, thus validating the objectives of conservation planning on a long-term scale. While conservation rank of sites (as determined by the summed irreplaceability values) varied through time, the locations of the top three sites selected as reserves in a simulated reserve selection procedure in each sampling period were identical in the long-term data set in each sampling period. These sites are therefore unique and are highlighted as high conservation priority. Although the short-term data set showed some variation, temporal influence on site selection for conservation in the Port Stephens estuary consistently highlighted the same sites as high priority.

The key principles for marine spatial planning have been determined as the maintenance or restoration of native species diversity, habitat diversity and heterogeneity, key species and connectivity (Foley *et al.* 2010). Systematic conservation approaches involve identifying an optimal set of sites to achieve a conservation goal in a planning region (Margules and Pressey 2000; Geselbracht *et al.,* 2009). The relative value of sites in the planning region, for the achievement of the conservation goal, is quantified by its conservation value and the measures used in this study are some of the more commonly used approaches to assigning conservation value (Margules and Pressey 2000). In an optimal scenario, conservation planning decisions will reflect the inherent temporal variability of biodiversity in the planning region. Although temporal variation in Australian benthic fauna has been known for some time (e.g. Rainer, 1981; Morrisey *et al.,* 1992b), its influence on conservation value and the ramifications for conservation site selection are unknown. This is particularly so within an estuarine ecosystem and proves challenging for marine protected area design (Neely and Zajec, 2008). Additional temporal variation may also arise from anthropogenic stressors in estuaries occurring on a variety of temporal and spatial scales (Roberts *et al.,* 2003; Neely and Zajec, 2008). Major weather events such as flood and drought have aso been shown to impact temporal patterns in macrobenthic species (e.g. Jones 1989). Conservation will therefore require a different management approach that effectively addresses these unique biodiversity-related characteristics of estuaries and the dynamic changes caused by human activities (Neely and Zajac, 2008).

The degree of temporal and spatial variation in conservation value found by this study may represent an extreme end of the range. The use of polychaetes as the study species and the known high spatial and temporal turnover may be responsible in part (Hutchings, 1998). It is therefore recommended that future studies of this kind also utilize other biota to ensure conservation value is adequately quantified and the likely range in temporal variation is understood.

5.4.4 Improved conservation planning and decision-making

A key criterion for the design of a national representative system of marine protected areas is that the network must be comprehensive, adequate and representative, i.e., the CAR principles (ANZECC TFMPA, 1998). Assessing conservation value will help in decision-making about whether an area should or should not be protected, and the trade-offs with other uses of the area (Kalamandeen and Gillson, 2007). With little known about the distribution and abundance of many marine species (Costello *et al.*, 2010), prioritising areas for conservation needs to be firmly grounded in knowledge of how marine ecosystems work if networks of marine reserves are to be effectively introduced and maintained.

Loss or reduction of species diversity and changing environmental conditions can push ecosystems beyond critical thresholds and drastically alter community structure and ecological functioning (Foley *et al.,* 2010). Restoring and maintaining species diversity and composition is critical for sustaining productive and resilient ecosystems. Australia has committed to the protection of marine biodiversity and ecological integrity, and the sustainable use of marine resources under the goals and principles of ecological sustainable development (ANZECC TFMPA, 1998). Sound biodiversity and other baseline data are essential to ensure that decision-making is underpinned by good science in the selection of a marine protected area (ANZECC TFMPA, 1998). With increasing threats to biodiversity, conservation managers require increasingly sophisticated tools for decision-making, notably ways to prioritise conservation actions that are efficient, accountable and transparent (Edgar *et al.,* 2008). With the existence of significant temporal variation in most measures of conservation value evaluated in this study, continual assessment of the biological value of candidate reserves and re-assessment of the achievement of conservation goals is, theoretically, the optimal approach to ensuring the representation of biodiversity (Roberts *et al.,* 2003). However, this would be an extremely costly and time-consuming approach to conservation planning, with considerable opportunity costs and socio-economic impacts. Faced with this constraint, results from this study suggest an alternative approach that utilizes a more detailed understanding of the factors underlying temporal (and spatial) variation in estuarine biodiversity is needed, such as modelling-based approaches that can incorporate some measure of uncertainty and predict biodiversity patterns and the interactive effects of human disturbance (Pressey *et al.*, 2007).

Chapter 6. Two new species of *Micronephthys* Friedrich, 1939 and one new species of *Nephtys* Cuvier, 1817 (Polychaeta: Phyllodocida: Nephtyidae) from eastern Australia with notes on *Aglaophamus australiensis* (Fauchald, 1965)[4]

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[4] Chapter 6 has been written for submission to the journal Zootaxa

Abstract

There are currently over 130 described species of Nephtyidae worldwide, with 20 species known from Australian waters belonging to four genera. Three new species are described, *Micronephthys aurantiaca* n.sp., and *M. derupeli* n.sp., and *Nephtys triangula* n.sp., from Eastern Australia. *M. aurantiaca* n. sp. has notopodia of chaetiger 1 without specialised dentate chaetae. The prostomium of this species is not produced anteriorly, long flowing chaetae absent. *M. derupeli* n.sp. has a prostomium that is not produced anteriorly, and long flowing chaetae are absent. Branchiae of this species are from chaetigers 7-8, without lateral foliaceous lobes. Branchiae from this species are from chaetigers 8 to 22, pharynx with median dorsal papilla, verrucae absent, and barred chaetae are present from chaetiger 1-9. *N. triangula* n. sp. has a prostomium that is produced anteriorly with long flowing chaetae. The prostomium is elongate, triangular with antennae at apex. Further descriptions are provided for all species examined. A key to all Australian species of *Nephtys* and *Micronephthys* is provided. Comments are given about the recent transfer of *Nephtys australiensis* to *Aglaophamus*.

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Dixon-Bridges, K., Gladstone, W. and Hutchings, P. 2014. One new species of Micronephthys Friedrich, 1939 and one new species of Nephtys Cuvier, 1817 (Polychaeta: Phyllodocida: Nephtyidae) from eastern Australia with notes on Aglaophamus australiensis (Fauchald, 1965) and a key to all Australian species. *Zootaxa*, **3872**: 513-540.

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Chapter 7. General discussion and conclusions

7.1 Introduction

Australia has some of the most diverse and unique marine life in the world, comprising extensive coral reefs in the tropical north, rocky shores in the temperate south, sandy beaches, seagrass beds, mangrove forests, the open ocean, seamounts, and the habitats of the continental shelf and slope (ANZECC TFMPA 1998). Marine protected areas (MPAs) are an effective method for protecting marine environments and biodiversity, sustaining productivity of marine resources, and managing conflicting uses (Edgar and Stuart-Smith, 2009; Lester *et al.,* 2009; Babcock *et al.,* 2010). A national system of MPAs, which includes marine parks, aquatic reserves and marine components of national parks, is being established in Australia under the National Representative System of Marine Protected Areas program to conserve representative examples of Australia's marine biodiversity (Voyer *et al.,* 2012).

The state of New South Wales (NSW), Australia has adopted a multiple-use approach to achieve the goals of a representative network of MPAs (Banks and Skilleter 2010). MPAs must be arranged as a network to maximise the protection of: 1) ecosystems; 2) ecosystem processes; and 3) ecosystem linkages/connectivity (Harris *et al.* 2008). This should be founded on thorough knowledge of the system. However, if networks of MPAs are to be established, managers need guidance on their placement which is firmly grounded in knowledge of spatial variation in marine biodiversity (Roberts *et al.*, 2003). The key role that science must play in marine park planning and design involves identifying threatened, endangered or protected species, critical habitat to these species, locating biodiversity 'hotspots' or iconic features and identifying measureable ecological indicators that can be used to gauge the MPA's performance (Harris *et al.* 2008).

7.2 The use of habitat classification schemes to select marine protected areas

The value of a habitat classification scheme, currently used for MPA planning in NSW, as a surrogate for biodiversity was tested in an estuary within the Port Stephens-Great Lakes Marine Park. The current habitat classification scheme divides the estuary into a complex mix of habitats based on sediment type, depth, and vegetation types. A combination of environmental variables (distance to the estuary mouth, depth, sediment grain size) was found to be a more relevant correlation with assemblage variation than the distribution of habitat types used in the classification scheme. An alternative scheme was proposed that divided the estuary into three sections with boundaries determined by gradients in the three environmental variables shown to be important in determining polychaete distributions. In comparison with the current habitat protection scheme, this scheme is a more accurate representation of spatial variation in polychaete assemblage diversity within the Port Stephens estuary. It also captures variation in polychaete ecological functions by representing the functional guilds of polychaetes found within the estuary and is advantageous by potentially offering a more cost-effective, time efficient and clearly defined approach to conservation management.

Despite the assumed value of habitat classification schemes there have been surprisingly few other tests of their actual effectiveness (Ward *et al.*, 1999; Shokri and Gladstone 2013). This research devised a new scheme that has the potential to be more accurate than the current habitat classification scheme utilised as common practise in marine park design. As part of a broader application, this new scheme warrants further testing in other estuaries and at different times to ensure it is temporally consistent. Although polychaetes are a reliable indicator of other taxa of benthic macro-invertebrates (Papageorgiou *et al.*, 2006; Cardoso *et al.* 2007; Shokri *et al.*, 2009), further research based on other taxa is required. This is required to determine whether taxa other than polychaetes are suitable as indicators. This research is also the first to identify systematically the polychaete fauna of the Port

Stephens estuary and provided a snapshot of spatial patterns of polychaete biodiversity.

7.3 Ecosystem engineers and Marine Park conservation planning

Marine communities are structured by complex interactions among biotic and abiotic processes (Crawford *et al.*, 2002; Dernie *et al.,* 2003; Barnes *et al.,* 2006; Siebert and Branch, 2006). Ecosystem engineers provide living space, alter and ameliorate physical conditions and affect biological interactions, and therefore enhance diversity and change patterns of species composition and dominance on local or landscape scales. This study showed that, when colonies are aggregated into large beds, the soft coral *Dendronephthya australis* acts as an ecosystem engineer within the PSGLMP. Sampling over two periods found this unique 'habitat' hosts a distinctive polychaete assemblage compared to all other unvegetated and uncolonised habitats present within the marine park. Variation in sediment physico-chemical properties and depth was not found to be driving the variation in polychaete assemblage distribution that was associated with the soft coral habitat. This study is the first to provide an overview of polychaete fauna associated with the rare *D. australis* colony in Port Stephens and shows the high conservation value of this species.

The presence of a unique habitat will provide invaluable information for management and add significantly to the conservation value of a location. This is largely attributed to the relationship between habitat-forming species and processes maintaining local and regional biodiversity. The evidence from this study that the bed of *Dendronephthya australis* is a distinctive habitat will be useful in future revisions of the zoning plan that attempt to improve protection of biodiversity within the PSGLMP. This is because *D. australis* currently occurs within a General Purpose Zone (GPZ) and within close proximity to the Port Stephens marina. This location is at risk from anthropogenic activity such as anchor damage, fishing line entanglement, potential fuel leakage contamination, and possibly aquarium collection. A GPZ allows multiple uses, including fishing from a boat and trawling, as long as they are ecologically sustainable, however Sanctuary Zones allow for total protection of marine animals, plants and habitat. This is possible by prohibiting any activity that may involve harming any animal, plant or habitat such as fishing from a boat, motorised water sports and commercial or private collection.

7.4 Temporal variation in conservation

A potential consequence of spatio-temporal variation in the biodiversity of estuaries is that the conservation value of candidate sites may vary, depending on the time they were assessed. If true, this has implications for the achievement of conservation goals, e.g., temporal variation may lead to changes in the number and position of sites required to achieve a conservation goal. This also has potential socio-economic implications, e.g., when achieving a conservation goal requires restriction and re-distribution of human activities. This study showed that conservation value of each site changed over short-term (i.e. months) and long-term (i.e. years). A different makeup of sites was required to be conserved in order to protect 100% of species. The results of this study highlighted the potential consequences from using data from a single ‘snapshot’ sampling event, it will not provide adequate biological information for a system of conservation networks designed for longevity, particularly within a dynamic estuary open to influences from the land and sea.

The finding that conservation value of polychaete assemblages are not similar over a short-term and long-term scale has significant ramifications on how marine parks are mapped, particularly within an estuarine ecosystem that form a transition zone between the land and the sea. This research highlights that with evident temporal variation in benthic faunal assemblage structure, continual assessment of the biological value of candidate reserves is optimal in order to ensure a conservation system designed for longevity is adequately conserving not only a representative sample of the diversity of marine biota, but also accounts for temporal variation.

7.5 Identification of new species

Contributions to the identification and naming of Australia's taxa will assist in biodiversity conservation by ensuring a more complete representative portion of Australia's marine biota is included. With the identification of three new species (Family Nephtyidae) within the Port Stephens estuary, this study significantly contributed to knowledge of polychaete fauna. Two new species from the genus *Micronephthys* were described within this research. Previously 9 species of this genus had been identified in Australian and Indo-Pacific waters. The last contribution to this genus occurred in 2001; more than 10 years ago. One new species from the *Nephtys* genus was described. Previously 20 species of this genus had been identified in Australian and Indo-Pacific waters. The last contribution to this genus occurred in 1997; more than 15 years ago.With little known about the distribution and abundance of many marine species, the identification of previously unknown species will ensure conservation measures are more representative of the marine biota present.

7.6 Future research

This research was the first to provide a comprehensive species inventory of the polychaete fauna for the Port Stephens estuary of the Port Stephens-Great Lakes Marine Park. This baseline data can be utilised in further research necessary for the area. This research has also enabled managers to better understand key environmental variables influencing benthic faunal distributions within the dynamic marine park estuary. Further research is required in implementing the revised marine park zoning strategy to replace the current habitat protection scheme within other estuarine environments. The extensive time required to identify the large number of polychaetes collected from a large number of sites in Port Stephens estuary did not permit repeat sampling of the entire area, only selected sites in identified habitats. Therefore, further research of this topic needs to assess not only the applicability of the revised bio-geomorphic scheme in other estuaries, but also its temporal stability. This research has also highlighted the impact of temporal variation of benthic species on the conservation value of sites selected for conservation. Additional research needs to assess these changes over a longer time period and in other estuaries. When considering sediment dynamics, results from the current analyses show that the sediment had changed with time. This helps explain why in chapter 3 measured sediment parameters from 2009 correlate better with the fauna than the Habitat Classes from 2001. This use of these same Habitat Classes/changed sediments in Chapter 4 and 5 could also influence the results of the analyses. Future research should investigate this. In addition, it will be important to assess the consequences of changes in the sites prioritized for conservation through time on the human uses within the estuary. The current study on temporal variation in conservation value did not modify conservation value with any measure of threat or vulnerability. However, the Port Stephens estuary (like all other estuaries in NSW and internationally) is experiencing considerable growth in human uses. Therefore, the effects of temporal variation in anthropogenic activity (e.g. from increased tourist activity) needs to be incorporated in future analyses to ensure marine parks mapped only once using habitat surrogates are performing adequately. Also the rare soft coral habitat formed by *Dendronephthya australis* requires further investigation in terms of its effects on future revisions of the zoning plan, as do the consequences of these changes on conservation decisions regarding other habitats and species. Further research should also investigate polychaetes living symbiotically with the *D. australis* species and investigate if commensals inhabit the soft coral. Lastly, as a consequence of the crisis of biodiversity, this research highlights the imperative need to revalue the importance of taxonomic activities and expand on our taxonomic knowledge base. Numerous new species were discovered in the duration of this research which will need to be described in the future. Description of new species found in this study will contribute to the knowledge of polychaete biodiversity within Australian waters. Potential new species were discovered from polychaete families including Onuphidae (Hannelore Paxton *pers. comm.*). Specimens of Magelonidae and Phyllodocidae were also found which could help yield further information on these lesser known families.

A key argument for the use of surrogates in conservation planning is the lack of understanding and knowledge of ecological processes, and even species richness and distributions, within the marine realm. This coupled with a lack of funding and resources means that while marine parks are designed on scientific foundations, there is considerable room for more research to ensure a system designed for conservation and longevity is performing optimally and on a long term basis. Student projects such as this with the support of marine park managers (e.g., from the Marine Parks Authority) will ensure that marine protected networks are continually conserving, enhancing and re-establishing marine ecosystem condition, species abundance and species diversity.

Bibliography

AAAT (Aquaculture Action Agenda Taskforce). 2001. Aquaculture industry action agenda, discussion paper. Department of Aquaculture, Fisheries and Forestry, Australia.

ABRS. 2013. Australian Faunal Directory. Australian Biological Resources Study, Canberra. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/index.html [Date accessed: 23rd October 2012].

AFMA. 2013. The Australian Fisheries Management Authority. Available at: http://www.afma.gov.au/ [Date accessed: 14th June 2013].

ALA, 2014. Atlas of Living Australia. http://biocache.ala.org.au/occurrences/search?q=lsid:urn:lsid:biodiversity.org.au:afd.taxon:3b79a7e9-9403-471d-8f27-0668e6a7ca45#tab_recordsView [Date accessed: 13th March 2014].

Albouy, C., Guilhaumon, F., Araujo, M., Mouillot, D. and Leprieur, F. 2012. Combining projected changes in species richness and composition reveals climate change impacts on coastal Mediterranean fish assemblages. *Global Change Biology,* **18**: 2995-3003.

Anderson, M. 2001. A new method for non-parametric multivariate analysis of variance. *Austral Ecology,* **26**: 32-46.

Anderson, M., Ford, R., Feary, D. and Honeywill, C. 2004. Quantitative measures of sedimentation in an estuarine system and its relationship with intertidal soft-sediment infauna. *Marine Ecology Progress Series,* **272**: 33–48.

Anderson, M., Gorley, R. and Clarke, K. 2008. PERMANOVA+ for PRIMER: Guide to Software and Statistical Methods. University of Auckland, Auckland and PRIMER-E Ltd Plymouth.

Anderson, T., Nichol, S., Syms, C., Przeslawski, R. and Harris, P. 2011. Deep-sea bio-physical variables as surrogates for biological assemblages, an example from the Lord Howe Rise. *Deep-Sea Research II*, **58**: 979-991.

Angulo-Valdés, J. and Hatcher, B. 2009. A new typology of benefits derived from marine protected areas. *Marine Policy,* **34**: 635-644.

ANZECC TFMPA. 1998. Guidelines for establishing the national representative system of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council, Task Force on Marine Protected Areas. Environment Australia, Canberra.

Appletans, W., 120 others. 2012. The magnitude of global marine species diversity. *Current Biology*, **22**: 2189-2202.

Attrill, M. and Rundle, S. 2002. Ecotone or ecocline: ecological boundaries in estuaries. *Estuarine, Coastal and Shelf Science*, **55**: 929-936.

Augener, H. 1913. Polychaeta 1, Errantia *in* Michaelsen, W. and R. Hartmeyer (eds.): Die Fauna Sudwest-Australiens. *Ergebnisse der Hamburger sudwest-australischen Forschungsreise 1905*. **4**: 65-304.

Augener, H. 1922. Uber littoral Polychaeten von Westindien. *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin*, **1922**: 38-63.

Augener, H. 1927. Bijdragen tot de Kennis der Fauna van Curacao. Resultaten eener Reis van Dr. C.J. van der Horst in 1920. Polychaeten von Curaçao. *Bijdragen tot de dierkunde*, **25**: 39-82.

Australian Government. 2013. Biodiversity Conservation Strategy 2013. Great Barrier Reef Marine Park Authority, http://www.gbrmpa.gov.au/about-the-reef/biodiversity/biodiversity-conservation-strategy-2013 [Date accessed: 11th June 2013].

Australian Standard. 1977. Methods of testing soil for engineering purposes: Determination of the particle size distribution of a soil – standard method of analysis by sieving. AS 1289.C6.1. Standards Association of Australia, Sydney.

Babcock, R., Shears, N., Alcala, A., Barrett, N., Edgar, G., Lafferly, K., McClanahan, T. and Russ, G. 2010. Decadal trends in marine reserves reveal differential rates of change in direct and indirect effects. *Proceedings of the National Academy of Sciences of the United States of America,* **107**: 18251–18255.

Banks, S. and Skilleter, G. 2002. Mapping intertidal habitats and an evaluation of their conservation status in Queensland, Australia. *Ocean and Coastal Management*, **45**: 485-509.

Banks, S. and Skilleter, G. 2007. The importance of incorporating fine-scale habitat data into the design of an intertidal marine reserve system. *Biological Conservation*, **138**: 13-29.

Banks, S. and Skilleter, G. 2010. Implementing marine reserve networks: A comparison of approaches in New South Wales (Australia) and New Zealand. *Marine Policy,* **34**: 197-207.

Barnes, D., Linse, K., Waller, C., Morely, S., Enderlein, P., Fraser, K. and Brown, M. 2006. Shallow benthic fauna communities of South Georgia Island. *Polar Biology*, **29**: 223-228.

Barnes, R. and Ellwood, M. 2012. The critical scale of small-scale spatial variation in ecological patterns and processes in intertidal macrobenthic seagrass assemblages. *Estuarine, Coastal and Shelf Science,* **98**: 119-125.

Beesley, P., Ross, G. and Glasby, C. (eds). 2000. Polychaetes and allies: The southern synthesis. Fauna of Australia. Vol. 4A Polychaeta, Myzostomida, Pogonophora, Echiura, Sipuncula. CSIRO Publishing, Melbourne.

Beger, M., McKenna, S. and Possingham, H. 2007. Effectiveness of surrogate taxa in the design of coral reef reserve systems in the Indo-Pacific. *Conservation Biology*, **21**: 1584-1593.◘

Benham, W. 1915. Report on the Polychaeta obtained by the F.I.S. Endeavour on the coasts of New South Wales, Victoria, Tasmania and South Australia. Part I. *In*: *Biological Results of the Fishing Experiments carried on by the P.I.S. ENDEAVOUR, 1909-14*, **3**: 173-237.

Benham, W. 1916. Report on the Polychaeta obtained by the F.I.S. Endeavour on the coasts of New South Wales, Victoria, Tasmania and South Australia Part II. *In: Biological Results of the Fishing Experiments carried on by the P.I.S. ENDEAVOUR*, 1909-14. **4**: 125-162.

Bergström, U., Englund, G. and Bonsdorff, E. 2002. Small-scale spatial structure of Baltic Sea zoobenthos – inferring processes from patterns. *Journal of Experimental Marine Biology and Ecology,* **281**: 123-136.

Berke, S. 2010. Functional groups of ecosystem engineers: A proposed classification with comments on current issues. *Integrative and Comparative Biology,* **50**: 147-157.

Bertasi, F., Colangelo, M., Colosio, F., Gregorio, G., Abbiati, M. and Ceccherelli, V. 2009 Comparing efficacy of different taxonomic resolutions and surrogates in detecting changes in soft bottom assemblages due to coastal defence structures. *Marine Pollution Bulletin,* **58**: 686–694.

Borthagaray, A. and Carranza, A. 2007. Mussels as ecosystem engineers: Their contribution to species richness in a rocky littoral community. *ACTA Oecologica,* **31**: 243-250.

Breen, D., Avery, R. and Otway, N. 2004. Broad-scale biodiversity assessment of the Manning Shelf Marine Bioregion. NSW Marine Parks Authority, Sydney.

