BIODIVERSITY CHANGES IN THE DERWENT ESTUARY:

A Temporal Analysis of Intertidal and Subtidal Reefs (2010–2024)

Charlotte McAneney, Ashlee Bastiaansen and Neville Barrett

December 2025

The Derwent Estuary is one of Tasmania's most ecologically and economically significant waterways, supporting a wide range of biodiversity, recreational and commercial uses, and critical habitats for threatened species such as the Spotted Handfish. Despite its value, the estuary has experienced longstanding pressures from urbanisation, industrial pollution, introduced species, and climate change.

This project forms part of the Derwent Estuary Program's long-term monitoring initiative. It assessed changes in the abundance and distribution of fish, invertebrates, and algal communities on intertidal to subtidal rocky reefs and adjacent sediment habitats, using data from 27 sites surveyed in both 2010 and 2024. Two complementary underwater visual survey methods were employed to capture temporal and spatial changes across habitats and depths.

Key findings indicate that while species richness fluctuated across taxa, several positive ecological shifts have occurred, particularly in algal communities and cryptic fish populations. Notably, *Ecklonia radiata*, a canopy-forming kelp and indicator of water clarity, expanded both in abundance and depth range, coinciding with the disappearance of widespread tubeworm matting and suggesting a shift towards healthier subtidal habitats.

In the fish community, overall richness declined slightly, but community composition remained broadly consistent. Several species exhibited range expansions, while others, such as *Latridopsis forsteri* and *Trachinops caudimaculatus*, declined in both abundance and spatial extent. The marked decline in *L. forsteri* may be at least in part related to changing social behaviour, related to an increase in the popularity of recreational spearfishing. Cryptic fish richness and abundance increased significantly at several upper estuary sites, potentially reflecting improving environmental conditions and habitat complexity.

Mobile macro-invertebrate richness remained stable overall. However, introduced species such as the seastars *Asterias amurensis* and *Patiriella regularis,* as well as the red seaweed *Grateoloupia turuturu* increased sharply in abundance and remain a concern