Breen, D., Avery, R. and Otway, N. 2004. Broad-scale biodiversity assessment of the Manning Shelf Marine Bioregion. NSW Marine Parks Authority, Sydney.

Brooks, T., Mittermeier, R., da Fonseca, G., Gerlach, J., Hoffmann, M., Lamoreux, J., Mittermeier, C., Pilgrim, J. and Rodrigues, A. 2006. Global biodiversity conservation priorities. *Science*, **313**: 58–61.

Buhl-Mortensen, L., Vanreusel, A., Gooday, A., Levin, L., Priede, I., Buhl-Mortensen, P., Gheerardyn, H., King, N. and Raes, M. 2010. Biological structures as a source of habitat heterogeneity and biodiversity on the deep ocean margins. *Marine Ecology,* **31**: 21-50.

Bunce, R., Bogers, M., Evans, D., Halada, L., Jongman, R., Mucher, C., Bauch, B., de Blust, G., Parr, T. and Olsvig-Whittaker, L. 2013. The significance of habitats as indicators of biodiversity and their links to species. *Ecological Indicators*, **33**: 19-25.

Capa, M. 2008. The genera *Bispira* Krøyer, 1856 and *Stylomma* Knight-Jones, 1997 (Polychaeta: Sabellidae): systematic revision, relationships with close related taxa and new species from Australia. *HydrobiologiaI*, **596**: 301–327.

Cardoso, P., Bankovic, M., Raffaelli, D. and Pardal, M. 2007. Polychaete assemblages as indicators of habitat recovery in a temperate estuary under eutrophication. *Estuarine, Coastal and Shelf Science*, **71**: 301-308.

Carwardine J., Rochester W., Richardson K., Williams K., Pressey R. and, Possingham H. (2007) Conservation planning with irreplaceability: does the method matter? *Biodiversity and* Conservation, **16**: 245-258. doi:10.1007/s10531-006-9055-4.

CDFW (California Department of Fish and Wildlife). 2013. California Marine Protected Areas (MPAs). http://www.dfg.ca.gov/marine/mpa/index.asp [Date accessed: 1st July 2013].

Chapman, C. 2009. ABRS Numbers of living species in Australia and the world: A Report for the Australian Biological Resources Study September 2009 Australian Biodiversity Information Services, Toowoomba, Australia http://www.environment.gov.au/biodiversity/abrs/publications/other/species-numbers/2009/03-exec-summary.html [Date accessed: 15th June 2013]

Chapman, M., Underwood, A. and Clarke, K. 2009. New indicies for ranking conservation sites using ‘relative endemism’. *Biological Conservation*, **142**: 3154-3162.

C GOV (People's Republic of China Government). 2013. State Oceanic Administration. http://english.gov.cn/2005-10/01/content_73182.htm [Date accessed: 1st July 2013].

Christensen, P., Glud, R., Dalsgaard, T. and Gillespie, P. 2003. Impacts of longline mussel farming on oxygen and nitrogen dynamics and biological communities of coastal sediments. *Aquaculture,* **218**: 567-588.

Clarke, K. 1993. Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology,* **18**: 117-143.

Clarke, K. and Ainsworth, M. 1993. A method of linking multivariate community structure to environmental variables. *Marine Ecology Progress Series,* **92:** 205-219.

Clarke, K. and Gorley, R. 2006. PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth.

Codling, I., Doughty, R., Hunter, J., Henderson, A. and Naismith, I. 1995. Strategies for monitoring sediments and fauna around cage fish farms. Scotland and Northern Ireland Forum for Environmental Research. Report No. SR 4018.

Cognetti, G. and Maltagliati, F. 2000. Biodiversity and adaptive mechanisms in brackish water fauna. *Marine Pollution Bulletin*, **40**: 7-14.

Coleman, F. and Wiliams, S. 2002. Overexploiting marine ecosystem engineers: potential consequesnces for biodiversity. *Trends in Ecology and Evolution,* **17**: 40-44.

Connolly, R. 1997. Differences in composition of small, motile invertebrate assemblages from seagrass and unvegetated habitats in a southern Australian estuary. *Hydrobiologia,* **346**: 137-148.

Cornish, A. and DiDonato, E. 2004. Resurvey of a reef flat in American Samoa after 85 years reveals devastation to a soft coral (Alcyonacea) community. *Marine Pollution Bulletin,* **48**: 768-777.

Costello, M., Coll, M., Danovaro, R., Halpin, P., Ojaveer, H. and Miloslavich, P. 2010. A census of marine biodiversity knowledge, resources, and future challenges. *PLoS ONE*, **5**: e12110. DOI:10.1371/journal.pone.0012110

Crain, C. and Bertness, M. 2006. Ecosystem engineering across environmental gradients: implications for conservation and management. *BioScience,* **56**: 211-218.

Crawford, C., Macleod, C. and Mitchell, I. 2002. Evaluation of techniques for environmental monitoring of salmon farms in Tasmania. *Tasmanian Aquaculture and Fisheries Institute Technical Report Series*, **8**: 1441-8487.

Crawford, C., Macleod, C. and Mitchell, I. 2003. Effects of shellfish farming on the benthic environment. *Aquaculture*, **224**: 117-140.

Creese, R. and Breen, D. 2003. Marine Protected Areas in NSW: Challenges for research *In*: *Conserving marine environments: out of sight out of mind. Hutchings, P. and Lunney, D. (eds). Royal Zoological Society of NSW,* Mosman, NSW, p120-128.

Creese, R., Glasby, T., West, G. and Gallen, C. 2009. Mapping the habitats of NSW estuaries. Industry and Investment NSW – Fisheries Final Report Series, No. 113. ISSN 1837-2112.

Crooks, J. and Khim, H. 1999. Architectural vs. Biological effects of a habitat-altering, exotic mussel, *Musculista senhousia*. *Journal of Experimental Marine Biology and Ecology,* **240**: 53-75.

Cuvier, G. 1817. Le règne animal distribué d'après son organisation : pour servir de base a l'histoire naturelle des animaux et d'introduction a l'anatomie comparée. VOLUME 4. Les Zoophytes, les Tables, et les Planches. Deterville, Paris.

Dauer, D., Llansó, R. and Lane, M. 2008. Depth-related patterns in benthic community condition along an estuarine gradient in Chesapeake Bay, USA. *Ecological Indicators*, **8**: 417-424.

Day, J. and Hutchings, P. 1979. An annotated check-list of Australian and New Zealand Polychaeta, Archiannelida and Myzostomida. *Records of the Australian Museum*, **32**: 80-161.

Day, J., Hall, C., Kemp, W. and Yάῃez-Arancibia, A. 1989. Estuarine Ecology *In*: John Wiley and Sons, Inc., (eds). New York, Chichester, Brisbane, Toronto, Singapore, p558.

De'ath, G. and Fabricius, K. 2000. Classification and regression trees: A powerful yet simple technique for ecological data analysis. *Ecology,* **81**: 3178-3192.

Dean, W. Jr. 1974. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignition: Comparison with other methods. *Journal of Sedimentary Petrology,* **44**: 242-248.

Dernie, K., Kaiser, M. and Warwick, R. 2003. Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*, **72**: 1043-1056.

Delle Chiaje, S. 1841. Descrizione e Notomia degli Animali Invertebrati della Sicilia Citeriore osservati vivi negli anni 1822-1830. Naples, 1841-1844.

Dixon-Bridges, K., Hutchings, P. and Gladstone, W. 2013. Effectiveness of habitat classes as surrogates for biodiversity in marine reserve planning. *Aquatic Conservation: Marine and Freshwater Ecosystems*, DOI: 10.1002/aqc.2377.

Dolbeth, M., Martinho, F., Viegas, I., Cabral, H. and Pardal, M. 2008. Estuarine production of resident and nursery fish species: conditioning by drought events? *Estuarine, Coastal and Shelf Science*, **78**: 51-60.

Dubois, A. 2003. The relationships between taxonomy and conservation biology in the century of extinctions. *Comptes Rendus Biologies*, **326**: 9-21.

Dunning, J., Danielson, B. and Pulliam, H. 1992. Ecological processes that affect populations in complex landscapes. *Oikos*, **65**: 169-175.

Edgar, G. and Barrett, N. 2002. Benthic macrofauna in Tasmanian estuaries: scales of distribution and relationships with environmental variables. *Journal of Experimental Marine Biology and Ecology*, **270**:1–24.

Edgar, G. and Stuart-Smith, R. 2009. Ecological effects of marine protected areas on rocky reef communities: a continental-scale analysis. *Marine Ecology Progress Series,* **388**: 51–62.

Edgar, G., Barrett, N., Graddon, D. and Last, P. 2000. The conservation significance of estuaries: a classification of Tasmanian estuaries using ecological, physical and demographic attributes as a case study. *Biological Conservation*, **92**:383-397.

Edgar, G., Langhammer, P., Allen, G., Brooks, T., Brodie, J., Crosse, W., De Salva, N., Fishpool, L., Foster, M., Knox, D., McCosker, J., McManus, R., Millar, A. and Mugo, R. 2008. Key biodiversity areas as globally significant target sites for the conservation of marine biological diversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **18**: 969-983.

Ellingsen, K., Brandt, A., Ebbe, B. and Linse, K. 2007. Diversity and species distribution of polychaetes, isopods and bivalves in the Atlantic sector of the deep Southern Ocean. *Polar Biology,* **30**:1265–1273.

Environment Australia. 2002. Overview of the conservation of Australian marine invertebrates chapter 2 http://malsocaus.org/marine_invert/chapt2mn.html [Date accessed: 23rd May 2013].

EPBC ACT. 2013. Department of Sustainability, Environment, Water, Population and Communities http://www.environment.gov.au/coasts/species/marine-species-list.html [Date accessed: 1st July 2013]

EPBC Act 1999. Department of Sustainability, Environment, Water, Population and Communities. http://www.environment.gov.au/biodiversity/threatened/ [Date accessed: 8th May 2013].

Fabricius, K. and Alderslade, P. 2001. Soft Corals and Sea Fans: a comprehensive guide to the tropical shallow-water genera of the Central-West Pacific, the Indian Ocean and the Red Sea. *Australian Institute of Marine Sciences,* **30**: 1-15.

Fauchald, K. 1963. Nephtyidae (Polychaeta) from Norwegian waters. *Sarsia*, **13**: 1-32.

Fauchald, K. 1965. Some Nephtyidae (Polychaeta) from Australian waters. *Records of the Australian Museum*, **26**: 333-340.

Fauchald, K. 1977. The polychaete worms, definitions and keys to the orders, families and genera. *Natural History Museum of Los Angeles County: Los Angeles, CA (USA) Science Series,* **28**: 1-188.

Fauchald, K. and Jumars, P. 1979. The diet or worms: A study of polychaete feeding guilds. *Oceanography and Marine Biology: Annual Review,* **17**: 193-284.

Fauchald, K. and Rouse, G. W. 1997. Cladistics and polychaetes. *Zoologica Scripta,* **26**: 139-204.

Ferrier, S., Pressey, R., and Barrett, T. 2000. A new predictor of the irreplaceability of areas for achieving a conservation goal, its application to real-world planning, and a research agenda for further refinement. *Biological Conservation*, **93**: 303–325.

Foley, M., Halpern, B., Micheli, F., Armsby, M., Caldwell, M., Crain, C., Prahler, E., Rohr, N., Sivas, D., Beck, M., Carr, M., Crowder, L., Duffy, J., Hacker, S., McLeod, K., Peterson, C., Regan, H., Ruckelshaus, M., Sandifer, P. and Steneck, R. 2010. Guiding ecological principles for marine spatial planning. *Marine Policy*, **34**: 955-966.

Ford, E. and Hutchings, P. 2005. An analysis of morphological characters of Owenia useful to distinguish species: description of three new species of Owenia (Oweniidae: Polychaeta) from Australian waters. *Marine Ecology*, **26**: 181-196.

França, S., José Costa, M. and Cabral, H. 2009. Assessing habitat specific fish assemblages in estuaries along the Portuguese coast. *Estuarine, Coastal and Shelf Science*, **83**:1-12.

Fraser, C., Hutchings, P. and Williamson, J. 2006. Long-term changes in polychaete assemblages of Botany Bay (NSW, Australia) following a dredging event. *Marine Pollution Bulletin*, **52**: 997-1010.

Freidrich, H. 1937. Polychaetenstudien 1-111. *Kiler Meeresforsch,* **1**: 343-351.

Friedlander, A., Sladek Nowlis, J., Sanchez, J., Appeldoorn, R., Usseglio, P., McCormick, C., Bejarano, S. and Mitchell-Chui, A. 2003. Designing effective Marine Protected Areas in Seaflower Bioshere Reserve, Columbia, based on biological and sociological information. *Conservation Biology,* **17**: 1769-1784.

Frojan, C., Kendall, M., Paterson, G., Hawkins, L., Nimsantijaroen, S. and Aryuthaka, C. 2009. The importance of bare marine sedimentary habitats for maintaining high polychaete diversity and the implications for the design of marine protected areas. *Aquatic Conservation: Marine and Freshwater Ecosystems,* **19**: 748–757.

FSC. 2010. Fisheries Scientific Committee: Final Determination. The marine worm - *Hadrachaeta aspeta* as a species presumed extinct in NSW**.** Ref. No. FD47; File No. FSC 10/04. http://www.dpi.nsw.gov.au/data/assets/pdf_file/0003/408279/Hadrachaeta-aspeta.pdf [Date accessed: 5th July 2013].

Gaspar, M., Carvalho, S., Cúrdia, J., dos Santos, M. and Vasconcelos, P. 2011. Restoring coastal ecosystems from fisheries and aquaculture impacts. Reference Module in Earth Systems and Environmental Sciences, from Treatise on Estuarine and Coastal Science, Volume 10, p. 165-187.

Geselbracht, L., Torres, R., Cumming, G., Dorfman, D., Beck, M. and Shaw, D. 2009. Identification of a spatially efficient portfolio of priority conservation sites in marine and estuarine areas of Florida. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **19**: 408-420.

Giangrande, A., Licciano, M. and Musco, L. 2005. Polychaetes as environmental indicators revisited. *Marine Pollution Bulletin,* **50**: 1153-1162.

Gladstone, W. 2002. The potential value of indicator groups in the selection of marine reserves. *Biological Conservation,* **104**: 211-220.

Gladstone, W. 2007. Requirements for marine protected areas to conserve the biodiversity of rocky reef fishes. *Aquatic Conservation: Marine and Freshwater Systems*, **17**: 71-87.

Gladstone, W. and Alexander, T. 2005. A test of the higher-taxon approach in the identification of candidate sites for marine reserves. *Biodiversity and Conservation*, **14**: 3151-3168.

Glasby, C. and Fauchald, K. 2003. POLiKEY: An information system for polychaete families and higher taxa Version 2. www.environment.gov.au/biodiversity/abrs onlineresources/polikey/index.html [Date accessed: 11th June 2013].

Glasby, C. and Hutchings, P. 2010. A new species of *Marphysa* Quatrefages, 1965 (Polychaeta: Eunicida: Eunicidae) from Northern Australia and a review of similar taxa from the Indo-west pacific, including the genus *Nauphanta* Kinberg, 1865. *Zootaxa,* **2352**: 29-45.

Glasby, C., Hutchings, P., Fauchald, K., Paxton, H., Rouse, G., Russell, C. and Wilson, R. 2000. Class Polychaeta *In: Beesley, P., Ross, G. and Glasby, C. (eds) 2000. Polychaetes and allies: The southern synthesis. Fauna of Australia. Vol. 4A*

Polychaeta, Myzostomida, Pogonophora, Echiura, Sipuncula. CSIRO Publishing, Melbourne, p1-296.

Gotelli, N. and Colwell, R. 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. *Ecology Letters,* **4**:379-391.

Grant, J., Hatcher, A., Scott, D., Pocklington, P., Schafer, C. and Winters, G. 1995. A multi disciplinary approach to evaluating impacts of shellfish aquaculture on benthic communities. *Estuaries*, **18**: 124-144.

Gray J. 2001. Marine diversity: the paradigms in patterns of species richness examined. *Scientia Marina,* **65**: 41-56.

Great Barrier Reef Marine Park Authority. 2013. Great Barrier Reef Biodiversity Conservation Strategy 2013, GBRMPA, Townsville.

Grilo, T., Cardoso, P., Dolbeth, M., Bordalo, M. and Pardal, M. 2011. Effects of extreme climate events on the macrobenthic communities'structure and functioning of a temporate estuary. *Marine Pollution Bulletin,* **62**: 303-311.

Groves, C. 2003. *Drafting a Conservation Blueprint.* Washington (DC): Island Press.

Grube, A. 1850. Die Familien der Anneliden. *Archiv für Naturgeschichte,* **16**: 249 – 364.

Grube, A. 1878. Annulata Semperiana. Beitrage zur Kenntniss der Annelidenfauna der Philippinennach den von Herrn Prof. Semper mitgebrachten Sammlungen. *Mémoires de l'Académie Impériale des Sciences de St.-Pétersbourg,* **25**: 1-300.

Halpern, B., Walbridge, S., Selkoe, K., Kappel, C., Micheli, F., D'Agrosa, C., Bruno, J., Casey, K., Ebert, C., Fox, H. Fujita, R., Heinemann, D., Lenihan, H., Madin, E., Perry, M., Selig, E., Spalding, M., Steneck, R. and Watson, R. 2008. A global map of human impact on marine ecosystems. *Science,* **319**: 948–952.

Hansen, G., Ban, N., Jones, M., Kaufman, L., Panes, H., Yasué, M. and Vincent, A. 2011. Hindsight in marine protected area selection: A comparison of ecological representation arising from opportunistic and systematic approaches. *Biological conservation*, **144**: 1866-1875.

Harris, P. 2012. Surrogacy *In: Seafloor Geomorphology as benthic habitat: GeoHAB atlas of seafloor geomorphic features and benthic habitats. Marine and Coastal Environment Group, Geoscience Astralia, Canberra, Australia, p93-108.*

Harris, P., Heap, A., Whiteway, T. and Post, A. 2008. Application of biophysical information to support Australia's representative marine protected area program. *Ocean and Coastal Management,* **52**: 701-711.

Hartman, O. 1938. Review of the annelid worms of the family Nephtyidae from the northeast Pacific, with descriptions of five new species. *Proceedings of the United States National Museum*, **85**: 143-158.

Hartman, O. 1950. Goniadidae, Glyceridae and Nephtyidae. *Allan Hancock Pacific Expedition,* **15**: 1-181.

Hartman, O. 1959. Catalogue of the polychaetous Annelids of the world. Part I. Occasional Paper. *Allan Hancock Foundation Publications,* **23**: 1–353.

Hébert-Chatelain, E., Breton, S., Lemieux, H. and Blier, P. 2008. Epitoky in *Nereis* (*Neanthes*) *virens* (polychaeta: Nereididae): A story about sex and death.

Comparative Biochemistry and Physiology - B Biochemistry and Molecular Biology, **149**: 202-208.

Hentschel, B. 1996. Ontogenetic changes in particle-size selection by deposit-feeding spionid polychaetes: the influence of palp size on particle contact. *Journal of Experimental Marine Biology and Ecology,* **206**: 1-24.

Hermoso, V., Januchowski-Hartley, S. and Pressey, R. 2013. When the suit does not fit biodiversity: Loose surrogates compromise the achievement of conservation goals. *Biological Conservation,* **159**: 197-205.

Hewitt, C., Campbell, M., Thresher, R. and Martin, R. 1999. Marine biological invasions of Port Phillip Bay, Victoria. *CRIMP Technical Report No. 20, CSIRO Marine Research, Hobart, Tasmania, p1-344.*

Hirst, J. 2008. Surrogate measures for assessing cryptic faunal biodiversity on macroalgal-dominated subtidal reefs. *Biological Conservation,* **141**: 211-220.

Hooper, J. and Wiedenmayer, F. 1994. Zoological catalogue of Australia. Volume 12. Porifera. CSIRO, Melbourne.

Hourston, M., Potter, I., Warwick, R. and Valesini, F. 2011. The characteristics of the nematode faunas in subtidal sediments of a large microtidal estuary and nearshore coastal waters differ markedly. *Estuarine, Coastal and Shelf Science*, **94**: 68-76.

Howell, K. 2010 A benthic classification system to aid in the implementation of marine protected area networks in the deep/high seas of the NE Atlantic. *Biological Conservation*, **143**: 1041-1056.

Huang, Z., Brooke, B. and Harris, P. 2011. A new approach to mapping marine benthic habitats using physical environmental data. *Continental Shelf Research*, **31**: 4-16.

Hughes, A., Williams, S., Duarte, C., Heck Jr., K. and Waycott, M. 2009. Associations of concern: declining seagrasses and threatened dependent species. *Frontiers in Ecology and the Environment,* **7**: 242-246.

Hutchings, P. 1974. Polychaeta of Wallis Lake, New South Wales. *Proceedings of the Linnean Society of New South Wales*, **98**: 175-195.

Hutchings, P. 1977. The Terebelliform polychaeta from Australia, chiefly from Moreton Bay, Queensland. *Records of the Australian Museum*, **31**: 1-39.

Hutchings, P. 1990. Review of the effects of trawling on macrobethnic epifaunal communities. *Australian Journal of Marine and Freshwater Research*, **41**: 111-120.

Hutchings, P. 1998. Biodiversity and functioning of polychaetes in benthic sediments. *Biodiversity and Conservation,* **7**: 1133-1145.

Hutchings, P. 1999. Taxonomy of estuarine invertebrates in Australia. *Australian Journal of Ecology,* **24**: 381-394.

Hutchings, P. 2003. Polychaetes – their biological diversity. *Records of the South Australian Museum Monograph Series*, **7**: 39-49.

Hutchings, P. 2012. Death of life Sciences: a personal perspective*. Australian Zoologist, **36**: 242-46.*

Hutchings, P. and Glasby, C. 1986. The Polycirrinae (F. Terebellidae) of Australia. *Records of the Australian Museum,* **38**: 319–350.

Hutchings, P. and Glasby, C. 1987. The Thelepinae (F. Terebellidae) from Australia together with a discussion of the generic and specific characters of the family. *Bulletin of the Biological Society of Washington,* **7**: 217–250.

Hutchings, P. and Glasby, C. 1988. The Amphitritinae (F. Terebellidae) of Australia. *Records of the Australian Museum,* **40**: 1–60.

Hutchings, P. and Jacoby, C. 1994. Temporal and spatial patterns in the distribution of infaunal polychaetes in Jervis Bay, New South Wales. *Mémoires du Muséum D'Histoire Naturelle,* **162**: 441–452.

Hutchings, P. and Johnson, R. 2001. A catalogue of the Australian polychaetes, http://www.environment.gov.au/abrs/abif-faunal/vols.www.htm. [Date accessed: 24th May 2013].

Hutchings, P. and Murray, A. 1984. Taxonomy of polychaetes from the Hawkesbury River and the southern estuaries of New South Wales, Australia. *Records of the Australian Museum*, **36**: 1-113.

Hutchings, P. and Peart, R. 2000. A revision of the Australian Trichobranchidae (Polychaeta). *Invertebrate Taxonomy*, **14**: 225–272.

Hutchings, P. and Ponder, W. 2003. Editorial - Marine invertebrates and their conservation. *Marine Pollution Bulletin,* **46**: 153-154.

Hutchings, P. and Recher, H. 1974. The fauna of Careel Bay with comments on the ecology of mangrove and sea grass communities. *Australian Zoology*, **18**: 99-128.

Hutchings, P. and Turvey, S. 1982. The Nereididae of South Australia. *Transactions of the Royal Society of South Australia*, **106**: 93-144.

Hutchings, P., Wells, F., Walker, D. and Kendrick, G. 1991. Seagrass, sediment and infauna – a comparison of *Posidonia australis, Posidonia sinuosa,* and *Amphibolis antarctica In: Wells, F., Walker, D., Kirkman, H. and Lethbridge, R. (eds)Princess Royal Harbour, south-western Australia. II. Distribution, composition and abundance of macrofauna in Proceedings of the Third International Marine Biological Workshop: The marine flora and fauna of Albany, Western Australia, Western Australian Museum, Perth. Volume 2, p. 611-633.*

Idjadi, J. and Edmunds, P. 2006. Scleractinian corals as facilitators for other invertebrates on a Caribbean reef. *Marine Ecology Progress Series,* **319**: 117-127.

Imajima, M. and Takeda, Y. 1987. Nephtyidae (Polychaeta) from Japan. II. The genera Dentinephtys and Nephtys. *Bulletin of the National Science Museum, Tokyo, Series A (Zoology)*, **13**: 41-77.

Jackson, J. 2008. Ecological extinction and evolution in the brave new ocean. *Proceedings of the National Academy of Sciences of the United States of America,* **105**: 11458-11465.

Jamieson, G. 1993. Marine invertebrate conservation: evaluation of fisheries over-exploitation concerns. *Integrative and Comparative Biology*, **33**: 551-567.

Jha, R. and Zi-rong, X. 2004. Biomedical compounds from marine organisms. *Marine Drugs*, **2**: 123-146.

Jones, A. 1989. Zoobenthic variability associated with a food and drought in the Hawkesbury Estuary, New South Wales: some consequences for environmental monitoring. *Environmental Monintoring and Assessment,* **14**: 185-195.

Jones, C., Lawton, J. and Shackak, M. 1994. Organisms as ecosystem engineers. *Oikos,* **69**: 373-386.

Jones, P. 1994. A review and analysis of the objectives of marine nature reserves. *Ocean and Coastal Management*, **24:** 149-178.

Jung, R. and Hong, J. 1997. Nephtyidae (Annelida: Polychaeta) from the Yellow Sea. *Bulletin of Marine Science*, **60**: 371-384

Just, J. 1998. Biodiversity: the scene in Australia and the role of the Australian Biological Resource Study. *International Journal for Parasitology,* **28**: 881-885.

Kalamandeen, M. and Gillson, L. 2007. Demything wilderness: implications for protecting area designation and management. *Biodiversity and Conservation,* **16**: 165-182.

Kaplan, D., Planes, S., Fauvelot, C., Brochier, T., Lett, C., Bodin, N., Loc'h, F. Le, Tremblay, Y. and Georges, J. 2010. New tools for the spatial management of living marine resources. *Current Opinion in Environmental Sustainability*, **2**: 88–93.

Kenchington, R. and Hutchings, P. 2012. Science, biodiversity and Australian management of marine ecosystems. *Ocean and Coastal Management*, **69**: 194-199.

Kennish, M. 1990. Ecology of Estuaries *In: Biological Aspects, vol. II. CRC Press, Boca Raton, Florida, USA, p. 380.*

Kinberg, J. 1866. Annulata nova. *Öfversigt af Königlich Vetenskapsakademiens förhandlingar, Stockholm*, **23**: 337-357.

Kirkegaard, J. 1995. Bathyal and abyssal polychaetes (errant species). *Galathea Report*, **17**: 7-56.

Kitamori, R. 1960. Two new species of cirratulid and Nephthydidae (Annelida: Polychaeta). *Bulletin of the Japanese Society for Scientific Fisheries*, **26**: 1082-1085.

Knox, G. and Cameron, D. 1971. Port Phillip Bay Survey 1957-1963, Victoria, Australia. Part 2(4). *Polychaeta. Memoirs of the National Museum of Victoria*, **32**: 21-42.

Konishi, K. 1981. *Alcyonarian spiculities*: limestone of soft corals. *Proceedings of the Fourth International Coral Reef Symposium,* **1**: 643-649.

Kristensen, E. 1988. Life cycle, growth and production in esuarine populations of the polychaetes *Nereis virens* and *N. diversicolor*. *Holarctic Ecology,* **7**: 249-256.

Labrune, C., Crémare, A., Amouroux, J., Sardá, R., Gil, J. and Taboada, S. 2007. Assessment of soft-bottom polychaete assemblages in the Gulf of Lions (NW Mediterranean) based on a mesoscale survey. *Estuarine Coastal and Shelf Science,* **71**: 133-147.

Lamarck, J. 1818. Histoire naturelle des animaux sans vertèbres, présentant les caractères généraux et particuliers de ces animaux, leur distribution, leurs classes, leurs familles, leurs genres, et la citation des principales espèces qui s'y rapportent; précédée d'une introduction offrant la détermination des caractères essentiels de l'animal, sa distinction du végétal et des autres corps naturels, enfin, l'exposition des principes fondamentaux de la Zoologie. *Paris: Déterville and Verdière, p. 612.*

Last, P., Lyne, V., Williams, A., Davies, C., Butler, A. and Yearsley, G. 2010. A hierarchical framework for classifying seabed biodiversity with application to planning and managing Australia's marine biological resources. *Biological Conservation*, **143**: 1675-1686.

Lattig, P., Martin, D. and San Martín, G. 2010. Syllinae (Syllidae: Polychaeta) from Australia. Part 4. The genus *Haplosyllis* Langerhans, 1879. *Zootaxa*, **2552**: 1-36.

Lester, S., Halpern, B., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B., Gaines, S., Airame´, S. and Warner, R. 2009. Biological effects within no-take marine reserves: a global synthesis. *Marine Ecology Progress Series,* **384**: 33–46.

Lindsay, M., Patterson, H. and Swearer, S. 2008. Habitat as a surrogate measure of reef fish diversity in the zoning of the Lord Howe Island Marine Park, Australia. *Marine Ecology Progress Series,* **353**: 265-273.

Lovell, S., Harmer, M., Slotow, R. and Herbert, D. 2007. Assessment of congruency across invertebrate taxa and taxonomic levels to identify potential surrogates. *Biological Conservation*, **139**: 113-125.

Mackie, A., Parmiter, C. and Tong, L. 1997. Distribution and diversity of Polychaeta in the Southern Irish Sea. *Bulletin of Marine Science*, **60**: 467-481.

Magalhães, W. and Barros, F. 2011. Structural and functional approaches to describe polychaete assemblages: ecological implications for estuarine ecosystems. *Marine and Freshwater Research,* **62**: 918-926.

Malaquias, M., Bentes, L., Erzini, K. and Borges, C. 2006. Molluscan diversity caught by trawling fisheries: a case study in southern Portugal. *Fisheries Management and Ecology*, **13**: 39-45.

Malcolm, H., Foulsham, E., Pressey, R., Jordan, A., Davies, P., Ingleton, T., Johnstone, N., Hessey, S. and Smith, S. 2012. Selecting zones in a marine park: Early systematic planning improves cost-efficiency; combining habitat and biotic data improves effectiveness. *Ocean and Coastal Management,* **59**: 1-12.

Malcolm, H., Jordan, A., Smith, S. 2010. Biogeographical and cross-shelf patterns of reef fish assemblages in a transition zone. *Marine Biodiversity,* **40**:181-193.
Malcolm, H., Jordan, A., Smith, S. 2011. Testing a depth-based Habitat Classification System against reef fish assemblage patterns in a subtropical marine park. *Aquatic Conservation: Marine and Freshwater Ecosystems,* **21**: 173–185.

Malm, A. 1874. Annulata i hafvet utmed Sveriges westkust och omkring Goeteborg. *Göteborgs Königlich vetenskaps- och vitterhetssamhälles handlingar*, **14**: 67-105.

Margules, C. and Pressey, R. 2000. Systematic conservation planning. *Nature*, **405**: 243-253.

Margules, C., Nicholls, A. and Pressey, R. 1994. Apparent species turnover, probability of extinction and the selection of nature reserves: a case study on the Ingleborough limestone pavements. *Conservation Biology*, **8**: 398–409.

Mattila, J., Chaplin, G., Eilers, M., Heck, K. Jr., O'Neal, J. and Valentine, J. 1999. Spatial and diurnal distribution of invertebrate and fish fauna of a *Zostera marina* bed and nearby unvegetated sediments in Damariscotta River, Maine (USA). *Journal of Sea Research,* **41**: 321–332.

May, R. 1988. How many species on earth? *Science*, **241**: 1441-1449.

McArdle, B. and Anderson M. 2001. Fitting multivariate models to community data: a comment on distance-based redundancy analysis. *Ecology,* **82**: 290-297.

McArthur, M., Brooke, B., Przeslawski, R., Ryan, D., Lucieer, V., Nichol, S., McCallum, A., Mellin, C., Cresswell, I. and Radke, L. 2010. On the use of abiotic surrogates to describe marine benthic biodiversity. *Estuarine, Coastal and Shelf Science,* **88**: 21-32.

Meadows, P., Meadows, A. and Murray, J. 2012. Biological modifiers of marine benthic seascapes: Their role as ecosystem engineers. *Geomorphology,* **157-158**: 31-48.

Mellin, C., Delean, S., Caley, J., Edgar, G., Meekan, M., Pitcher, R., Przeslawski, R., Williams, A. and Bradshaw, C. 2011. Effectiveness of biological surrogates for predicting patterns of marine biodiversity: A global meta-analysis. *PLoS ONE*, **6**: e20141. Doi:10.1371/journal.pone.0020141.

Mesa, L., Fernάndez, H. and Manzo, M. 2009. Seasonal patterns of benthic arthropods in a subtropical Andean basin. *Limnologica,* **39**: 152-162.

Miller, R., Hocevar, J., Stone, R. and Fedorov, D. 2012. Structure-forming corals and sponges and their use as fish habitat in Bering Sea submarine canyons. *PLoS ONE,* **7**: 1-9.

Moore, J. 1903. Polychaeta from the coastal slope of Japan and from Kamchatka and Bering Sea. *Proceedings of the Academy of Natural Sciences, Philadelphia*, **55**: 401-490.

Morrisey, D., Howitt, L., Underwood, A. and Stark, J. 1992a. Spatial variation in soft-sediment benthos. *Marine Ecology Progress Series,* **81**: 197-204.

Morrisey, D., Underwood, A., Howitt, L. and Stark, J. 1992b. Temporal variation in soft sediment benthos. *Journal of Experimental Marine Biology and Ecology*, **164**: 233-245.

Mortensen P. 2001. Aquarium observations on the deepwater coral *Lophelia pertusa* (L., 1758) (Scleractinia) and selected associated invertebrates. *Ophelia,* **54**: 83–104.

MPA (NSW Marine Parks Authprity). 2010. Marine Parks strategic research framework 2010-2015. Available at http://www.mpa.nsw.gov.au/pdf/Marine-Parks-Strategic-Research-Framework-2010-2015.pdf [Date accessed: 14th June 2013].

MPA NSW. 2013. Port Stephens-Great Lakes and Batemans Marine Park - Recreational and commercial activities. http://www.mpa.nsw.gov.au/psglmp-activities.html [Date accessed: 22nd May 2013].

MPA. 2009. Marine Parks Authority: Port Stephens-Great Lakes Marine Park, http://www.mpa.nsw.gov.au/psglmp.html [Date accessed: 22nd May 2013].

Müller, O. 1789. Zoologia Danica seu animalium Daniae et Norvegiae rariorum ac minus notorum. *Descriptiones et historia* (Vol. 3). Havinae.

Musco, L., Mikac, B., Tataranni, M., Giangrande, A. and Terlizzi, A. 2011. The use of coarser taxonomy in the detection of long-term changes in polychaete assemblages. *Marine Environmental Research,* **71**:131-138.

Mutlu, E., Çinar, M. and Ergev, M. 2010. Distribution of soft-bottom polychaetes of the Levantine coast of Turkey, eastern Mediterranean Sea. *Journal of Marine Systems,* **79**: 23-35.

Naeem, S. 2006. Expanding scales in biodiversity-based research: challenges and solutions for marine systems. *Marine Ecology Progress Series,* **311**: 273-283.

Nanami, A., Saitoa, H., Akitab, T., Motomatsuc, K. and Kuwaharaa, H. 2005. Spatial distribution and assemblage structure of macrobenthic invertebrates in a brackish lake in relation to environmental variables. *Estuarine, Coastal and Shelf Science,* **63**: 167-176.

Nateewathana, A. and Hylleberg, J. 1986. Nephtyid polychaetes from the west coast of Phuket Island, Andaman Sea, Thailand with description of five new species. *Proceedings of the Linnean Society of New South Wales*, **108**: 195-215

Neely, A. and Zajac, R. 2008. Applying marine protected area design models in large estuarine systems. *Marine Ecology Progress Series*, **373**: 11-23.

Newton, K., Creese, B. and Raftos, D. 2007. Spatial patterns of ascidian assemblages on subtidal rocky reefs in the Port Stephens-Great Lakes Marine Park, New South Wales. *Marine and Freshwater Research,* **58**: 843-855.

Nixon, S. 1995. Coastal marine eutrophication: a definition, social causes, and future concerns. *Ophelia*, **41**: 199–219.

Norden, B., Ryberg, M., Gotmark, F. and Olausson, B. 2004. Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. *Biological Conservation,* **117**:1–10.

Noss, R. 1987. From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy (USA). *Biological Conservation,* **41**: 11–37.

NRMMC (Natural Resource Management Ministerial Council). 2010. Australia's Biodiversity Conservation Strategy 2010-2030, Australian Government, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

NSW DPI. 2013. NSW Department of Primary Industries: Fishing and Aquaculture. http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what-current [Date accessed: 5th July 2013].

NSW Marine Parks. 2013. NSW Marine Parks. http://www.mpa.nsw.gov.au/index.html [Date accessed: 1st July 2013].

NSW Marine Parks Authority. 2001. Developing a representative system of marine protected areas in NSW – an overview. *Environment Australia*, Canberra.

NSW Marine Parks Authority. 2006. Socio-Economic Assessment of the Port Stephens – Great Lakes Marine Park. Environment Australia, Canberra.

Olive, P. 1984. Environmental control of reproduction in Polychaeta. *Fortschritte der Zoologie,* **29**: 17-38.

Olive, P. 1999. Polychaete aquaculture and polychaete science: a mutual synergism. *Hydrobiologia,* **402**: 175-183.

Olive, P. and Clark, R. 1978. Physiology of reproduction *In: Mill PJ. (eds) Physiology of annelids. Academic Press, London, p271-368.*

Olsgard, F., Brattegard, T. and Holthe, T. 2003. Polychaetes as surrogates for marine biodiversity: lower taxonomic resolution and indicator groups. *Biodiversity and Conservation,* **12**: 1033-1049.

Olsgard, F. and Somerfield, P. 2000. Surrogates in marine benthic investigations- which taxonomic unit to target? *Journal of Aquatic Ecosystem Stress and Recovery*, **7**: 25-42.

Olsgard, F., Somerfield, P. and Carr, M. 1997. Relationships between taxonomic resolution and data transformations in analyses of a macrobenthic community along an established pollution gradient. *Marine Ecology Progress Series*, **149**: 173-181.

Olsgard, F., Somerfield, P. and Carr MR 1998. Relationships between taxonomic resolution, macrobenthic community patterns and disturbance. *Marine Ecology Progress Series*, **172**: 25–36.

Ourives, T., Rizzo, A. and Boehs, G. 2011. Composition and spatial distribution of the benthic macrofauna in the Cachoeira River estuary, Ilhéus, Bahia, Brazil. *Revista de Biología Marina y Oceanografía*, **46**: 17-25.

Paiva, P. 2001. Spatial and temporal variation of a nearshore benthic community in Southern Brazil: Implications for the design of monitoring programs. *Estuarine, Coastal and Shelf Science*, **52**: 423-433.

Palmer, P. 2010. Polychaete – assisted sand filters. *Aquaculture*, **306**: 369-377.

Palumbi, S., Sandifer, P., Allan, J, Beck., M., Fautin, D., Fogarty, M., Halpern, B., Incze, L., Leong, J., Norse, E., Stachowicz, J. and Wall., D. 2009. Managing for ocean diversity to sustain marine ecosystem services. *Frontiers in Ecology and the Environment*, **7**: 204-211

Papageorgiou, N., Arvanitidis, C. and Eleftheriou, A. 2006. Multicausal environmental severity: A flexible framework for microtidal sandy beaches and the role of polychaetes as an indicator taxon. *Estuarine, Coastal and Shelf Science,* **70**: 643-653.

Passarelli, C., Olivier, F., Paterson, D. and Hubas, C. 2012. Impacts of biogenic structures on benthic assemblages: microbes, meiofauna, macrofauna and related ecosystem functions. *Marine Ecology Progress Series,* **465**: 85-97.

Paxton, H. 1974. Contribution to the study of the Australian Nephtyidae (Polychaeta). *Records of the Australian Museum*, **29**: 197-208.

Paxton, H. 1986. Generic revision and relationships of the family Onuphidae (Annelida: Polychaeta). *Records of the Australian Museum*, **38**: 1-74.

Pearson, T. and Rosenberg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. *Oceanography and Marine Biology Annual Review*, **16**: 229-311.

Peterson, A., Ortega-Huerta, M., Bartley,J., Sanchez-Cordero, V., Soberon, J., Buddemeir, R. and Stockwell, D. 2002. Future projections for Mexican fauna under global climate change scenarios. *Nature,* **416**: 626-629.

Pitcher, C., Poiner, R., Hill, B. and Burridge, C. 2000. Implications of the effects of trawling on sessile megazoobenthos on a tropical shelf in northeastern Australia. *ICES Journal of Marine Science,* **57**: 1359-1368.

Platell, M. and Potter, I. 1996. Influence of water depth, season, habitat and estuary location on the macrobenthic fauna of a seasonally closed estuary. *Journal of the Marine Biological Association of the United Kingdom,* **76**: 1-21.

Pocklington, P. and Wells, P. 1992. Polychaetes: key taxa for marine environmental quality monitoring. *Marine Pollution Bulletin,* **24**: 593–598.

Ponder, W., Hutchings, P. and Chapman, R. 2002. Overview of the Conservation of Australia's marine invertebrates. A report for Environment Australia. Available at http://www.amonline.net.au/invertebrates/marine_overview/index.html [Date accessed: 22nd November 2012].

Post, A. 2008. The application of physical surrogates to predict the distribution of marine benthic organisms. *Ocean and Coastal Managment*, **51**: 161-179.

Post, A., Wassenberg, T. and Passlow, V. 2006. Physical surrogates for macrofaunal distributions and abundance in a tropical gulf. *Marine and Freshwater Research,* **57**: 469-483.

Poulos, D., Harasti, D., Gallen, C. and Booth, D. In press. Biodiversity value of a geographically restricted soft coral species withn a temporate estuary. *Aquatic Conservation: Marine and Freshwater Ecosystems*. Available at: DOI: 10.1002/aqc.2362.

Pressey, R. 1994. *Ad hoc* reservations: forward or backward steps in developing representative reserve systems? *Conservation Biology*, **8**: 662-668.

Pressey, R. 1998. Algorithms, politics and timber: an example of the role of science in a public, political negotiation process over new conservation areas in production forests. *In*: *Wills, R. and Hobbs, R. (eds) Ecology for everyone: communicating ecology to scientists the public and the politicians. Surrey Beatty and Sons, Sydney, pp 73–87*

Pressey, R. 1999. Applications of irreplaceability analysis to planning and management problems. *Parks*, **9**: 42–51.

Pressey, R., Cabeza, M., Watts, M., Cowling, R. and Wilson, K. 2007. Conservation planning in a changing world. *Trends in Ecology and Evolution,* **22**: 583-592.

RAC. 1993. Coastal zone enquiry: final report. Resource Assessment Commission. Australian Government Publishing Service, Canberra.

Rahman, M. and Oomori, T. 2009. Analysis of Protein-induced Calcium Carbonate Crystals in Soft Coral by Near-Field IR Microspectroscopy. *Analytical Sciences,* **25**: 153-155.

Rainer, S. 1981. Temporal patterns in the structure of macrobenthic communities of a shallow Australian estuary. *Estuarine, Coastal and Shelf Science,* **13**: 597-620.

Rainer, S. and Hutchings, P. 1977. Nephtyidae (Polychaeta: Errantia) from Australia. *Records of the Australian Museum,* **31**: 307–347.

Rainer, S. and Kaly, U. 1988. Nephtyidae (Polychaeta: Phyllodocida) of Australia: new species from the North West Shelf, and a key to Australian species. *Journal of Natural History*, **22**: 685-703.

Ramey, P. and Bodnar, E. 2008. Selection by a deposit feeding polychaete, *Polygordius jouinae*, for sands with relatively high organic content. *American Society of Limnology and Oceanography,* **53**: 1512-1520.

Ravara, A., Cunha, M. and Pleijel, F. 2010b. Nephtyidae (Annelida, Polychaeta) from southern Europe. *Zootaxa,* **2682**: 1-68.

Ravara, A., Wiklund, H., Cunha, M. and Pleijel, F. 2010a. Phylogenetic relationships within Nephtyidae (Polychaeta, Annelida). *Zoologica Scripta*, **39**: 394–405.

Read, G., and Fauchald, K. (Eds.). 2013. World Polychaeta database. http://www.marinespecies.org/polychaeta [Date accessed: 14th June 2013].

Rhoads, D. and Young, D. 1970. The influence of deposit-feeding organisms on sediment stability and community trophic structure. *Journal of Marine Research,* **23**: 150-178.

Roberts, C. andelman, S., Branch, G., Bustamante, R., Castilla, J., Dugan, J., Halpern, B., Lafferty, K., Leslie, H., Lubchenco, J., McArdle, D., Possingham, H., Ruckelshaus, M. and Warner, R. 2003. Ecological criteria for evaluating candidate sites for marine reserves. *Ecological Applications*, **13**: 199-214.

Rodrigues, A., Gregory, R. and Gaston, K. 2000. Robustness of reserve selection procedures under temporal species turnover. *Proceedings of the Royal Society London Biological Science*, **267**: 49–55.

Rouse, G. and Pleijel, F. 2001. Polychaetes. Oxford University Press, Oxford.

Roy, P. 1983. Quaternary geology, *In*: *C. Herbert, (ed.) Geology of the Sydney Region, 1:100 000 sheet. New South Wales Department of Mineral Resources, p225.*

Roy, P., Williams, R., Jones, A., Yassini, I., Gibbs, P., Coates, B., West, R., Scanes, P., Hudson, J. and Nichol, S. 2001. Structure and function of South-east Australian estuaries. *Marine Coastal and Shelf Science,* **53**: 351-384.

Rozas, L., Minello, T., Munuera-Fernández, I., Fry, B. and Wissel, B. 2005. Macrofauna distributions and habitat change following winter-spring release of freshwater into the Breton Sound estuary, Lousiana (USA). *Estuarine, Coastal and Shelf Science*, **65**: 319-336.

Rullier, F. 1965. Contribution a la faune des annelides polychetes du Dahomey et du Togo. *Cahiers ORSTOM (Office de la Recherche Scientifique et Technique Outre-Mer), Series Océanographie*, **3**: 5-66.

Rützler, K. 2004. Sponges on coral reefs: a community shaped by competitive cooperation. *Bollettino dei Musei Intituti dell'Universitá di Genova*, **68**: 85-148.

Sala, E., Aburto-Oropeza, O., Paredes, G., Parra, I., Barrera, J. and Dayton, P. 2002. A general model for designing networks of marine reserves. *Science,* **298**: 1991-1993.

Samuelson, G. 2001. Polychaetes as indicators of environmental disturbance on subarctic tidal flats, Iqaluit, Baffin Island, Nunavut Territory. *Marine Pollution Bulletin*, **42**: 733-741.

San Martin, G. 1982. Una nueva especie de Nephtyidae (Poliquetos: Errantes) del Mediterraneo: *Micronephthys maryae* n. sp. *Cahiers de Biologie Marine*, **23**: 427-434.

San Martin, G., Lopez, E. and Aguado, M. 2009. Revision of the genus *Pionosyllis* (Polychaeta: Syllidae: Eusyllinae), with a cladistic analysis, and the description of five new genera and two new species. *Journal of the Marine Biological Association of the United Kingdom*, **89**: 1455–1498.

Santos, S and Simon, J. 1974. Distribution and abundance of the polychaetous Annelids in a south Florida estuary. *Bulletin of Marine Science,* **24**: 669-689.

Sars, M. 1835. Beskrivelser og Iagttagelser over nogle moerkelige eller nye i Havet ved den Bergenske Kyst levende Dyr af Polypernes, Acalephernes, Radiaternes, Annelidernes og Molluskernes classer, med en kort Oversigt over de hidtil af Forfatteren sammesteds fundne Arter og deres Forekommen (Thorstein Hallegers Forlag: Bergen).

Schwartz, M. 1999. Choosing the appropriate scale of reserves for conservation. *Annual Review of Ecology and Systematics,* **30**: 83–108.

Shima, J. 2001. Recruitment of a coral reef fish: roles of settlement, habitat and post-settlement losses. *Ecology,* **82**: 2190–2199.

Shimeta, J. and Koehl, M. 1997. Mechanisms of particle selection by tentaculate suspension feeders during encounter, retention, and handling. *Journal of Experimental Marine Biology and Ecology,* **209**: 47-73.

Shokri, M., Gladstone, W. 2013. Limitations of habitats as biodiversity surrogates for conservation planning in estuaries. *Environmental Monitoring and Assessment*, **185**: 3477–3492.

Shokri, M., Gladstone, W. and Jelbart, J. 2009a. The effects of seahorses and pipefish (Pisces: Syngathidae) as a flagship group to evaluate the conservation value of estuarine seagrass beds. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **19**: 588-595.

Shokri, M., Gladstone, W. and Kepert, A. 2009b. Annelids, arthropods or molluscs are suitable as surrogate taxa for selecting conservation reserves in estuaries. *Biodiversity and Conservation,* **18**: 1117-1130.

Siebert, T. and Branch, G. 2006. Ecosystem engineers: Interactions between eelgrass *Zostera capensis* and the sandprawn *Callianassa kraussi* and their indirect effects on the mudprawn *Upogebia Africana*. *Journal of Experimental Marine Biology and Ecology,* **338**: 253-270.

Simpson, S., Batley, G., Chariton, A., Stauber, J., King, C., Chapman, J., Hyne, R., Gale, S., Roach, A. and Maher, W. 2005. Handbook for sediment quality assessment. CSIRO, Australia.

Snelgrove, P. 1999. Getting to the bottom of marine biodiversity: sedimentary habitats – ocean bottoms are the most widespread habitat on Earth and support high biodiversity and key ecosystem services. *BioScience*, **49**: 129–138.

Sokal, R. and Rohlf, F. 1994. Biometry: The Principles and Practices of Statistics in Biological Research. WH Freeman, New York.

Southern, R. 1921. Polychaeta of the Chilka Lake and also of fresh and brackish waters in other parts of India. *Memoirs of the Indian Museum*, **5**: 563-659.

Stevens, T. and Connolly, R. 2004. Testing the utility of abiotic surrogates for marine habitat mapping at scales relevant to management. *Biological Conservation,* **119**: 351-362.

Stevens, T. and Connolly, R. 2005. Local-scale mapping of benthic habitats to assess representation in a marine protected area. *Marine and Freshwater Research,* **56**: 111-123.

Stigebrandt, A., Aure, J., Ervik, A. and Kupka Hansen, P. 2004. Regulating the local environment impact of intensive marine fish farming III. A model for estimation of the holding capacity in the modelling – ongrowing fish farm – monitoring system. *Aquaculture*, **234**: 239-261.

Stimpson, W. 1856. Description of some new marine invertebrates. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **7**: 385-395.

Surugiu, V. 2005. The use of polychaetes as indicators of eutrophication and organic enrichment of coastal waters: A study case–Romanian Black Sea coast. *Biologie Animal,* **42**: 55-62.

Syms, C. and Kingsford, M. 2008. Coral reef habitats and assemblages *In: Hutchings, P., Kingsford, M. and Hoegh-Guldberg, O. (eds) The Great Barrier Reef biology, environment and management. CSIRO Publishing, Victoria.*

Terlizzi, A., Benedetti-Cecchi, L., Bevilacqua, S., Fraschetti, S., Guidetti, P. anderson, M. 2005. Multivariate and univariate asymmetrical analyses in environmental impact assessment: a case study of Mediterranean subtidal sessile assemblages. *Marine Ecology Progress Series*, **289**: 27–42.

Théel, H. 1879. Les annélides polychètes des mers de la Nouvelle-Zemble. *Kungliga Svenska Vetenskapsakademiens Handlingar*, **16**: 1–75.

Thom, B., Sheperd, M., Roy, P., Bowman, G. and Hesp, P. 1992. Coastal geomorphology and quaternary geology of the Port Stephens-Myall Lakes Area. Department of Biogeography and Geomorphology, A.N.U. Monograph No. 6, p407.

Thrush, S. 1991. Spatial patterns in soft bottom communities. *Trends in Ecological Evolution*, **6**: 75-79.

Thrush, S., Hewitt, J., Funnell, G., Cummings, V., Ellis, J., Schultz, D., Talley, D. and Norkko, A. 2001. Fishing disturbance and marine biodiversity: the role of habitat structure in simple soft-sediment systems. *Marine Ecology Progress Series,* **223**: 277-286.

Thrush, S., Whitlatch, R., Pridmore, R., Hewitt, J., Cummings, V. and Wilkinson, M. 1996. Scale-dependent recolonization: The role of sediment stability in a dynamic sandflat habitat. *Ecology*, **77**: 2472-2487.

Tomiyama, T, Komizunai, N, Shirase, T, Ito, K and Omori, M. 2008. Spatial intertidal distribution of bivalves and polychaetes in relation to environmental conditions in the Natori River estuary, Japan. *Estuarine, Coastal and Shelf Science,* **80**: 243-250.

Trakhtenbrot, A. and Kadmon, R. 2006 Effectiveness of environmental cluster analysis in representing regional species diversity. *Conservation Biology,* **20**: 1087–1098.

UK GOV. 2013. Protecting and sustainably using the marine environment. https://www.gov.uk/government/policies/protecting-and-sustainably-using-the-marine-environment [Date accessed: 1st July 2013].

Van Hoey, G., Degraer, S. and Vincx, M. 2004. Macrobenthic community structure of soft-bottom sediments at the Belgian Continental Shelf. *Estuarine Coastal and Shelf Science*, **59**: 599-613.

van Ofwegen, L. 2005. A new genus of nephtheid soft corals (Octocorallia: Alcyonacea: Nephtheidae) from the Indo-Pacific. *Zoologische Mededelingen (Leiden),* **30**: 1-236.

van Ofwegen, L. 2012. Nephtheidae. Accessed through: World Register of Marine Species at http://www.marinespecies.org/aphia.php?p=taxdetailsandid=146762 [Date accessed: 21st March 2013].

Verselveldt, J., Alderslade, P. 1982. Description of types and other alcyonacean material (Coelenterata: Octocorallia) in the Australian Museum, Sydney. *Records of the Australian Museum,* **34**: 619–647.

Vila-Concejo, A., Short, A., Hughes, M. and Ranasinghe, R. 2007. Flood-tide delta morphodynamics and management implications, Port Stephens, Australia. *Journal of Coastal Research* SI, **50**: 705–709.

Vo, T-S., N, D-H., Van Ta, Q. and Kim, S-K. 2011. Marine organisms as a therapeutic source against herpes simplex virus infection. *European Joournal of Pharmaceutical Sciences,* **44**: 11-20.

Voyer, M., Gladstone, W. and Goodall, H. 2012. Methods of social assessment in Marine Protected Area planning: Is public participation enough? *Marine Policy,* **36**: 432-439.

Ward, T. and Hutchings, P. 1996. Effects of trace metals on infaunal species composition in polluted intertidal and subtidal marine sediments near a lead smelter, Spencer Gulf, South Australia. *Marine Ecology Progress Series*, **135**: 123–135.

Ward, T., Vanderklift, M., Nicholls, A. and Kenchington, R. 1999. Selecting marine reserves using habitats and species assemblages as surrogates for biological diversity. *Ecological Applications,* **9**: 691-698.

Warwick, R. and Clarke, K. 1994. Relearning the ABC: taxonomic changes and abundance/biomass relationships in disturbed benthic communities. *Marine Biology*, **118**: 739-744.

Warren, L., Hutchings, P. and Doyle, S. 1994. A revision of the genus *Mediomastus* Hartman, 1944 (Polychaeta: Capitellidae). *Records of the Autralian Museum*, **46**: 227-256.

Watling, L. and Norse, E. 1998. Disturbance of the Seabed by Mobile Fishing Gear: A Comparison to Forest Clearcutting. *Conservation Biology*, **12**: 1180-1197.

Wells, F., Walker, D. and Hutchings, P. 1991. Seagrass, sediment and infauna – a comparison of *Posidonia australis, Posidonia sinuosa,* and *Amphibolis antarctica* in Princess Royal Harbour, south-western Australia. III. Consequences of seagrass loss *In: Proceedings of the Third International Marine Biological Workshop: The marine flora and fauna of Albany, Western Australia. Wells, F., Walker, D., Kirkman, H. and Lethbridge R. (eds). Western Australian Museum, Perth. Volume 2.*

Wesenberg-Lund, E. 1949. Polychaetes of the Iranian Gulf. *Danish Scientific Investigations in Iran*, **4**: 247-400.

White, K., O'Neill, B. and Tzankova, Z. 2004. At a crossroads: Will aquaculture fulfil the promise of the Blue Revolution? SeaWeb Aquaculture Clearinghouse, USA.

Whitfield, A. 1998. Biology and Ecology of Fishes in Southern African Estuaries. Ichthyological Monographs of the J.L.B. Institute of Ichthyology, No. 2. p. 223.

Wildsmith, M., Potter, I., Valesini, F. and Patell, M. (2005) Do the assemblages of benthic macroinvertebrates in nearshore waters of WA vary among habitat types, zones and seasons? *Journal of the marine biological association of the United Kingdom*, **85**: 217-232.

Wilson, R., Hutchings, P. and Glasby, C. 2003. Polychaetes – Interactive Identification and Information Retrieval, CSIRO Publishing, Melbourne.

Włodarska-Kowalczuk, M. and Kędra, M. 2007. Surrogacy in natural patterns of benthic distribution and diversity: selected taxa versus lower taxonomic resolution. *Marine Ecology Progress Series*, **351**: 53-63.

Worm, B., Barbier, E., Beaumont, N., Duffy J., Folke C., Halpern B., Jackson J., Lotze H., Micheli, F., Palumbi, S., Sala, E., Selkoe K., Stachowicz J. and Watson, R. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science,* **314**: 787-790.

Wright, J., Jones, C. and Flecker, A. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. *Oecologia,* **132**: 96-101.

Zacharias, M. and Roff, J. 2000. A hierarchical ecological approach to conserving marine biodiversity. *Conservation Biology,* **14**: 1327-1334.

Zühlke, R., Blome, D., Heinz van Bernem, K. and Dittmann, S. 1998. Effects of the tubebuilding polychaete *Lanice conchilega* (Pallas) on benthic macrofauna and nematodes in an intertidal sandflat. *Senckenbergiana Maritima,* **29**: 131–138.

Appendix A: Polychaete Species Categorisations

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Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SCOLECIDA	**Capitellidae**	*Barantolla lepte*	Non-selective/ partially selective deposit-feeders[1],[2]	Evert a papillose, sac-like pharynx. The pharyngeal epithelium secretes a muco-polysaccharidae used to agglutinate sand grains, and select particles of low specific gravity [1]	Non-selective but gut usually conatins algal fragments[1],[2]	Some capitellids build tubes at or near the surface of the sediment (e.g. *Capitella capitata*), others build horizontal or vertical tubes or burrows stretching up to 15cm below the surface (e.g. *Heteromastus filiformis*)[2]. Some are tubicolous as juveniles but become free-living as adults[2]	Motile[2]	Most commonly encountered polychaete especially in some highly polluted habitats[1]. They are found in estuaries to the deep sea[2]. Tubes maintain contact with the surface and allow the worm to feed in black, anoxic muds, getting the necessary oxygen from the overlying waters by irrigation of the burrow[2]. Thought to be indicators of organic pollution[1]. Adult size varies extensively and may reflect genetic variation, which allows the population to respond to changes in the environment[1]	Capitellids have more than one mode of fertilisation and larval development. Some species within this family have external fertilisation and swimming larvae. *Capitella* may transfer spermatiphores*** during copulation which disintegrate within the female, releasing sperm into the coelom where fertilisation occurs or may be self-fertilising hermaphrodites[2]
		Capitella sp.							
		Heteromastus filiformis							
		Mediomastus australiensis							
		Notomastus annulus							
		Notomastus chrysosetus							
		Notomastus estuaries							
		Notomastus sp. 1							
		Notomastus torquatus							
		Scyphoproctus djiboutiensis							
		Scyphoproctus sp.							
		Scyphoproctus towraiensis							

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SCOLECIDA	**Cossuridae**	*Cossura* sp.	Deposit-feeders[2]	Tzetlin (1994) suggests that when the wide mouth is fully opened the tentacles are pressed onto the substratum and high currents created by dense cilia transport the food particles along the tentacles into the mouth[2]	Food particles[2]	Do not build tubes; rather contiually produce mucus to which sediment particels adhere[2]		They live in sandy mud in depths randing from shallow intertidal areas to abyssal depths[2]. Family has been recorded in Australia but no speces have been formally described[2]	Little is known about the reproductive system, although gametes have been recorded in the posterior region of the body[2]
	Maldanidae	*Maldane sarsi*	Mostly non-selective deposit-feeders[2]	Feed by eversion of a sac-like pharynx[2]	The food is usually characterized as detritus, food particles[2]	Most are tubiculous[2]. Some forms have strong tubes with thick linings and a thick outer covering of mud (*Maldane sarsi*); others lack the sediment cover, so the tube consists of the organic matrix only (*Rhodine spp.*). In several the tubes are no more than poorly consolidated burrows (some species of *Clymenella*)[2]	Move slowly from one location to another but are considered sessile[2]	Common in soft substrata at all depths[2]. Live on sheltered sand flats, intertidally and subtidally[1]. Range in size from 3mm to >200mm[1]	Maldanids have more than one mode of fertilisation and larval development. Sexual reproduction varies from broadcast spawning and free-swimming lecithotrophic larvae to intratubular brooding of directly-developing larvae. Australian maldanids nicomachine genus *Micromaldane* found they are brooders, with eggs being fertilised in the tube in batches of up to more than 30[1]. The directly developing larvae crawl from the tube as juveniles
		Maldanidae sp.							
		Euclymene trinalis							

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SCOLECIDA	**Opheliidae**	*Armandia sp.*	Non-selective/selective deposit-feeders[1], [2]	A species of *Polyophthalmus* feeds on dead copepods and other organic debris suggesting feeding selectively[1]	Food particles[2]. The low level of food specialization in adults contrasts sharply with the high level of precision in the selection of substrata by the juveniles[2]	Non-tubiculous[1]	Motile[2]	Opheliids are burrowers in sandy or muddy sediments[2]. They burrow head downwards in sand or mud[1]. Species range from a few millimetres to approximately 30 mm in length[1]	Sexes are separate and occur in about equal numbers (1:1). Four species have been investigated and all undergo mass spawning, two produce planktotrophic larvae and two produce lecithotrophic larvae. The Australian species of *Armandia* has ectaquasperm. For most opheliids no reproduction information is available. Some species in this family are epigamous epitokes[2]
		Armandia intermedia							
		Ophelia multibranchia							
		Polyophthalmus sp.							
		Travisia sp.							
	Orbiniidae	*Leitoscoloplos normalis*	Deposit-feeders[2]	Orbiniids do not feed while burrowing unlike other deposit-feeders[2]	Ingest sediment particles, detritus, and associated organisms such as diatoms and foraminiferans[1]. Unlike other deposit-feeders orbiniids do not feed while burrowing. The egestion of waste particles at the sediment surface by *Scoloplos* species contributes to the verticle mixing of the surface layers of sediment[2]	Non-tubicolous[1]	Freely motile[2]	Common in muddy areas. Found from salt marshes to abyssal depths[2]. Unlike other deposit-feeders they do not feed while burrowing[1]. They are moderate sized worms, often ranging from 35-300 mm in length[1]	Most species appear to be gonochoristic and fertilisation is thought to be external. Many species lay eggs in gelatinous cocoons, which are thought to prevent excessive dispersal of the larvae[2]
		Leodamas johnstonei							
		Phylo felix							

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SCOLECIDA		*Scoloplos simplex*							
	Paraonidae	*Allia* sp.	Burrowing deposit- and/or surface-feeders[2]	Short, eversible, sac-like pharynx[2]	Likely food items are foraminiferans, diatoms, dinoflagellates and possibly the bacterial film surrounding sand grains[1]. Perhaps feed in tight horizontal spirals below the sediment surface, moving upwards or downwards before the next spiral[2]	Non-tubicolous[1]	Motile[2]	Paraonids have a spiraling burrow pattern[2]. Found from the littoral zone to abyssal depths[1]. Inhabit soft bottoms, sand to mud sediments[1]. They are small, thread like worms and range in length from 2-3 mm up to 40 mm[1]	Paraonids are dioecious. Gametes develop in discrete gonads of the postbranchial segments and are expelled by rupture of the body wall. Spawning in surface waters apparently occurs in at least some species[2]
		Aricidea fauveli							
		Levinsenia sp.							
		Paraonella sp. 1							
		Paraonidae sp.							
	Scalibregmatidae	*Hyboscolex dicranochaetus*	Surface and burrowing deposit feeders[2]	Scalibragmatids have a sac-like eversible pharynx. *Scalibregma inflatum* are active burrowers and feed on detritus in the sediment. They also feed at the surface[2]	Feed on detritus found in the sediment[1],[2]. Sediment particles[2]	Do not build tubes, but live in galleries in soft sediments, often buried as much as 0.3-0.6 m below the surface[2]. *Hyboscolex* live in muddy rock crevices and often occur in old tubes formed by other invertebrates[2] *Scalibregma* have	Active burrowers[1]	Live in galleries in soft sediments in a wide range of depths[2]. *Hyboscolex* species have been found in depths of 27-45 m and a species of *Scalibregma* occurs in depths of 43-45 m[2]	Little information is available on the reproductive strategies of Scalibregmatids. They have been observed swimming in the plankton in waters of the Great Barrier Reef, associated with spawning[2]

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SCOLECIDA		*Scalibregma inflatum*				been dredged from under loose stones and muddy environments[2]			
EUNICIDA	**Dorvillidae**	*Schistomeringos loveni*	Most dorvilleids are carnivores, but can survive on a herbivore diet[1]	The dorvilleids have a jaw apparatus consisting of paired series of independent maxillary plates and paired mandibles mounted in partially eversible muscular bulbs[1]	*Schistomeringos loveni* have been observed to contain detrital material and sediment in the gut of specimens found in Sydney, and calcareous material from specimns found in the Great Barrier Reef (Glasby 1984). This suggests that this species can both feed on detrital matter and bore into corals[2]	They surround themselves with abundant quantities of mucus, but do not build solid tubes like many other eunicidans[2]	Move freely through the substratum. The smaller species are interstitial, living between sand grains, and larger ones can be found underneath stones or shells[2]	Dorvilleids may be free living, symbiotic or parasitic[2]. Most are small in size and comprise of some of the smallest polychaetes. *Schistomeringos loveni* was one of the first described Australian species[2]	The sexes are usually separate and lack sexual dimorphism. Small dorvilleids often brood their egg masses, whereas moderately sized species broadcast spawn, sometimes after a brief swimming phase[2]

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
EUNICIDA	Eunicidae	*Eunice* sp. 1	Free-living and tubulous species are mainly carnivorous, whereas burrowing species are omniverous[2]. Not exclusively carnivores[1]	Species of *Eunice* are primarily carnivores, feeding on all kinds of small invertebrates[1]. *Marphysa spp.* live largely on detritus (Day 1967).	Feed on organisms living in the substratum[1]	Free-living, tubicolous or burrows[1]	Anteriorly, they are very muscular, providing strength for burrowing and locomotion[1]. They are motile or discretely motile[2]	Live in a wide range of habitats including crevices and under rocks on rocky shores, in sand or mud and dead coral[1]. They range from less than 10 mm to 6 m in length[1]	Eunicids are dioecious and show no sexual dimorphism. Most reports of reproduction in this family comprise observations of swimming reproductive worms or eggs in gelatinous masses. Some eunicids are schizogamous epitokes** [2]
		Eunice sp.							
		Eunice australis							
		Marphysa sp.							
		Nematonereis sp.							
		Nematoneris unicornis							
	Lumbrineridae	*Augeneria verdis*	Have been reported as herbivores, carnivores and deposit-feeders[1]	Different modes of feeding have been exhibited in all species examined. They have large eversible jaw complexes that exist of a pair of mandibles and four pairs of maxillae. The most doral pair of maxillae tong-shaped and at least one pair has series of blunt teeth[1]	Gut contect of *Lumbrineris fragilis* was found to contain other polychaetes (*Pherusa plumosa* and tube-worms), ophiuroids, nemerteans, small crustaceans and bivalves Blegvad 1914 Another species of *Lumbrineris, L.*	Lumbrinerids are not usually tubicolous, but are capable of secreting temporary mucous housings, at least in aquaria[2]. Some are tubicolous but are usually free-living[1]	They are discretely motile and motile [2]. They usually burrow through sediment or crawl over the substratum or in crevices[1]	Usually do not exceed 100 mm in length and 2 mm in width[1]. Most common in sandy and muddy bottoms at shelf depths, but can be found anywhere from the intertidal zone to abyssal depths[1]	Lumbrinerids are dioecious and show no sexual dimorphism. Nothing is known about the reproduction or development of Australian lumbrinerids[2]

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EUNICIDA		*Lumbrineris* cf *latreilli*			*impatiens*, is a herbivore and known to eat plant fragments, usually of *Zostera*[1]. Also suspended food particle[2]. *Ninoe nigripes* is a selective deposit-feeder, feeding on the surface of the mud. Specimens of four other species have been found to contain detritus and sand[2]				
		Lumbrineris sp.							
	Oenonidae	*Drilonereis* sp.	Carnivorous[2]	Variably developed jaw apparatus[1]	Most are predators, but a number of species are endoparasitic in other polychaetes, bivalves and echiuroids[1]	They are free-living[1]. Although they are not tubicolous, they secrete copious amounts of mucus which lubricates	Motile[1]	Oenonids burrow in sand and mud. A number of species are parasitic[1]. They are long in length, up to 900 mm long[1]. Oenonids are found from the intertidal zone to	Oenonids are dioecious and show no sexual dimorphism. *Arabella iricolor* from Massachusetts, USA, spawn throughout summer. Nothing is known about

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EUNICIDA		*Notocirrus* sp.				their burrow[1]		great depths[1]	the reproduction of Australian oenonids[2]
	Onuphidae	*Diopatra dentata*	Primarily omnivorous scavengers[1]	Jaws consist of ventral, unfused mandibles, and dorsal maxillae of the labidognath type[2]	*Diopatra neapolitana* gut contained algae, sponges, bryozoans, crustaceans, and detritus, indicating a rather more catholic taste[2]. *D. ornata*feeds largely on kelp and may also feed on foraminiferans[1]. Feeding experiments have shown that it will accept any plant or animal material, dead or alive, fresh or rotten[2]	Tubicolous[2]. Most forms have permanently fixed tubes, but some are capable of moving around with their tubes (e.g. *Nothria conchylega* and *Hyalinoecia spp.*). All species are capable of leaving their tubes and constructing new tubes[2]	They are discretely motile and motile[2]. They may be sedentary in their tubes, or epibenthic crawlers pulling their tubes around with them[1]	Found in soft substrata and in rubble [2]. Common in shallow water and better represented in bathyal and abyssal areas[2]. Range from a few millimetres to 3 m in length[1]	Sexes are usually separate and show no sexual dimorphism, but instances of hermaphroditism and male dwarfism have been observed. Sperm transfer involving spermatophores and the presence of seminal receptacles as well as viviparity has been reported. Asexual reproduction has not been recorded in this family[2]
		Kinbergonuphis aucklandensis							
		Kinbergonuphis nr. *aucklandensis*							
		Mooreonuphis n.sp.							
		Onuphis n.sp.							
	Glycerid ae	*Glycera* cf *lapidum*	Include both carnivorous and detritivorous species[1]	Enormous eversible pharynges tipped by four jaws. The jaws are penetrated by a canal	Glycerids living in nutrient-rich environments may supplement their	Some glycerids form semi-permanent burrow systems in soft	Glycerids are active burrowers[1]. They are	Glycerids are widely distributed in soft sediments[1]. If disturbed they are able to rebury	Sexes are separate and neither asexual reproduction nor hermaphroditism has been

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
PHYLLODOCIDA		*Glycera ovigera*		connection basally to a gland[1]	feeding mode by direct uptake of dissolved organic matter[2]. The secretion from a gland in *Glycera convolute* is toxic to small crustaceans[2]. As detritivores they are capable of feeding on faecal pellets[2]	substratum, other species are free-living under rocks and crawling on algae[2]	discretely motile and motile[2]	themselves quickly, using rapid thrusting actions of the eversible pharynx[1]. They are found in all oceans from the intertidal to the deep sea[1]. Glycerids can reach up to 400 mm in length[1]	recorded in this family. At least nine species of *Glycera* are known to form breeding swarms in surface waters. In *Glycera dibranchiata* the release of gonads must occur through rupture of the body wall, and most but perhaps not all worms die after spawning. Some species in this family are epigamous epitokes[2]
		Glycera oxycephala							
		Glycera sp. 1							
		Glycera sp. 2							
		Hemipodus simplex							
PHYLLODOCIDA	**Goniadidae**	*Goniada* cf *antipoda*	Little is known but suspected and observed carnivores[1], [2]	Enormous eversible pharynx tipped with a series of small jaws[1]	Little is known about the feeding habits of Goniadids but a species has been observed feeding principally on deposit-feeding polychaetes[2]	Goniadids are not tubicolous, but whether they form burrows or move freely in the sediment is unknown[1]	Locomotory patterns are unknown[1]	Goniadids are long-bodied, active, burrowing, predatory worms[2]. They occur mostly in soft sediments[2]	Functional gonoducts have been described in *Goniada*, suggesting that spawning is not associated with rupture of the body and death[2]
		Goniada sp.							
	Hesionidae	*Ophiodromus angustifrons*	Detrivorous, carnivorous, surface deposit-feeders[1]	Hesionids possess an eversible muscular, armed or unarmed pharynx[1]	Most interstitial forms feed on diatoms and bacteria-rich detritus	Tube absent or unconsolidated[2]	All non-commensal hesionids are freely	Hesionids have an eversible muscular, armed or unarmed pharynx[1]. They comprise	The sexes are separate. Asexual reproduction is unknown in hesionids. Some hesionids are active

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PHYLLODOCIDA		*Ophiodromus microantennata*			and some species may ingest copepods and foraminiferans (Wolff 1973). Larger hesionids feed on a variety of small invertibrates[1]. Hesionids unusually reach higher numbers in polluted, oxygen deficient environments[2]		motile[1]. No quantitative information is available[1]	one of the least known of the major polychaete families, systematically as well as biologically[1]	swimmers, and these probably spawn in the water column. Reproduction in large species appears to take place in animals of mature age[1]; after spawning they do not die[2]
		Ophiodromus sp.							
		Podarke microantennata							
		Podarkeopsis arenicolus							
	Nephtyidae	*Micronephthys aurantiaca* n. sp.	Carniovorous and suggested subsurface deposit-feeding with little evidence[1]	Prey is captured by the muscular eversible pharynx[2]	They are predators, seeking out other small motile invertebrates including molluscs, crustaceans, and other polychaetes[1],[2]	All are free-living burrowers which may periodically form poorly agglutinated burrows[2]. They do not form permanent tubes[1]	Motile predators[2]. They burrow and swim powerfully and their swimming ability may be enhanced by the development of forms with long chaetae[1]	The nephtyids are common in soft substrata from the intertidal to abyssal depths and may be extremely abundant[2]	Sexes are separate. Fertilisation occurs in the water column, and the larvae are planktonic. There are no studies of reproductive biology in nephtyids from Australia. Some species in this family are epigamous epitokes[2]
		Nephtys longipes							
		Aglaophamus australiensis							
		Nephtys inornata							

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PHYLLODOCIDA		*Micronephthys derupeli* n. sp. One of the new species missing							
	Nereididae	*Australonereis ehlersi*	Surface-deposit feeding and herbivory most common in species but omnivory and carnivory are also known[2]. Australoneris ehlersi are suspected deposit-feeder[2]	Large jaws are used to collect surface sediments for ingestion[2]. *Australoneris ehlersi* may constructs a mucous suspension-feeding net[2]	Suspended food particles, algae and diatoms[2]	Nereidids may nestle in holes made by other organisms. Can form mucous tubes[2]	Discretey motile and motile[2]. They can leave their tubes when conditions become unacceptable[2]	Most common in shallow water[2]. Australian nereidids are typically less than 100 mm long[1]	The sexes are almost always separate. Asexual reproduction has not been reported. Reproduction is typically monotelic, with adults typically dying after spawning. Some members of this family are epigamous epitokes. In this case the whole worm becomes epitokous: sperm and ova form in its posterior. This form may be accompanied by partial or full degeneracy of digestive organs causing the animal to die quickly) and enhancement of motor and sensory organs; in particular, while normally crawling, the worm develops swimming appendages: broad parapodia with paddle-shaped chaetae[2]
		Leonnates stephensoni							
		Neanthes cricognatha							
		Platynereis antipoda							
		Platynereis dumerilii antipoda							
		Pseudonereis anomala							

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PHYLLODOCIDA	**Phyllodocidae**	*Anaitides longipes*	Carnivorous[2]. Perhaps scavangers[1]	Eversible muscular pharynx is used to catch prey[1]	Intertidal species such as *Phyllodoce,* follow mucous trails left on intertidal mud flats by prey species and have been observed hunting on a rising tide[1]. They are believed to be in part non-selective, feeding on all kinds of polychaetes, and in part highly selective[2]	No phyllodocid is tubicolous[2]	Motile[2]	They are almost exclusively marine or estuarine[1]. Few are territorial[2]. Phyllodocids are typically less than 100 mm in length but some species may reach 300 mm[1]	Many form breeding swarms in surface waters, but only the adults of a few species undergo somatic changes at sexual maturity. There are currently no reproductive studies of phyllodocids from Australia. Some species in this family are epigamous epitokes[2]
		Anaitides sp.							
		Paranaitis inflata							
		Phyllodoce novaehollandiae							
		Phyllodocidae sp. 1							
		Phyllodocidae sp. 2							

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PHYLLODOCIDA	**Pisionidae**	*Pisionid* sp.		A pair of enlarged buccal aciculae is directed forwards in front of the mouth[2]. The peristomium is reduced to lips around the mouth[2]. The pharynx is eversible and may bear jaws[2]		The cuticles often thick[2]	Active burrowers found in the soft sediments of intertidal and shallow subtidal zones[2]	They are a poorly studied group[2]. Typically found in sand and shallow waters[2]. They are one of the rarer families encountered in benthic studies[2]. In Australia, two named species are known: *Pisione gopalia* and *P. tortuosa* from the Upper Spencer Gulf, South Australia. There is also an undescribed species found in the Sydney region, Gladstone and Saunders Beach, north of Townsville, Queensland[2]	Copulation has not been observed, however in some species the reduced parapodia, sucker-like structures, which may help in copulation, appear on the ventral side of both sexes during the reproductive period[2]. Spermatogenesis is almost completed in the testis before the sperm pass through the genital funnel. Oogenesis occurs on the germinal epithelium[2]. In *Pisione remota*, spermatozoa are inserted into the female pores and the fertilised eggs are spawned directly into the sediment where indirect development occurs[2]
	Polynoidae	*Harmothoinae* sp.	Carnivorous[1]	Eversible pharynx armed with jaws[1]	Feed on small crustacians, chinoderms, polychaetes, gastropods, sponges and hydroids[1]. Algal fragments have been found in the gut[1].	None are tubicolous[2]	Discretely motile and motile[2]. Active[1]. The species Antinoella sarsi may be partially	Juvenile Polynoids become carnivores immediately upon metamorphosis. The most rich in species of the non-tubicolous polychaete families[2]. They are found worldwide from the	They have separate sexes. Most species studies exhibit free-spawning and planktotrophic larvae. Polynoids display pseudocopulation[2]
		Lepidonotus sp.							
		Paralepidonotus ampulliferus							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
PHYLLODOCIDA		*Paralepidonotus ampulliferus*			The most common prey is amphipods[1]		pelagic, swimming rapidly using its long parapodia[1]	tropics to the Antarctic and the Arctic[1]. Often found in the intertidal zone to deep water and found in both soft sediments and hard substrata[1]. Have been reported from abyssal and hadal depths[1]. Some species (e.g. *Eulagisca gigantea*) from the Antarctic may reach 190 mm in length, however most polynoids are much smaller[1]	
		Polynoid sp. 1							
		Polynoid sp. 2							
		Polynoid sp. 3							
		Polynoid sp. 4							
		Polynoid sp. 5							
		Sthenelais sp.							
	Sigalionidae	*Euthalenessa* sp.	Considered predators. Thought to be carnivorous but little evidence. Detritus found in the gut of *Psammolyce arenosus*[1]	Muscular eversible pharynx with four jaws[1]	Small invertebrates, including polychaetes[1]	Some are tubicolous[2]	Motile-Burrow rapidly in mud and sand[1]	Sigalionids occur worldwide and are common in benthic samples, although are rarely present in large numbers[1]. They occur from the intertidal zone to deep water[1]. They are frequent in soft sediments, more frequent in abyssal depths than any other scale worms. Most abundant in shelf depths[2]. These scale worms have much longer bodies than polynoids[1]	Little is known on this family. Only *Stenelais boa* appears to be the only species whose reproduction has been studies. It releases gametes directly into the water column and the larvae are planktotrophic[1]
		Horstileanira sp. 1							
		Horstileanira sp. 2							
		Leanira sp.							
		Sigalion sp. 1							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
PHYLLODOCIDA		*Sigalion* sp. 2							
	Syllidae	*Astreptosyllis acrassiseta*	*Autolytinae* and *Syllinae* are carnivorous, *Eusyllinae* feed on diatoms and detrius[2]. *Exogoninae* are highly selective deposit-feeders and carnivorour if opportunity arises[1]	Perhaps involves piercing the surface of the prey with the pharyngeal tooth and sucking out the contents using the proventrical[2]	*Autolytinae* and *Syllinae* feed on hydroids, bryozoans, and other colonial invertebrates and sponges, *Eusyllinae* feed on diatoms and detritus[2], and *Exogoninae* feed on the surface of the mud[1]	Generally considered non-tubicolous. Forms associated with hydroids, however, often build mucous tubes along the colonies[2]	Motile[2]	Syllids are usually free-living and are very common in shallow coastal waters in soft sediments, in hard substrata and as epibionts[1]. They are usually less than 10 mm long and 1 mm wide[1]	In this family the sexes are separate and fertilisation is external. The posterior body region is relatively unmodified and contains the gametes in sexually mature adults[1]
		Exogone (Exogone) africana							
		Exogone (Exogone) haswelli							
		Exogone (Parexogone) wilsoni							
		Exogone (Sylline) fustifera							
		Haplosyllis sp. 1							
		Odontosyllis gravelyi							
		Paraehlersia ehlersiaeformis							
		Perkinsyllis augeneri							
		Perkinsyllis koolalya							
		Pionosyllis heterochaetosa							
		Pionosyllis sp. 1							
		Sphaerosyllis bifurcata							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
		Syllid sp. 1							
		Syllides tam							
SABELLIDA	**Oweniidae**	*Owenia australis*	Capable of filter-feeding and surface deposit-feeding[1]	Feed either by ciliary means or by swallowing sand and detrius[2]. Oweniids will project the tentacular crown from one end of their tube[1]. They can feed in an upright position or bent over towards the substratum; thus they are capable both of filter-feeding and of surface deposit-feeding[1]. While surface deposit-feeding, the lips are used to pick up particles directly[1]	Sand grains smaller than 200 µm and detritus[2]	Tubicolous worms[1]. Oweniids live in characteristic tubes of cemented sand grains[2]	Considering the size of the tubes in relation to the size of the contained specimen, they probably do not move around, but feed in a manner similar to that of the maldanids[1]	The structure of the feeding apparatus in all oweniids indicates the potential for high levels of selectivity, both in terms of particle size and composition[1]. Quantitative investigations are lacking[1] and a detailed phylogenetic study of the family has not been undertaken[2]	Rouse (1988) inferred that of the species *Owenia fusiformis* gametes are released into the water column where fertilisation occurs[2]
		Myriochele sp.							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SABELLIDA	**Poecilochaetidae**	*Poecilochaetidae* sp.	Suspension-feeders[2]	They have paired palps and may use these for suspension-feeding[2]	Particles, small algae and diatoms or in selective deposit-feeding from the surface of the substratum[2]	Long branching tubes in sand and mud[2]. The tubes are U-shaped and lined with mucous[1]	Discretely motile[2]	Found infrequently but abundantly in sand and mud both in shallow and deep water. They are extremely patchy in distribution and can wholly dominate small areas[2]. Found in soft sediments[1]. Little is known of the biology of this family and little is known of poecilochaetids in Australia[1]	Sexes are separate, but reproductive behaviour has not been observed directly; it is assumed that fertilisation is external. The larvae apparently live for a long time in the plankton[1]
	Sabellidae	*Bispira serrata*	Suspension-feeders[2]	Tentacular crown to filter-feed[2]	Filter suspended particles from the water column[1]. Major food items include pelagic diatoms, dinoflagellates, and other unicellular algae, as well as small invertebrates including larvae[1]	Tubicolous[2]. They have a mucous/sediment tube[1]	Sessile and discretely motile[2]	Sabellids apparently select particles exclusively on size[2]. The smallest recorded sabellid is *Fabriciola minuta*-adult length is 0.85 mm. The longest recorded was *Schizobranchia insignis*-body length is 260 mm[1]. Members of the subfamily *Fabriciinae* are common in deep water[2]	Both sexual and asexual reproduction occurs in this family. Asexual reproduction takes the form of schizotomy. They display a range of sexual reproductive modes, from broadcast spawning to ovovivparity. In this sessile polychaete sperm released into the water is detected, collected by females and stored in spermathecae (sperm receptacles)[1]
		Euchone limnicola							
		Euchone variabilis							
		Laonome triangularis							
		Parasabella sp.							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SABELLIDA	**Chaetopteridae**	*Chaetopterus* sp. 1	Suspension-feeders[2]	Use a mucous bag to collect particles from the water current which is maintained through the tube[2]	The widespread *Chaetopterus variopedatus* gut contents include planktonic skeleta, unicellular algae and protozoan, small metazoans, and detritus, indicating a pelagic derivation of the food[2]	Tubicolous-they live in parchment like tubes[1]	Sessile[2]	Common in shallow water[2]. Also range from intertidal to shelf depths[1]	In this family the sexes are separate and fertilisation is external. The posterior body region is relatively unmodified and contains the gametes in sexually mature adults[1]
	Magelonidae	Magelonidae sp. 1	Surface deposit feeder[2]	Eversible pharynx burrows through soft sediments while the paired papillated tentacular palps, which are held above the sediment, collect descending food particles[2]	Suspended food particles[2]	No distinct tubes are formed[1]		The magelonids are very good burrowers, living in sands and muds[1]. They are present at all depths[1]. There have been no studies of magalonids in Australian waters, and very few worldwide on their biology[2]	The sexes are separate, ut little is known of reproduction[2]. It appears fertilisation is external and gametes are present in adults, and planktonic larvae occur in costal waters during the summer[2]
	Spionidae	*Dipolydora* sp. not cf *flava), posterior*	Deposit- and/or suspension-feeders[2]. Some species may alternate between the two modes depending on environmental conditions[2]	Potential food particles are transported to the mouth by ciliary action in the longitudinal groove of the feeding palps, or in taxa lacking the groove, by muscular contraction of the palp. Direct feeding using the proboscis has been observed but is unusual[2]	Suspended food particles[1,2]	Most live in mud tubes. Certain species (especially of the genera *Aonides* and *Scolelepis*) living in shifting sand, build only loosely constructed burrows or are entirely free-living[2]	Discretely motile- capable of leaving their tubes[2]	May partition food on particle size[2]. They are common and widespread in soft sediments throughout most marine habitats[1]. They are among the most ubiquitous of polychaetes and occur often in large numbers[1]	. Spionids have more than one mode of fertilisation and larval development. Spionid genera have been split into two groups based on sexual reproduction. In one group, including *Aonidea, Laonice, Prionospio, Spiophanes, Scolelepis* and
		Dipolydora sp. cf *flava*							
		Dipolydora tentaculata							
		Dispio glabrilamellata							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SABELLIDA		*Leodamus johnstonei*							*Malacoceros*, gametes are discharged into the water where fertilisation occurs. The other group, which includes *Spio, Microspio* and the *Polydorid* genera, internal fertilisation occurs after copulation; many of these genera maintain larvae in capsules until they are released for a planktonic phase. Males of several spionid species release spermatophores that are detected by females and manipulated into spermathecae[2]
		Polydora haswelli							
		Polydora sp. *1*							
		Prionospio aucklandica							
		Prionospio australiensis							
		Prionospio paucipinnulata							
		Prionospio steenstrupi							
		Prionospio tridentata							
		Prionospio sp. *1*							
		Pseudopolydora glandulosa							
		Pseudopolydora paucibranchiata							
		Pseudopolydora sp.							
		Pseudopolydora sp. cf. *paucibranchiata*							
		Pseudopolydora sp. cf *kempi*							
		Rhynchospio glycera							
		Scolelepis carunculata							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
SABELLIDA		*Scolelepis* cf *occipitalis*							
		Scolelepis occipitalis							
		Spiophanes sp. cf. *bombyx* cf *kroeyeri*							
		Spio pacifica							
TEREBELLIDA	Ampharetidae	*Amphicteis dalmatica*	Surface deposit feeder[1]	Retractable, ciliated buccal tentacles pick up food particles[1]	Food particles[1], ingested materials include detritus, unicellular algae and larval invertebrates[2]	Tubicolous; all make mucous-lined tubes covered with sediment particles[2]. The fragile tube, made of sandy mud, is sometimes attached to sponges, compound ascidians or the shells of living molluscs[1]	Considered non-motile sessile, however the family is well represented bathyally where food is sparse so some form of locomotion seems necessary[2]	Species may be either solitary or live in dense colonies in both warm and cold waters[1]. They are short and compact polychaetes[1]. They are the second most species rich family in the deep-sea trenches[1]. Few species live in shallow water and become more common with increasing depth[1]	Reproduction has been investigated in relatively few ampharetids. It has been found that four species in four genera vary from brooding with indirect development in *Alkmaria romijni* to free-spawning with entirely direct benthonic development in *Ampharete grubei*[2]
	Cirratulidae	*Caulleriella bioculatus*	Usually considered non-selective[2], surface deposit-feeders[1]	Use grooved palps to collect and transport food to the mout [2]. Some species of Caulleriella may be both a surface deposit-feeder and a burrowing deposit-	Suspended food particles[2]	Some live in mud-covered tubes, others drill in coral or other calcareous substrata or build calcareous tubes, but most are free	Some are sessile, discretely motile and motile [2]	Some species are extremely abundant in polluted areas and others are among the most abundant macrofaunal species in the deep sea [2] They mainly live in	No information is available on the reproductive strategies. Some species in this family are epigamous epitokes [1]
		Caulleriella cf *tricapillata*							
		Caulleriella dimorphosetosa							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
TEREBELLIDA		*Caulleriella* sp. *1*		feeder[1]. Some species of Cirriformia have been know to feed at or below the sediment-water interface[1]		living[2]		sediment associated with rock crevices, algal holdfasts or seagrass[1]. They range in length up to 250mm[1]	
		Caulleriella sp. 2							
		Caulleriella tricapillata							
		Cirriformia filigera							
		Cirriformia sp. 1							
		Cirriformia sp. 2							
		Cirriformia sp3							
	Flabillegeridae	*Pherusa* sp.	Surface-deposit feeders[2]	Organic material coated sediment is usually gathered up by grooved palps. A study on *Pherusa* (Amor 1994) observed the chaete of the cephalic cage separating and moving backwards to form a filtering system. The ciliated groove base of the palps were swept regularly across the cephalic cage and food particles were transported by the rapid capillary current to the mouth between the dorsal and medial lips[2]	Sediment coated with organic material[2]. A species of *Pherusa* was found to feed during the day on detritus and small planktonic organisms[2]	Some genera are tubicolous, whereas others live under stones and some burrow just below the surface of the sediment[1]. Some may have a mucoid or sandgrain sheath covering the body[1]	Some are discretely motile and motile[2]	This family is found worldwide from the intertidal zone to abyssal depths, although species are rarely abundant[1]. They are relative short worms[1]	Little is known of this family with the exception of *Flabelliderma commensalism*. The Californian population is dioecious. Vitellogenesis occurs throughout summer and autumn leading to spawning in December[2]

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
TEREBELLIDA	**Terebellidae**	*Amaeana apheles*	Selective surface deposit-feeders[1]	The numerous grooved buccal tentacles extend over the surface of the sediment a fine layer of mucus is secreted from the epithelium. Bundles of mucus coated sediment is moved to the mouth by currents caused from beating the cilia[2]	Suspended food particles[2]. Detritus is selected or rejected using buccal tentacles[1]	Usually tubicolous polychaetes [2] However, some live naked in the sediment[1]	Some are sessile or discretely motile [2]. May leave their tubes when necessary and some species are capable of swimming A more unusual mode of locomotion is a peristaltic crawling[2]	May be capable of absorbing dissolved organic matter[2]. Terebellids range in size from 1-2 mm to 300 mm in length[1]	Terebellids are dioecios. Asexual reproduction has not been recorded in this family. Sexual dimorphism does not occur except just before spawning when the colour of gametes distinguishes male from female. Gametes are proliferated by patches of germinal epithelium and released into the coelomic cavity where the vitellogenic phase of oogenesis and spermatogenesis occurs. In the species *Nicolea zostericola*, males shed spermatozeugmata**** via their elongate nephridial papillae; females collect them via their feeding tentacles and spawn shortly afterwards[2]
		Amaeana sp.							
		Amaeana/Lysilla							
		Baffinia sp.							
		Lanice sp.							
		Lysilla							
		Lysilla sp. 2							
		Polycirrus sp. 1							
		Polycirrus sp. 2							
		Rhinothelepus lobatus							
		Terebella sp.							
	Trichobranchidae	*Terebellides narribri*	Non-selective deposit-feeders[2]	Numerous grooved buccal tentacles are used to collect sediment, which they either	Trichobranchids obtain their nutrition from the bacterial and algal films	Tubicolous[2]. Some species live in muddy tubes[1]. It is suggested they do	Sessile[2]	Strongly cephalized[2]. Trichobranchids live in soft sediments from shallow water to depths	Sexes are separate. Reproduction has only been studies in the Northern European

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
TEREBELLIDA		*Terebellides kowinka*		swallow or use to collect their tubes[2]	covering the sediment particles[1]. They are detritivores[1]. Suspended food particles[2]	not form well-constructed tubes; however some Australian species do make well-constructed tubes of fine mud[1]		of 2700 m[1]. Range in size from a few millimetres up to 100 mm in length[1]	populations of *Trichobranchus glacialis* and *Terebellidea stroemii.* Both species are dioecious. The germinal epithelium of both sexes produces the early gametocytes, which are then released into the coelom where vitellogenesis and spermatogenesis occur. This process takes 8-9 months to complete. Spawning in these species occurs in December to January[2]
		Terebellides woolawa							
		Trichobranchus bunnabus							
		Trichobranchus sp.							

Order	Family	Species	Feeding guild	Feeding mechanism	Diet	Tube	Locomotion	Notes	Sexual reproduction and fertilisation mechanisms
CANALIPALPATA	**Saccocirridae**	Saccocirrid sp.	Species found on the central New South Wales coastline are hebivorous browsers[2]. Other species are known to be carnivorous[2]	Herbivorous browsers sweep algae into the mouth with ventral ciliary band[2]. Species without ventral ciliation are carnivorous, feeding on copepods[2]	Herbivorous browsers feed on algae, carnivorous species feed on copepods[2]		Move actively in a leech-like fashion, attaching to sand grains[2]	Saccocirrids live in coarse intertidal and shallow subtidal sand[2]	Saccocirrids are dioecious and have complicated reproductive systems[2]. The fertile segments are in the middle of the body and may comprise up to 100 segments. Each segment has its own reproductive system with paired or unpaired genital structures, comprising a gonad and gonadal ducts, and intromittant organs for males and spermathecae for females[2]

[1]Fauchald and Jumars, 1979.
[2]Glasby *et al.*, 2000.

***An epitoke is a polychaete individual that is morphologically modified to leave the bottom for the purposes of reproduction. Epigamous epitokes are the result of the transformation of the pre-existing individual from an atoke into an epitoke.**

**** Schizogamous epitokes arise by modification and separation from the prosterior end of the body.**

*****Spermatophores are bundles of sperm that are enclosed by a sheath or capsule that isolates then from the surrounding environment. Spermatophores may be transferred during copulation or pseudocopulation, or are released into the water column to be gathered by the female.**

******Spermatozeugmata differs from spermatophores in that the sperm are not surrounded by an external covering.**

Appendix B: Location of the study sites in the Port Stephens–Great Lakes Marine Park, NSW, Australia

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Appendix C: Polychaete Data May 2009 Sampling Period

Appendix C: May 2009 sampling period polychaete data: Number of individuals of each polychaete species per site (i.e. 1-34) replicates (i.e. a-e).

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	1	4	3	1	0	0	0	0	0	0
	Capitella sp. 1	0	0	1	0	0	0	0	0	1	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	1	1	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	1	0	0	0	1	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	4	4	2	7	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	1	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	1
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	1	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	1	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	1	1	2	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	1	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	1	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	1	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	2	0	1	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	2	0	0	0
Lumbrineridae	*Augeneria verdis*	3	2	8	0	4	0	0	0	0	0
	Lumbrineris sp.	0	0	0	1	0	9	7	0	7	6
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	1	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	1	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	1	0	1	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	2	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	1	3	10	3	4	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	1	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	1	1	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	1	0	0	0	1	4	2	0	0
	Prionospio sp.1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Syllidae	*Exogone africana*	0	0	0	0	0	2	4	3	1	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	42	50	18	69	36
	Sphaerosyllis bifurcata	0	0	0	0	0	1	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	2	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	1	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**3a**	**3b**	**3c**	**3d**	**3e**	**4a**	**4b**	**4c**	**4d**	**4e**
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Capitella sp. 1	1	0	1	0	0	0	2	1	1	0
	Mediomastus australiensis	0	2	0	0	0	0	0	0	0	2
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	2	0	0	0	0	0
	Cirriformia sp. 1	0	0	1	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	1	0	0	0	1	1	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	1	0	0	0
	Lumbrineris sp.	0	0	0	1	0	0	1	0	1	1
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**3a**	**3b**	**3c**	**3d**	**3e**	**4a**	**4b**	**4c**	**4d**	**4e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	1	1	0	0	0
	Neanthes cricognatha	0	2	0	0	2	0	0	2	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	1	1
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	1	2	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	1	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	3	1	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	1	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	1	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	2	2	1	0	1	2	3	1	0	0
	Prionospio sp.1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	Species	3a	3b	3c	3d	3e	4a	4b	4c	4d	4e
Syllidae	*Exogone africana*	0	0	1	0	0	0	0	0	1	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	1	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	3	2
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	5a	5b	5c	5d	5e	6a	6b	6c	6d	6e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	1	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	1	0	0	0
	Cirriformia sp. 1	0	0	0	1	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	1	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	1	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	1	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	3	0	3	2	1	1	0	0	0
Magelonidae	*Magelona* sp. 1	0	1	0	0	0	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	3	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	1	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	Species	5a	5b	5c	5d	5e	6a	6b	6c	6d	6e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	1	0	0	0	1	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	1	0	0
Oenonidae	*Drilonereis* sp. 1	1	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	3	7	1	2	2	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	1	1	0	0	0	0	1	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	1	0	1	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	1	8	9	7	2	1	0	0	0	3
	Prionospio sp.1	6	0	0	1	0	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	Species	5a	5b	5c	5d	5e	6a	6b	6c	6d	6e
Syllidae	*Exogone africana*	1	1	0	0	2	1	4	0	5	3
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	2	0	0	1	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	1	0	1	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	1	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	7a	7b	7c	7d	7e	8a	8b	8c	8d	8e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	5	0	0	0	0	0	0	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	4	2	12	5	7	0	1	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	1	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	1	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	1	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	1	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	1	1	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	1	0	3	3	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	1	1	0	0	0	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	1	0	0	0	1
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	0	1
	Nephtys inornata	3	1	2	0	0	0	0	0	0	1
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	1	0	1	0

Family	**Species**	**7a**	**7b**	**7c**	**7d**	**7e**	**8a**	**8b**	**8c**	**8d**	**8e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	2	7	3	1	8	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	1	0	0	0	2	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	1	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	1	0	0	0	1	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	1	1	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	1	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	1	1	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	4	4	0	1	0	0	0	0	0
	Prionospio sp.1	0	0	0	0	0	1	0	1	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	1	0	0
	Polydora sp.1	1	0	0	0	0	0	0	0	0	0

Family	**Species**	**7a**	**7b**	**7c**	**7d**	**7e**	**8a**	**8b**	**8c**	**8d**	**8e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	1	1	1	1
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	1	0	0	0

Family	**Species**	**9a**	**9b**	**9c**	**9d**	**9e**	**10a**	**10b**	**10c**	**10d**	**10e**
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	6	2	3	1	8	0	0	1	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	2	0	0	2	3
	Notomastus estuarius	0	0	0	0	0	0	0	1	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	1	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	1	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	1	0	0	0	1	1	1	0	3
	Lumbrineris sp.	2	0	0	1	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	15	2	6	5	5	0	0	0	0	1
Maldanidae	*Maldane sarsi*	0	0	0	0	0	1	2	0	0	0
	Maldane sp. 1	0	0	0	0	0	2	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	8	4	1	7	1	0	0	0	0	1
	Nephtys inornata	0	0	0	0	0	2	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	1	0

Family	Species	9a	9b	9c	9d	9e	10a	10b	10c	10d	10e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	1	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	1	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	1	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	2	0	0	2	1	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	1	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	1	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	1	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	1	0	0	1	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	1	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	23	10	5	2	4	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**9a**	**9b**	**9c**	**9d**	**9e**	**10a**	**10b**	**10c**	**10d**	**10e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	11a	11b	11c	11d	11e	12a	12b	12c	12d	12e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	3	8	10	6	11	2	7	14	5	3
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	1	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	1	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	1	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	3	0	0
Magelonidae	*Magelona* sp. 1	4	4	7	9	4	4	0	4	10	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	13	8	14	16	17	18	34	12	31	16
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**11a**	**11b**	**11c**	**11d**	**11e**	**12a**	**12b**	**12c**	**12d**	**12e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	1	0	1	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	1	0	1	0	1	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	1	0	0	0	0	0	0	0	1	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	1	0	0	1	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	0	1	0	2	0	0	2	0	0	1
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**11a**	**11b**	**11c**	**11d**	**11e**	**12a**	**12b**	**12c**	**12d**	**12e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	13a	13b	13c	13d	13e	14a	14b	14c	14d	14e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	1	0	0	0	1	0
	Capitella sp. 1	0	0	0	1	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	1	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	2	1	1	2	2	2	3	1	2	1
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	2	0	7	7	4	27	39	30	40	34
	Nephtys inornata	0	0	0	0	0	0	0	2	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	Species	13a	13b	13c	13d	13e	14a	14b	14c	14d	14e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	1	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	1	0	0	0	0	0	1	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	0	1	0	0	0	5	1	5	1	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	1
	Polydora sp.1	0	0	0	1	0	0	0	0	0	0

Family	**Species**	**13a**	**13b**	**13c**	**13d**	**13e**	**14a**	**14b**	**14c**	**14d**	**14e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**15a**	**15b**	**15c**	**15d**	**15e**	**16a**	**16b**	**16c**	**16d**	**16e**
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	1	2	1	0	1	1	0	0	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	9	5	7	12	29
	Notomastus estuarius	0	0	0	1	0	0	1	0	1	0
	Notomastus torquatus	0	1	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	1	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	1	1	1	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	3	0	3	3	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	6	13	8	10	11	7	0	2	3	3
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	6	2	8	7	2	1	0	0	1	0
	Nephtys inornata	0	0	0	0	0	1	1	2	3	2
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	3	0	0	0	0

Family	**Species**	**15a**	**15b**	**15c**	**15d**	**15e**	**16a**	**16b**	**16c**	**16d**	**16e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	1	0	1	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	1	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	1	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	1	0	1	0	1	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	1	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	1	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	3	0	3	2	0	0	0	1	1	0
	Bispira serrata	0	0	0	0	0	0	0	1	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	1	0	2	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	0	3	1	4	0	1	0	1	0	0
	Pseudopolydora glandulosa	2	0	0	0	0	2	4	0	1	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**15a**	**15b**	**15c**	**15d**	**15e**	**16a**	**16b**	**16c**	**16d**	**16e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	1	0

Family	Species	17a	17b	17c	17d	17e	18a	18b	18c	18d	18e
Ampharetidae	*Amphicteis dalmatica*	0	1	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	1	0	0	3	4	4	2	2	3	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	1	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	5	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	1	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	1	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	2	1	0	0	3	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	2	1	0	0
Magelonidae	*Magelona* sp. 1	13	6	9	7	9	2	6	7	6	5
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	1	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	1	0	0	0	0	5	1	6	3	5
	Nephtys inornata	0	4	3	2	1	0	0	0	0	0
	Micronephthys derupeli n. sp.	12	2	0	1	2	0	1	1	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**17a**	**17b**	**17c**	**17d**	**17e**	**18a**	**18b**	**18c**	**18d**	**18e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	1	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	2	2	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	1	1	0	1	3	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	3	3	1	3	2
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	1	0	1	0
	Prionospio sp.1	1	0	1	2	0	0	0	0	0	1
	Pseudopolydora glandulosa	1	3	0	2	3	0	0	0	0	0
	Polydora sp.1	0	1	0	0	0	4	0	0	0	0

Family	Species	17a	17b	17c	17d	17e	18a	18b	18c	18d	18e
Syllidae	*Exogone africana*	0	0	0	0	0	1	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	1	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	1	0	0	1	0	0	0	0	0	0

Family	Species	19a	19b	19c	19d	19e	20a	20b	20c	20d	20e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	2	5	0	1	0	1	0	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	1	1	1	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	1	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	1	0	2	4	2	2	1	5
	Lumbrineris sp.	1	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	22	14	8	8	8	4	1	0	0	1
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	1	0	1
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	2	4	0	1	0	1	0	0	0	0
	Nephtys inornata	3	2	2	2	4	1	0	1	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	1
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	1	0	0

Family	**Species**	**19a**	**19b**	**19c**	**19d**	**19e**	**20a**	**20b**	**20c**	**20d**	**20e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	4	0	0	0	0	4	1	2	2	3
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	1	0	0	0	0	0	0	0	0	1
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	1	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	1	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	1	0	0	0	0
Sabellidae	*Laonome triangularis*	1	1	2	2	0	0	0	0	2	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	1	0	0
	Prionospio sp.1	0	0	0	1	0	0	0	0	0	0
	Pseudopolydora glandulosa	1	0	2	3	0	4	1	11	6	2
	Polydora sp.1	0	0	0	0	0	0	2	0	0	0

Family	Species	19a	19b	19c	19d	19e	20a	20b	20c	20d	20e
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	1	1	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	1	3	0	0	0	0	0	0	0

Family	Species	21a	21b	21c	21d	21e	22a	22b	22c	22d	22e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	4	3	1	3	4	0	0	0	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	1	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	1
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	1	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	11	7	10	11	11	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	12	6	0	6	6	0	0	5	0	1
	Nephtys inornata	0	1	0	2	2	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	1	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	2	0

Family	**Species**	**21a**	**21b**	**21c**	**21d**	**21e**	**22a**	**22b**	**22c**	**22d**	**22e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	1	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	1	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	1	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	1	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	1	1	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	1	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	4	2	3	2	3	0	0	0	1	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	1	0	1	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	0	0	0	4	0	0	0	0	0	0
	Pseudopolydora glandulosa	1	3	3	2	2	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	Species	21a	21b	21c	21d	21e	22a	22b	22c	22d	22e
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	2	3	2	2
	Amaeana apheles	0	0	0	0	0	2	0	0	1	0
	Baffinia sp. 1	0	1	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	23a	23b	23c	23d	23e	24a	24b	24c	24d	24e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	1	0	0	0	0	0	8	0	2
	Capitella sp. 1	0	1	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	1	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	1	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	2	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	1	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	1	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelona* sp. 1	21	13	18	10	12	13	11	13	31	4
Maldanidae	*Maldane sarsi*	0	0	0	0	0	2	0	0	1	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	4	0	4	2	4	0	1	0	0	1
	Nephtys inornata	0	0	1	0	0	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	3	1	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	Species	23a	23b	23c	23d	23e	24a	24b	24c	24d	24e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	1	0	1	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	1	0	0	0	1	0	1	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	1	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	3	1	0	0	2	0	0	0	1	0
	Bispira serrata	0	0	0	0	0	0	0	1	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	1
Spionidae	*Spio pacifica*	0	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	1	0	0	1	0	0	0	0	0	1
	Pseudopolydora glandulosa	0	0	1	0	0	0	0	3	4	1
	Polydora sp.1	0	0	2	0	0	0	0	0	0	0

Family	Species	23a	23b	23c	23d	23e	24a	24b	24c	24d	24e
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	1	0	0

Family	**Species**	**25a**	**25b**	**25c**	**25d**	**25e**	**26a**	**26b**	**26c**	**26d**	**26e**
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	1	1	0	0	0	0	2	0	0	0
	Capitella sp. 1	0	0	1	0	0	0	0	0	0	1
	Mediomastus australiensis	0	0	0	0	1	2	1	2	1	4
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	1	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	1	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	1	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	1
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	1	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	1	0	0	1	0	0
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	1	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	1	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	1	0	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	1

Family	Species	25a	25b	25c	25d	25e	26a	26b	26c	26d	26e
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	1	0	0	1
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	3	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	1	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	1	1	0	1	0	1	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	1	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	1	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	1	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	1	0	0	0	0	0	1	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	4	1	0	0	7	6	3	7	7
	Prionospio sp.1	1	2	1	0	0	0	1	3	3	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	1	0	0

Family	**Species**	**25a**	**25b**	**25c**	**25d**	**25e**	**26a**	**26b**	**26c**	**26d**	**26e**
Syllidae	*Exogone africana*	0	0	0	0	0	1	1	0	1	1
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	1	0	0	1	1
	Paraehlersia ehlersiaeformis	0	0	0	0	2	0	1	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	1	1	0	0
	Syllides tam	0	0	0	0	1	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**27a**	**27b**	**27c**	**27d**	**27e**	**28a**	**28b**	**28c**	**28d**	**28e**
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Capitella sp. 1	0	2	0	1	0	0	0	0	0	0
	Mediomastus australiensis	6	5	14	0	0	1	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	1	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	2	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	1	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	1	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	1	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	1	0	1	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	10	0	8	10	5
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	1	0	0	0	0	0	0	1
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**27a**	**27b**	**27c**	**27d**	**27e**	**28a**	**28b**	**28c**	**28d**	**28e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	2	5	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	5	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	1	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	1	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	1	0	0	0	1	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	3	2	0	0	0	0	0	2	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	1	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	1	1	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	1	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	1	1	1	1	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	9	2	3	0	2	0	3	0	7	0
	Prionospio sp.1	0	0	0	1	0	0	0	1	2	1
	Pseudopolydora glandulosa	0	0	0	1	0	0	0	0	0	0
	Polydora sp.1	1	0	0	0	0	0	0	0	0	0

Family	Species	27a	27b	27c	27d	27e	28a	28b	28c	28d	28e
Syllidae	*Exogone africana*	1	0	0	0	2	0	0	0	1	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	2	0	0	0
	Paraehlersia ehlersiaeformis	2	0	1	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	29a	29b	29c	29d	29e	30a	30b	30c	30d	30e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	1	0	0
Capitellidae	*Barantolla lepte*	0	1	0	0	0	0	0	10	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	3	4	5	15	0	23	13
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	1	0
	Cirriformia sp. 1	0	0	0	0	0	1	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	1	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	1	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	0	0	0	0	2	2	0	1	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	2	1	0	1	1
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	2	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	0	0	1
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	6	1	2	3
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	1	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	1	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	1	0	0	7	0	3	1
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	3	0	1	0	0

Family	**Species**	**29a**	**29b**	**29c**	**29d**	**29e**	**30a**	**30b**	**30c**	**30d**	**30e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	1	0	1	0	0	0
Oenonidae	*Drilonereis* sp. 1	1	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	1	0	1	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	1	0	0	0	0	0	1	0	3
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	1	0	1	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	1
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	1	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	1	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	1	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	2	2	2	4	4
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	0	1	0	1	0	0	1	1	5	0
	Prionospio sp.1	0	0	0	1	1	1	0	1	0	0
	Pseudopolydora glandulosa	0	0	2	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**29a**	**29b**	**29c**	**29d**	**29e**	**30a**	**30b**	**30c**	**30d**	**30e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	1	1	0
	Exogone (Sylline) fustifera	0	0	0	0	1	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	1	0	0	0	0	0	0	1
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	1	0

Family	Species	31a	31b	31c	31d	31e	32a	32b	32c	32d	32e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	3	0	0	0	0	0	0	0	0	0
	Capitella sp. 1	1	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	32	53	16	55	32	1	2	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	1	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	0	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	1	0	0	1	1	0	0	0	0	0
	Eunice sp. 2	1	0	0	1	0	0	0	0	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	1	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	1	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	0	1	0	2	0	1	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	0	0	0	1	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	1
	Ophiodromus microantennatus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	1	0	0
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	1	0	0	0	0
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	0
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	1	0	2	0
	Nephtys inornata	4	0	1	6	1	0	1	1	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	1	0	0	0	0	1	0	1	0

Family	**Species**	**31a**	**31b**	**31c**	**31d**	**31e**	**32a**	**32b**	**32c**	**32d**	**32e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	4	5	0	2	5	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	0	0	0	0	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	0	0	0	0	0	1	0	0	1
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	1	0	0	2	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	1	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	1	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	1	1	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	1	1	0	2	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	1	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	0	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	1	0	0	0	0	1	1	1	0	0
	Hyboscolex dicranochaetus	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Spio pacifica*	8	6	4	6	0	0	1	0	0	0
	Prionospio sp.1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**31a**	**31b**	**31c**	**31d**	**31e**	**32a**	**32b**	**32c**	**32d**	**32e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	1	0	0	0	0	0	0	0
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	0	0	0	0

Family	Species	33a	33b	33c	33d	33e	34a	34b	34c	34d	34e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	1	0	0
	Capitella sp. 1	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	3	0	1	0	0	0	0
	Notomastus estuarius	2	0	0	0	0	0	0	0	1	0
	Notomastus torquatus	0	0	0	0	0	0	1	0	0	0
	Scyphoproctus towraiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Caulleriella sp. 2	1	0	0	0	0	0	0	0	0	0
	Caulleriella cf *tricapillata*	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 1	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 2	0	0	0	0	0	0	0	0	0	0
	Cirriformia sp. 3	0	0	0	0	0	0	0	0	0	0
Cossuridae	*Cossura* sp. 1	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice* sp. 1	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	1	0	0	0	0	1	0	0
	Marphysa sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis sp. 1	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Pherusa* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera ovigera*	1	0	0	2	0	0	0	0	0	0
	Glycera cf *lapidum*	0	0	0	0	0	0	0	0	0	0
	Glycera oxycephala	0	0	0	0	0	0	0	0	0	0
	Hemipodia simplex	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* cf *antipoda*	0	0	2	1	2	0	0	0	0	0
Hesionidae	*Ophiodromus angustifrons*	0	0	0	0	0	0	0	0	0	0
	Podarkeopsis arenicolus	0	0	0	0	0	0	0	0	0	0
	Ophiodromus microantennatus	0	0	0	0	1	0	0	0	0	0
	Ophiodromus sp. 1	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	1	1	0	1	0	0	0	0	0
	Lumbrineris sp.	0	0	0	0	0	0	0	2	0	0
Magelonidae	*Magelona* sp. 1	1	0	0	0	0	1	0	0	0	1
Maldanidae	*Maldane sarsi*	0	0	0	0	0	0	0	0	0	1
	Maldane sp. 1	0	0	0	0	0	0	0	0	0	0
	Euclymene trinalis	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Aglaophamus australiensis*	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	1	1	0	2	1	0	0	0	0	0
	Micronephthys derupeli n. sp.	0	0	0	0	0	0	0	0	0	0
	Micronephthys aurantiaca n. sp.	0	0	0	0	0	0	0	0	1	0

Family	**Species**	**33a**	**33b**	**33c**	**33d**	**33e**	**34a**	**34b**	**34c**	**34d**	**34e**
Nereididae	*Australonereis ehlersi*	0	0	0	0	1	1	0	0	0	0
	Leonnates stephensoni	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis antipoda	0	0	0	0	0	0	0	0	0	0
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
	Notocirrus sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Kinbergonuphis aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Diopatra sp. *(juvenile)*	0	0	0	0	0	0	0	0	0	0
	Diopatra dentata	0	1	0	0	0	0	0	0	0	0
Opheliidae	*Ophelia multibranchia*	0	0	0	0	0	0	0	0	0	0
	Armandia intermedia	0	1	0	0	1	0	0	0	0	0
	Polyophthalmus sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Scoloplos (Scoloplos) simplex*	0	1	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0
	Myriochele sp. 1	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Paraonella* sp.1	0	0	0	0	0	0	0	0	0	0
	Allia sp. 1	0	0	0	0	0	0	0	0	0	0
	Paraonidae sp.	0	0	0	0	1	0	0	0	0	0
Phyllodocidae	*Phyllodoce novaehollandiae*	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodocidae sp. 2	0	0	0	0	0	0	0	0	0	0
	Paranaitis inflata	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Paralepidonotus ampulliferus*	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 1	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 2	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 3	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 4	0	0	0	0	0	0	0	0	0	0
	Polynoid sp. 5	0	0	0	0	0	0	0	0	0	0
	Sthenelais sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Laonome triangularis*	0	0	0	0	0	0	0	1	0	0
	Bispira serrata	0	0	0	0	0	0	0	0	0	0
	Euchone limnicola	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	4	0	1	0	1	0	0	0	0	0
	Hyboscolex dicranochaetus	0	0	0	0	1	0	0	0	0	0
Sigalionidae	*Sigalion* sp. 1	0	0	0	0	0	0	1	0	1	0
Spionidae	*Spio pacifica*	1	0	0	0	0	0	0	0	0	0
	Prionospio sp.1	2	0	0	0	2	0	0	0	0	0
	Pseudopolydora glandulosa	0	0	0	0	0	0	0	0	0	0
	Polydora sp.1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**33a**	**33b**	**33c**	**33d**	**33e**	**34a**	**34b**	**34c**	**34d**	**34e**
Syllidae	*Exogone africana*	0	0	0	0	0	0	0	0	0	0
	Exogone (Sylline) fustifera	0	0	0	0	0	0	0	0	0	0
	Exogone (Parexogone) wilsoni	0	0	0	0	0	0	0	0	0	0
	Pionosyllis heterochaetosa	0	0	0	0	0	0	0	0	0	0
	Paraehlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllides tam	0	0	0	0	0	0	0	0	0	0
	Pionosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Sphaerosyllis bifurcata	0	0	0	0	0	0	0	0	0	0
	Odontosyllis gravelyi	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Terebella* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana sp. 1	0	0	0	0	0	2	1	0	2	1
	Amaeana apheles	0	0	0	0	0	0	0	0	0	0
	Baffinia sp. 1	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides narribri*	0	0	0	0	0	0	1	0	0	0

Appendix D: Sediment Data May 2009 Sampling Period

Appendix D: 2009 sediment data May 2009 sampling period sediment data per site (i.e. 1-34).

Factor	**1**	**2**	**3**	**4**	**5**	**6**
%OM	7.7398647	0.3393172	0.510983	0.4083402	0.4158269	0.9803922
%CO	2.7142303	1.5131715	3.880078	4.4598047	3.3393444	1.1877828
5.6 mm	10.990017	1.1530018	0.1734917	0.2325798	0.0086254	0.1812099
4mm	2.9535672	1.2667225	0.0957195	0.2279282	0.0129381	0.1519376
2.8 mm	1.1768477	0.8971301	0.164518	0.218625	0.0143757	0.1198773
2 mm	1.0898434	1.4530981	0.3664264	0.3023537	0.0632529	0.1379983
1.4 mm	1.291327	4.5567261	0.8001555	0.9473749	0.215635	0.4153889
0.05 mm	2.8024544	80.163631	8.6521492	32.964307	2.898134	13.268748
212 µm	1.8225112	10.421241	87.155634	63.982696	95.304908	85.551993
63 µm	51.451598	0.0631782	2.367563	0.9721835	1.3009977	0.107332
< 63 µm	26.417254	0.0063178	0.0059825	0.0434149	0.0028751	0.0027878
Depth (m)	4	2.9	2	1.5	2.4	1.2
Distance from estuary mouth (km)	13.97	1.82	1.92	0.97	3.85	6.35

Factor	**7**	**8**	**9**	**10**	**11**	**12**
%OM	0.6854232	3.6215882	3.0929221	3.050602	3.6702199	4.7832802
%CO	0.3195554	23.357036	0.6656506	3.6435231	0.645437	0.7939956
5.6 mm	0.1915185	4.1219726	19.948652	2.2912378	3.2993353	0.0221658
4mm	0.4103967	5.0226	2.5866496	10.780453	7.7822798	16.139202
2.8 mm	0.3643171	27.885718	2.7663671	5.9898863	4.9759486	8.3983942
2 mm	0.4737562	11.407947	3.3215661	5.7840329	4.5348396	6.1596434
1.4 mm	0.7588739	12.463739	3.5462131	6.8043498	8.6165945	5.5931828
0.05 mm	28.72921	23.240909	10.160462	29.546675	28.919582	15.112184
212 µm	67.384261	9.9473791	23.30552	24.09156	34.3067	27.369899
63 µm	1.4673483	4.6886595	30.696406	14.192697	6.8361909	20.417211
< 63 µm	0.2059184	1.0355529	3.6136072	0.2304663	0.6446977	0.7068443
Depth (m)	2.1	3.3	0.9	3.3	0.8	0.9
Distance from estuary mouth (km)	10.89	15.44	17.49	15.39	20.49	21.52

Factor	**13**	**14**	**15**	**16**	**17**	**18**
%OM	9.9006721	5.7024472	1.0414344	4.9292184	4.8402754	2.8522847
%CO	1.8556039	1.0690658	1.023594	1.8357089	1.982165	8.9759556
5.6 mm	4.204442	1.6701177	1.8505034	28.918247	0.7407915	14.94461
4mm	4.188606	11.249455	0.2084013	5.1482856	2.7608204	12.07484
2.8 mm	2.5218734	5.8767437	3.1410852	2.7563077	2.8637081	6.6273387
2 mm	2.5614632	4.168483	2.6966631	2.4907215	2.537897	5.6538754
1.4 mm	2.9850746	3.4246949	2.5083486	3.427083	5.0552164	5.9147635
0.05 mm	27.978146	7.4324324	8.4063575	28.022745	17.189108	20.524502
212 µm	32.249891	6.7703793	16.601803	25.191528	32.680568	22.995152
63 µm	14.537393	41.167175	39.021267	3.423678	28.825708	8.560637
< 63 µm	8.4484738	18.136988	25.429985	0.5754367	7.3256053	2.7023344
Depth (m)	3.2	0.8	2.7	1.8	1.6	1.8
Distance from estuary mouth (km)	24.62	21.53	21.08	17.37	21.7	23.63

Factor	**19**	**20**	**21**	**22**	**23**	**24**
%OM	2.8963415	4.6548043	5.4804084	5.7135614	5.5395128	2.8216609
%CO	1.9316883	2.3250297	2.0682433	4.4090532	3.0001102	1.1658359
5.6 mm	8.9485561	2.152402	2.6580035	1.9709848	13.437682	1.4688313
4mm	9.5935997	2.9685211	4.6245787	0.9048945	3.841944	8.2343571
2.8 mm	5.8851686	1.5784281	1.4558215	0.4469519	1.4557793	4.8445663
2 mm	4.7136052	1.2047472	1.2195546	0.3883353	1.3098365	4.2167405
1.4 mm	4.950653	10.080416	0.7678677	0.4469519	4.6738179	4.8281678
0.05 mm	14.902104	19.808077	22.601716	4.5244725	24.05502	13.90353
212 µm	23.738974	27.335506	18.616448	7.8546307	24.368797	38.26692
63 µm	15.57222	25.030642	29.366596	39.177902	19.085668	22.915642
< 63 µm	11.503658	9.5901468	18.154338	44.079719	7.5780794	1.1924005
Depth (m)	1.2	1.6	0.9	3.6	1	1.7
Distance from estuary mouth (km)	20.93	19.48	20.69	16.59	28.55	20.71

Factor	**25**	**26**	**27**	**28**	**29**	**30**
%OM	0.7841552	1.0529019	1.0226224	0.5255858	0.4269932	0.7293316
%CO	5	6.5508708	2.3295837	0.6472492	4.1547116	11.119908
5.6 mm	0.1337409	0.2859439	2.1169077	0.0557251	0.9509264	10.986702
4mm	0.0555806	0.3230394	0.8238317	0.0362213	0.6985856	0.1575848
2.8 mm	0.0156321	0.3091286	0.7622566	0.033435	0.4874162	0.3248459
2 mm	0.0798972	0.5827073	1.0446525	0.0431869	0.6215552	0.5432529
1.4 mm	0.2344808	0.8779251	1.4098563	0.1170226	0.9867853	0.9233917
0.05 mm	3.2427832	15.694457	11.096248	45.414525	12.385949	10.974261
212 µm	89.422309	78.917432	79.098456	54.03937	76.614649	70.152885
63 µm	6.3153507	2.877987	3.2082723	0.143492	7.2023375	5.5154682
< 63 µm	0.3456421	0.0262759	0.2102045	0.0236831	0.0225779	0.402256
Depth (m)	3.1	12.6	5.8	2	7.4	3.2
Distance from estuary mouth (km)	3.59	3.48	4.56	5.21	8.31	8.67

Factor	**31**	**32**	**33**	**34**
%OM	0.744879	5.362436	1.099712	8.4390148
%CO	0.353092	13.591044	4.1179691	5.4889096
5.6 mm	4.1800326	6.8283672	0.0371923	9.6386758
4mm	0.4558501	5.5565649	2.3974709	7.5645943
2.8 mm	0.3081209	3.6306928	1.630738	3.1338312
2 mm	0.3081209	3.1128876	2.0656014	2.3264029
1.4 mm	0.5768473	2.9009205	2.6778434	1.6047638
0.05 mm	9.689628	20.924176	13.264766	22.875454
212 µm	82.628454	32.100896	73.347447	21.417037
63 µm	1.3183072	19.128513	3.9781424	20.947719
< 63 µm	0.3770612	5.5929021	0.3933798	10.340129
Depth (m)	1.6	5.8	4.2	3.1
Distance from estuary mouth (km)	10.1	12.51	13.09	14.47

Appendix E: Polychaete Data February 2011 Sampling Period

Appendix E: February 2011 sampling period polychaete data: Number of individuals of each polychaete species per site (i.e. 1, 2, etc.) replicates (i.e. a-e).

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Capitellidae	*Barantolla lepte*	0	0	1	0	0	0	0	0	0	0
	Mediomastus australiensis	0	1	0	1	0	1	0	1	0	0
	Notomastus estuarius	1	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	5	2	0	7
	Caulleriella tricapillata	0	0	1	0	0	0	14	8	1	8
	Cirriformia filigera	0	0	0	0	0	0	2	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	1
Eunicidae	*Eunice australis*	0	0	0	0	0	0	1	2	1	2
	Eunice sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	1	0	1	2	5
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	1	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	1	1	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	0	1	0	1	0	0	0	0	0
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	4	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	2	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	1	0	0	0	0	0	2	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	4	1	3	0	17
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	1	3	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	1	0	0	0
	Onuphis n.sp.	0	0	0	0	0	11	10	26	27	2
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	0	0	0	0	3
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Paraonidae	*Aricidea (Aricidea) fauveli*	1	0	0	1	7	0	0	0	1	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	0	0
	Anaitides sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	3	6	5	1	3	0	0	0	0	0
	Parasabella sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	0	0	0	0
	Scalibregma inflatum	0	0	0	1	0	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	1	1	0	1	0	0	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0	0	0	0	0	0
	Polydora haswelli	0	0	1	0	0	0	0	0	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora paucbranchiata	0	0	3	0	0	0	0	0	0	0
	Pseudopolydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	1	1	0	0	0	3	0	0	1	2
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	1	0	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	1	0	0	1	1
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	2	2	1	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	1	0	0	0	4	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	1	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	1	3	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	1	0	0	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	1	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	4a	4b	4c	4d	4e	5a	5b	5c	5d	5e
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	2	0	1	1	0	0	0	2	2	0
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	1	0	0	0
	Nephtys longipes	0	0	0	0	0	0	3	1	0	1
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	1	0	0	0	0	0	3	0	0	0
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	0	0	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	0	0	0	0
	Onuphis n.sp.	1	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	1	0
	Scoloplos (Scoloplos) simplex	1	1	0	0	0	0	1	0	1	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	4a	4b	4c	4d	4e	5a	5b	5c	5d	5e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	0	0
	Anaitides sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Parasabella sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	0	0	0	0
	Scalibregma inflatum	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0	0	0	0	0	0
	Polydora haswelli	0	0	0	1	0	0	0	0	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	0	1	2
	Pseudopolydora paucbranchiata	1	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	3	3	4	0	0	14	13	11	9	1
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	1	0	0	0	0	0	0
	Exogone (Exogone) haswelli	1	0	0	0	0	1	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	1	0	0	0	0
	Perkinsyllis augeneri	0	0	1	0	0	0	0	0	1	0
	Perkinsyllis koolalya	0	1	0	0	0	3	1	0	0	6
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	S 1a	S 1b	S 1c	S 1d	S 1e	S 2a	S2 b	S 2c	S 2d	S 2e
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	6	4	1	1	3	0	0	1	0	1
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	1
	Scyphoproctus djiboutiensis	0	0	0	0	0	1	1	0	0	1
Chaetopteridae	*Chaetopterus* sp. 1	0	1	2	1	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	2	1	0	0	0	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	1	0	0	1	1	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	1	1	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	2	0	0
Glyceridae	*Glycera* sp. 1	0	1	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	1	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	1	0	0	0	0	0	0	0	0
Magelonidae	*Magelonidae* sp. 1	1	0	0	0	0	0	0	1	0	1
Maldanidae	*Euclymene trinalis*	1	2	0	1	1	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	1
	Neanthes cricognatha	0	0	0	0	3	0	0	0	0	1
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	0	1	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	1	1	0	0
	Onuphis n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	1	0	0	1	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	1	1	0	0	0	1	4	0	2	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	S 1a	S 1b	S 1c	S 1d	S 1e	S 2a	S 2b	S 2c	S 2d	S 2e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	2	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	1	0	0	0	0	0	1
	Anaitides sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	1	0	0	0	1	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	1	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Parasabella sp. 1	0	0	0	0	1	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	1	0	0	0
	Scalibregma inflatum	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	0	0	0	0	1	0	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	1
	Leodamus johnstonei	0	0	0	0	0	1	0	0	0	0
	Polydora haswelli	0	0	0	0	0	0	0	1	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	0	0	1
	Pseudopolydora paucbranchiata	3	1	0	0	0	1	0	2	3	1
	Pseudopolydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	1
	Spio pacifica	0	14	5	1	5	25	7	19	0	30
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	1	0	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	1	0	0	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	4	2	4	0	1	0	3	0	10
	Perkinsyllis augeneri	0	0	0	2	0	0	0	0	0	0
	Perkinsyllis koolalya	2	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	1	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	2	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	1	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	1	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	1	0	0	0	0	0	0

Family	Species	S 3a	S 3b	S 3c	S 3d	S 3e	26 a	26 b	26 c	26 d	26 e
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	1	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	0	0	0	0
	Cirriformia filigera	2	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	1	1	4	1
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	1	0	0
	Eunice sp. 1	0	0	0	0	0	0	0	1	0	0
	Nematonereis unicornis	0	1	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	1	0	0	0	0	1	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	2	2	0	0	0	1	1	0	1	1
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	2	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	1	0	0	1	0	2	0
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	4	1	0	2
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	0	0	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	4	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	0	0	0	0
	Onuphis n.sp.	0	0	0	0	0	0	1	0	0	0
Opheliidae	*Armandia*	0	0	0	0	1	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	2	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	3	0	3	0	0	2	1	0	1	2
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	S 3a	S 3b	S 3c	S 3d	S 3e	26 a	26 b	26 c	26 d	26 e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	1	1	1	0	0	0
	Anaitides sp. 1	0	0	0	0	0	0	0	1	0	0
	Phyllodoce novaehollandiae	0	0	0	1	1	2	2	1	2	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	1	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	1	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Parasabella sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	0	0	0	0
	Scalibregma inflatum	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0	0	1	0	0	0
	Polydora haswelli	21	0	0	0	0	0	0	3	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	13	0	0
	Pseudopolydora paucbranchiata	1	0	5	0	2	0	5	4	0	1
	Pseudopolydora sp. 1	0	0	0	0	0	0	2	1	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	7	3	0	5	5	11	5	9	8	8
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	1
	Exogone (Exogone) africana	0	1	0	1	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	4	0	0	0	0
	Haplosyllis sp. 1	0	1	0	0	0	0	0	1	0	0
	Parahlersia ehlersiaeformis	4	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	1	1
	Perkinsyllis koolalya	2	0	1	2	3	1	2	4	8	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	2	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	27 a	27 b	27 c	27 d	27 e	29 a	29 b	29 c	29 d	29 e
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	0	0	1	0
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	1	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	1	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	14	28	5	6	15	0	0	0	0	0
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	1	0	0	0	0
	Nephtys longipes	1	0	0	1	4	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	0	0	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	0	0	0	0
	Onuphis n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	1	0	2	1	0	0	0	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	27 a	27 b	27 c	27 d	27 e	29 a	29 b	29 c	29 d	29 e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	1	0	0	0	0
	Anaitides sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	3	0	0	0	0
	Parasabella sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	0	0	0	0
	Scalibregma inflatum	0	0	0	0	0	1	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	0	0	0	0	0	1	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0	0	0	0	0	0
	Polydora haswelli	0	0	0	0	1	0	0	0	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora paucbranchiata	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	3	15	5	3	2	0	0	0	0	0
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) haswelli	7	0	1	0	6	0	0	0	0	0
	Haplosyllis sp. 1	0	0	1	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	**Species**	**30 a**	**30 b**	**30 c**	**30 d**	**30 e**	**32 a**	**32 b**	**32 c**	**32 d**	**32 e**
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	2	0	0	0	1	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0	0	0	1	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 1	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	3	0	0	0	0
	Lumbrineris cf *latreilli*	0	0	0	0	0	0	0	0	0	0
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	1	0	4	0	1
	Maldane sarsi	0	0	0	0	0	0	0	0	1	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	4	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	1	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	1	0	0	1	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0	0	0	0	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0	0	0	0	0	0
	Onuphis n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	0	0	1	0	0
Oweniidae	*Owenia australis*	0	0	0	0	0	0	0	0	0	0

Family	Species	30 a	30 b	30 c	30 d	30 e	32 a	32 b	32 c	32 d	32 e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	1	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	0	0
	Anaitides sp. 1	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	1	0	0	1	0
	Parasabella sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0	0	0	0	0	0
	Scalibregma inflatum	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	1	0	0	0	0	0	0	1	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0	0	0	0	0	0
	Polydora haswelli	0	0	0	0	0	0	0	0	0	0
	Polydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora paucbranchiata	0	0	0	0	0	2	1	1	0	0
	Pseudopolydora sp. 1	0	0	0	0	0	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	5	0	1	0	0	0	0	0	0	0
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	1
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	3	0	0	0	1
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	33 a	33 b	33 c	33 d	33 e
Capitellidae	*Barantolla lepte*	0	0	0	0	0
	Mediomastus australiensis	27	0	3	4	0
	Notomastus estuarius	0	0	0	0	0
	Notomastus sp. 1	0	0	0	0	0
	Scyphoproctus djiboutiensis	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0
Cirratulidae	*Caulleriella dimorphosetosa*	0	0	0	0	0
	Caulleriella tricapillata	2	0	0	0	0
	Cirriformia filigera	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0
	Eunice sp. 1	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	2	1	0	1	0
	Glycera sp. 2	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	1	0	0	0	0
	Lumbrineris cf *latreilli*	0	2	1	0	0
Magelonidae	*Magelonidae* sp. 1	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0
	Nephtys inornata	1	0	0	0	0
	Nephtys longipes	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0
	Neanthes cricognatha	0	2	0	0	0
Oligochaeta (subclass)	*Oligochaeta* sp. 1	0	0	0	0	0
Onuphidae	*Diopatra dentata*	0	0	0	0	0
	Kinbergonuphis cf. *aucklandensis*	0	0	0	0	0
	Mooreonuphis n.sp.	0	0	0	0	0
	Onuphis n.sp.	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	1	0
	Phylo felix	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	2	0	1
Oweniidae	*Owenia australis*	0	0	0	1	0

Family	Species	33 a	33 b	33 c	33 d	33 e
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0
	Anaitides sp. 1	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0
Polynoidae	*Harmothoinae* sp. 1	1	0	0	0	0
	Lepidonotus sp. 1	0	0	0	0	0
	Paralepidonotus ampulliferus	0	0	0	0	0
Sabellidae	*Euchone limnicola*	1	0	0	0	0
	Parasabella sp. 1	0	0	0	0	0
Scalibregmatidae	*Hyboscolex dicranochaetus*	0	0	0	0	0
	Scalibregma inflatum	0	0	0	0	0
Sigalionidae	*Horstileanira* sp. 1	0	0	0	0	0
Spionidae	*Dipolydora tentaculata*	0	0	0	0	0
	Leodamus johnstonei	0	0	0	0	0
	Polydora haswelli	0	0	0	1	0
	Polydora sp. 1	0	0	0	0	0
	Pseudopolydora paucbranchiata	2	0	0	0	0
	Pseudopolydora sp. 1	0	0	0	0	0
	Scolelepis cf.*occipitalis*	0	0	0	0	0
	Spio pacifica	0	0	0	0	0
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	1
	Exogone (Exogone) haswelli	5	0	1	1	0
	Haplosyllis sp. 1	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0
	Amaeana/Lysilla sp. 1	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0
	Polycirrus sp. 2	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0
Trichobranchidae	*Trichobranchus bunnabus*	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0

Appendix F: Polychaete Data October 2011 Sampling Period

Appendix F: October 2011 sampling period polychaete data: Number of individuals of each polychaete species per site (i.e. 1, 2, etc.) replicates (i.e. a-e).

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	1	0	1	0	0	0	0
	Notomastus annulus	0	0	0	0	0	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	1	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	1	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	1	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	2	1	0	1
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	1	1	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	2	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	1	0	0
	Nematonereis unicornis	0	0	0	0	0	1	0	1	1	1
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	1	0	0	0	1	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	2	0	0	1
Lumbrineridae	*Augeneria verdis*	1	0	0	0	1	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	0	0	0	0	0	8	1	0	9
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	2	0	2	0	0	0	1	0	0	0
	Maldane sarsi	0	1	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	2	0	1	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	2	0	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	0

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Onuphis* n.sp.	0	0	0	0	0	0	0	25	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	1	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Aricidea (Aricidea) fauveli*	1	0	2	1	0	0	0	1	0	0
	Levinsenia sp. 1	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	1	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	1	0	0	0	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	1	0	1	0	3	0	0	0	0	0
	Euchone variabilis	0	0	0	0	0	0	0	0	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	0	0	0
	Horstileanira sp. 1	1	1	1	0	1	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Sigalion sp. *2*	0	1	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava), posterior*	0	0	0	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0	0	0	1	1	0
	Dispio glabrilamellata	0	0	0	0	0	0	0	0	0	0
	Prionospio aucklandica	0	0	0	0	0	0	0	0	0	0
	Prionospio australiensis	0	0	0	0	0	0	0	0	0	0
	Prionospio paucipinnulata	0	0	0	0	0	0	0	0	1	0
	Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0	0	0	0	1	0
	Scolelepis carunculata	0	0	0	0	0	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	0	0	0	0	0	0	2	0	0	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0	0	0	0	0	0

Family	Species	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	1	1	6	3	1	6	2
	Exogone (Exogone) haswelli	0	0	0	0	0	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	1	1	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	5	1	2	2	0
	Perkinsyllis augeneri	0	0	0	0	0	0	1	0	1	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	1	0
	Syllid sp. 1	0	0	0	0	0	0	0	1	0	0
Terebellidae	*Amaeana* sp. 1	0	0	7	0	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	1	1	0	1	6	0	0	0	0	0
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	1	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	0	0	1	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	4a	4b	4c	4d	4e	5a	5b	5c	5d	5e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	1	0	0	0	0	0	0	0
	Notomastus annulus	0	0	0	0	0	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	0	0	0	0
	Cirriformia filigera	1	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	1	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	1	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	0	0	0	0	7	7	0	7	5
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	2	0	1	4	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	0

Family	Species	4a	4b	4c	4d	4e	5a	5b	5c	5d	5e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	1	0	0	0	1
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Onuphis* n.sp.	2	0	0	1	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	1	0	1
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	1	1	0	1	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
	Levinsenia sp. 1	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	1	2	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Euchone variabilis	1	0	0	0	0	0	0	0	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	1	0	0	1	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	0	0	0
	Horstileanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Sigalion sp. *2*	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava), posterior*	0	0	0	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	0	0	0	0	0	0
	Prionospio aucklandica	0	0	0	0	0	2	0	0	0	0
	Prionospio australiensis	0	0	0	0	0	0	0	0	0	0
	Prionospio paucipinnulata	0	0	0	0	0	0	0	0	0	0
	Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0	0	0	2	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0	0	0	0	0	1
	Scolelepis carunculata	0	0	0	0	0	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	0	0	1
	Spio pacifica	1	0	0	0	0	1	0	0	1	1
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0	0	0	0	0	0

Family	Species	4a	4b	4c	4d	4e	5a	5b	5c	5d	5e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	1	1	2	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	1	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	1	0	0	0	0	0	0	0	1	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllid sp. 1	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	0	0	0	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	S1 a	S1 b	S1 c	S1 d	S1 e	S2 a	S2 b	S2 c	S2 d	S2 e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	13	1	5	22	10	0	0	0	0	0
	Notomastus annulus	0	0	0	0	0	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	1	2	0	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	2	0	0	0	0	0	0
	Cirriformia filigera	1	1	0	0	2	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	2	0	1	1	0	3	0	1
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	1	2	0	1	1	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	1	0	0	1	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	1	0	1	1	1	0	0	0	0
Magelonidae	*Magelona* sp. 1	2	2	0	0	0	1	1	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	2	0	0	3	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	2	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	1	0	1	1	0	0	0	1	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	0

Family	Species	S1 a	S1 b	S1 c	S1 d	S1 e	S2 a	S2 b	S2 c	S2 d	S2 e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	1	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	1	0	0	0	0	0	0
Onuphidae	*Onuphis* n.sp.	0	1	1	2	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	1	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0	0	1	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	0	0	0	0	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
	Levinsenia sp. 1	0	1	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	1	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	2	0	0	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	1	0	1	0	1	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Euchone variabilis	0	0	0	0	0	0	0	1	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	1	0	0
	Horstileanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Sigalion sp. 2	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava), posterior*	0	0	1	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	1	0	0	0	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	0	0	0	0	0	0
	Prionospio aucklandica	0	0	0	1	0	0	0	0	1	0
	Prionospio australiensis	0	0	0	0	0	0	1	0	1	0
	Prionospio paucipinnulata	0	0	0	0	1	0	1	0	0	0
	Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0
	Prionospio tridentata	1	0	2	1	1	0	0	0	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	1	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	1	0	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0	0	0	0	0	0
	Scolelepis carunculata	0	0	0	0	0	0	1	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	13	16	19	5	9	2	1	0	0	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	2	1	0	2	1	0	0	0

Family	Species	S1 a	S1 b	S1 c	S1 d	S1 e	S2 a	S2 b	S2 c	S2 d	S2 e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	2	4	5	5	3	0	0	1	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	0	0	1	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	2	0	0	0	0
	Perkinsyllis augeneri	1	0	1	0	0	0	0	0	0	0
	Perkinsyllis koolalya	9	6	6	5	3	0	3	1	0	1
	Syllid sp. 1	0	0	0	4	1	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	0	0	0	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	1	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	1	0	0	0	0	0	0

Family	Species	S3 a	S3 b	S3 c	S3 d	S3 e	26 a	26 b	26 c	26 d	26 e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	4	0	0
	Notomastus annulus	0	0	0	0	0	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	1	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	1	0	0	0	1	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	1	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	0	0	0	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	1	0	0
Lumbrineridae	*Augeneria verdis*	0	0	1	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	0	0	1	0	0	1	0	3	2	0
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	1	0	0	0	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	1	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	0	0	0	0	0	1	0	1	1	1
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	12	0	0	0	0	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	1

Family	Species	S3 a	S3 b	S3 c	S3 d	S3 e	26 a	26 b	26 c	26 d	26 e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0	2	0	1	0	1
Onuphidae	*Onuphis* n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0	0	0	0	0	1
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	1	0	1	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	2	0	0	0	0	0	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
	Levinsenia sp. 1	0	0	0	0	0	1	0	0	0	1
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	1	0	0	0	0	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	0	0	0	0	0
	Euchone variabilis	1	0	0	0	1	0	0	0	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	0	0	0
	Horstileanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Sigalion sp. 2	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava), posterior*	0	0	0	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	0	0	0	0	0	0
	Prionospio aucklandica	0	0	0	1	0	1	0	0	0	1
	Prionospio australiensis	0	0	0	0	1	1	0	1	0	1
	Prionospio paucipinnulata	0	0	0	0	0	0	0	0	0	0
	Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0	0	0	1	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0	2	0	0	0	0
	Scolelepis carunculata	0	0	0	0	0	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	1	0	0
	Spio pacifica	0	0	0	0	1	0	0	0	0	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0	3	0	1	1	1

Family	Species	S3 a	S3 b	S3 c	S3 d	S3 e	26 a	26 b	26 c	26 d	26 e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	2	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	1	1	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0	1	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	1	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	2	1
	Perkinsyllis koolalya	0	0	0	0	1	0	0	0	0	0
	Syllid sp. 1	0	0	0	0	2	0	0	0	1	1
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	0	0	0	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	27 a	27 b	27 c	27 d	27 e	29 a	29 b	29 c	29 d	29 e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	0	0	0	0	0	1
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0
	Mediomastus australiensis	0	0	0	0	0	0	0	0	0	3
	Notomastus annulus	0	0	0	0	0	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	0	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	1	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0	0	1	0	0	0
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	1	0	0	0	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0	0	0	1	2	0
	Glycera sp. 2	0	1	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	0	1	0	1	0	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	1	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	0	0	0	0	0	0	0
	Lumbrineris cf *latreilli*	3	22	2	6	17	0	1	1	0	0
Magelonidae	*Magelona* sp. 1	0	0	0	0	0	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	1	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	1
Nephtyidae	*Micronephthys aurantiaca* n. sp.	0	0	0	0	0	3	1	1	0	1
	Aglaophamus australiensis	1	1	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	0	0	0
	Nephtys longipes	1	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	0

Family	Species	27 a	27 b	27 c	27 d	27 e	29 a	29 b	29 c	29 d	29 e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0	0	0	0	0	0
Onuphidae	*Onuphis* n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	1	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	1	0	0	0	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
	Levinsenia sp. 1	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0	0	0	0	1	0
	Phyllodoce novaehollandiae	0	0	0	0	0	0	0	0	0	0
Pisionidae	*Pisionidae* sp. 1	1	1	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	0	10	1	0	1	0
	Euchone variabilis	0	0	0	0	0	0	0	0	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	0	0	0	0	0	0	0	1
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	0	0	0
	Horstileanira sp. 1	1	0	0	0	0	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	1	1	1	0
	Sigalion sp. 2	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava), posterior*	0	0	0	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	0	0	0	0	0	0
	Prionospio aucklandica	0	1	0	1	0	0	0	0	0	0
	Prionospio australiensis	0	1	0	0	0	0	0	0	0	0
	Prionospio paucipinnulata	0	0	0	0	0	0	0	0	0	0
	Prionospio steenstrupi	0	0	0	0	1	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0	0	0	0	0	0
	Rhynchospio glycera	0	1	1	0	2	0	0	0	0	0
	Scolelepis carunculata	0	0	0	0	0	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	0	0	0	0	0	0	0	0	0	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0	0	0	0	0	0

Family	Species	27 a	27 b	27 c	27 d	27 e	29 a	29 b	29 c	29 d	29 e
Syllidae	*Astreptosyllis acrassiseta*	0	0	1	0	0	0	0	0	0	0
	Exogone (Exogone) africana	1	9	10	5	0	0	0	0	0	0
	Exogone (Exogone) haswelli	0	9	1	0	1	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllid sp. 1	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	0	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	0	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	0	0	1	0	2	4
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	0	0	0	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	30 a	30 b	30 c	30 d	30 e	32 a	32 b	32 c	32 d	32 e
Ampharetidae	*Amphicteis dalmatica*	0	0	0	0	1	0	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0	0	0	1	0	0
	Heteromastus filiformis	0	0	0	0	0	0	0	1	0	0
	Mediomastus australiensis	0	0	1	2	6	1	2	13	19	5
	Notomastus annulus	0	0	0	1	1	0	0	0	0	0
	Notomastus chrysosetus	1	4	1	0	0	0	0	0	0	0
	Notomastus estuarius	0	0	0	1	0	0	0	0	0	0
	Notomastus torquatus	0	0	0	0	0	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	1	1	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0	1	1	2	0	0
	Caulleriella tricapillata	0	0	1	1	0	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	2	1	0	0	1	0	0
	Glycera sp. 2	0	0	0	0	0	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	1	0	0	0	0	0	0	1	0
Hesionidae	*Podarke microantennata*	0	0	0	0	0	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	1	0	1	0	2	0	1	0	0	0
	Lumbrineris cf *latreilli*	0	0	0	0	0	0	1	1	0	2
Magelonidae	*Magelona* sp. 1	0	1	0	0	0	0	1	1	0	1
Maldanidae	*Euclymene trinalis*	0	0	0	0	0	0	0	0	0	0
	Maldane sarsi	0	0	0	0	0	0	0	0	0	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	2	0	0	0	1	0	0	0	0	0
	Aglaophamus australiensis	0	0	0	0	0	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	0	0	0	0	0	0	0	0	0
	Nephtys inornata	0	0	0	0	0	0	0	3	0	5
	Nephtys longipes	0	0	0	0	0	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	1	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0	0	0	0	0	0
	Platynereis dumerili antipoda	0	0	0	0	0	0	1	0	0	0
	Pseudonereis anomala	0	0	0	0	0	0	0	0	0	0

Family	Species	30 a	30 b	30 c	30 d	30 e	32 a	32 b	32 c	32 d	32 e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0	0	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0	2	0	0	1	0
Onuphidae	*Onuphis* n.sp.	0	0	0	0	0	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0	0	0	0	0	2
	Travisia sp. 1	0	0	0	0	0	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	1	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0	0	0	0	0	0
	Phylo felix	0	0	0	0	0	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0	0	0	1	1	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0	0	0	0	0	0
	Levinsenia sp. 1	0	0	0	0	0	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	1	0	1	0	2	0	0
	Phyllodoce novaehollandiae	0	0	0	0	1	0	0	0	1	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	0	0	0	0	0	0
Sabellidae	*Euchone limnicola*	0	0	0	0	1	0	0	0	0	0
	Euchone variabilis	0	0	0	0	0	0	0	0	0	0
	Laonome triangularis	0	0	0	0	0	0	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	0	0	2	1	0	0	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0	0	0	0	0	0
	Horstileanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Leanira sp. 1	0	0	0	0	0	0	0	0	0	0
	Sigalion sp. 2	0	0	0	0	0	0	0	0	0	0
Spionidae	*Dipolydora* sp. *(*not cf. *flava),* *posterior*	0	0	0	0	0	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	1	0	0	0	0	0
	Prionospio aucklandica	0	0	0	0	0	15	7	5	3	1
	Prionospio australiensis	0	0	0	0	0	0	0	0	0	0
	Prionospio paucipinnulata	0	0	0	0	0	0	0	0	0	0
	Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0	0	0	0	0	0
	Scolelepis carunculata	0	0	0	0	0	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0	0	0	0	0	0
	Spio pacifica	0	0	0	0	0	4	0	0	4	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0	0	0	0	0	0

Family	Species	30 a	30 b	30 c	30 d	30 e	32 a	32 b	32 c	32 d	32 e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	0	0	0	4	3	2
	Exogone (Exogone) haswelli	0	0	0	0	0	0	0	0	2	0
	Haplosyllis sp. 1	0	0	0	0	0	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0	0	0	0	0	0
	Syllid sp. 1	0	0	0	0	0	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	0	0	0	1	0	0	0	0	0	0
	Lanice sp. 1	0	0	0	0	1	0	0	0	0	0
	Lysilla sp. 1	0	0	0	0	12	0	0	0	0	0
	Lysilla sp. 2	0	0	0	0	0	0	0	0	0	0
	Polycirrus sp. 1	0	0	0	0	0	0	0	0	0	0
	Rhinothelepus lobatus	1	0	0	0	0	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	1	0	0	0	0	0	0	0
	Terebellides woolawa	0	0	1	0	0	0	0	0	0	0
	Trichobranchus bunnabus	0	0	0	0	0	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0	0	0	0	0	0

Family	Species	33 a	33 b	33 c	33 d	33 e
Ampharetidae	*Amphicteis dalmatica*	1	0	0	0	0
Capitellidae	*Barantolla lepte*	0	0	0	0	0
	Heteromastus filiformis	0	0	0	0	0
	Mediomastus australiensis	0	1	0	1	0
	Notomastus annulus	0	0	0	0	0
	Notomastus chrysosetus	0	0	0	0	0
	Notomastus estuarius	3	1	1	0	0
	Notomastus torquatus	0	0	0	0	0
	Scyphoproctus sp. 1	0	0	0	0	0
Chaetopteridae	*Chaetopterus* sp. 1	0	0	0	0	0
Cirratulidae	*Caulleriella bioculata*	0	0	0	0	0
	Caulleriella dimorphosetosa	0	0	0	0	0
	Caulleriella tricapillata	0	0	0	0	0
	Cirriformia filigera	0	0	0	0	0
Dorvilleidae	*Schistomeringos loveni*	0	0	0	0	0
Eunicidae	*Eunice australis*	0	0	0	0	0
	Eunice sp. 2	0	0	0	0	0
	Nematonereis unicornis	0	0	0	0	0
Flabelligeridae	*Diplocirrus* sp. 1	0	0	0	0	0
Glyceridae	*Glycera* sp. 1	0	0	0	0	0
	Glycera sp. 2	0	0	0	0	0
Goniadidae	*Goniada* sp. 1	0	0	0	0	1
Hesionidae	*Podarke microantennata*	0	0	0	0	0
Lumbrineridae	*Augeneria verdis*	0	0	0	4	0
	Lumbrineris cf *latreilli*	0	0	0	0	2
Magelonidae	*Magelona* sp. 1	0	0	0	0	0
Maldanidae	*Euclymene trinalis*	0	2	0	0	0
	Maldane sarsi	4	0	2	1	0
Nephtyidae	*Micronephthys aurantiaca* n. sp.	1	0	0	2	1
	Aglaophamus australiensis	0	0	0	0	0
	Micronephthys derupeli n.sp.	0	1	0	1	0
	Nephtys inornata	1	0	2	0	0
	Nephtys longipes	0	0	0	0	0
Nereididae	*Australonereis ehlersi*	0	0	0	0	0
	Neanthes cricognatha	0	0	0	0	0
	Platynereis dumerili antipoda	0	0	0	0	0
	Pseudonereis anomala	0	0	0	0	0

Family	Species	33 a	33 b	33 c	33 d	33 e
Oenonidae	*Drilonereis* sp. 1	0	0	0	0	0
Oligochaeta (Subclass)	*Oligochaete* sp. 1	0	0	0	0	0
Onuphidae	*Onuphis* n.sp.	0	0	0	0	0
Opheliidae	*Armandia*	0	0	0	0	0
	Travisia sp. 1	0	0	0	0	0
Orbiniidae	*Leitoscoloplos normalis*	0	0	0	0	0
	Scoloplos (Leodamas) johnstonei	0	0	0	0	0
	Phylo felix	0	0	0	0	0
	Scoloplos (Scoloplos) simplex	0	0	0	0	0
Paraonidae	*Aricidea (Aricidea) fauveli*	0	0	0	0	0
	Levinsenia sp. 1	0	0	0	0	0
Phyllodocidae	*Anaitides longipes*	0	0	0	0	0
	Phyllodoce novaehollandiae	0	0	0	0	0
Pisionidae	*Pisionidae* sp. 1	0	0	0	0	0
Poecilochaetidae	*Poecilochaetidae* sp. 1	0	0	0	0	0
Polynoidae	*Polynoid* sp. 1	0	0	0	0	1
Sabellidae	*Euchone limnicola*	5	1	0	0	4
	Euchone variabilis	0	0	0	0	0
	Laonome triangularis	1	0	0	0	0
Saccocirridae	*Saccocirrus* sp. 1	0	0	0	0	0
Scalibregmatidae	*Scalibregma inflatum*	1	0	0	0	0
Sigalionidae	*Euthalenessa* sp. 1	0	0	0	0	0
	Horstileanira sp. 1	0	0	0	1	0
	Leanira sp. 1	0	0	0	0	0
	Sigalion sp. 2	0	0	0	0	0
Spionidae	*Dipolydora* sp. (not cf. *flava), posterior*	0	0	0	0	0
	Dipolydora sp. cf. *flava*	0	0	0	0	0
	Dispio glabrilamellata	0	0	0	0	0
	Prionospio aucklandica	0	0	0	0	0
	Prionospio australiensis	0	0	0	0	0
	Prionospio paucipinnulata	0	0	0	0	0
	Prionospio steenstrupi	0	0	0	0	0
	Prionospio tridentata	0	0	0	0	0
	Pseudopolydora sp. cf. *paucibranchiata*	0	0	0	0	0
	Pseudopolydora sp. cf. *kempi*	0	0	0	0	0
	Rhynchospio glycera	0	0	0	0	0
	Scolelepis carunculata	0	0	0	0	0
	Scolelepis occipitalis	0	0	0	0	0
	Spio pacifica	0	0	0	0	0
	Spiophanes sp. cf. *bombyx* cf. *kroeyeri*	0	0	0	0	0

Family	Species	33 a	33 b	33 c	33 d	33 e
Syllidae	*Astreptosyllis acrassiseta*	0	0	0	0	0
	Exogone (Exogone) africana	0	0	0	0	0
	Exogone (Exogone) haswelli	0	0	0	0	0
	Haplosyllis sp. 1	0	0	0	0	0
	Parahlersia ehlersiaeformis	0	0	0	0	0
	Perkinsyllis augeneri	0	0	0	0	0
	Perkinsyllis koolalya	0	0	0	0	0
	Syllid sp. 1	0	0	0	0	0
Terebellidae	*Amaeana* sp. 1	1	1	0	1	0
	Lanice sp. 1	0	0	0	0	0
	Lysilla sp. 1	2	5	4	3	1
	Lysilla sp. 2	0	1	0	0	0
	Polycirrus sp. 1	0	0	0	0	0
	Rhinothelepus lobatus	0	0	0	0	0
Trichobranchidae	*Terebellides kowinka*	0	0	0	0	0
	Terebellides woolawa	0	0	1	0	0
	Trichobranchus bunnabus	0	0	0	0	0
	Trichobranchus sp. 1	0	0	0	0	0

Appendix G: Sediment Data 2011 Sampling Period

Appendix G: 2011 sampling period sediment data per site (i.e. S1, S2, etc.).

Factor (%)	**S1**	**S2**	**S3**
> 6.3mm	0.6	0.7	0.3
< 6.3mm > 4.75mm	0.19	0.34	0.09
< 4.75mm > 3.35mm	0.48	0.32	0.16
< 3.35mm > 2mm	1.18	0.47	0.21
< 2.00mm > 1.00mm	3.5	1.1	0.5
< 1.00mm > 0.6mm	8.4	4.3	1.7
< 0.6mm > 212µm	84.6	89.3	95.8
< 212µm > 63µm	1.19	3.5	1.2
< 63µm	<0.1	0.1	<0.1
CaCO3 Equivalent	0.64	0.22	0.46
Total Organic Carbon	0.05	0.04	<0.02
Depth (m)	11.3	11	8.2

Factor (%)	**26**	**27**	**29**	**30**	**32**	**33**
> 6.3mm	2.1	<0.1	<0.1	<0.1	<0.1	<0.1
< 6.3mm > 4.75mm	0.38	0.06	<0.01	<0.01	0.2	<0.01
< 4.75mm > 3.35mm	0.49	0.04	<0.01	<0.01	0.14	<0.01
< 3.35mm > 2mm	0.89	0.31	<0.01	<0.01	0.2	<0.01
< 2.00mm > 1.00mm	1.7	2.2	<0.1	0.3	0.3	<0.1
< 1.00mm > 0.6mm	3.3	13.9	0.3	1.5	0.5	0.3
< 0.6mm > 212µm	87.6	83.3	15.45	10.8	93.6	2.89
< 212µm > 63µm	3.52	0.19	17.15	12.2	4.88	2.29
< 63µm	<0.1	<0.1	67.1	75.2	0.1	94.5
CaCO3 Equivalent	3.32	4.5	7.06	8.43	1.93	3.4
Total Organic Carbon	0.02	0.03	2.06	2.84	0.1	2.08
Depth (m)	12.6	2.8	20	3.2	5.8	4.2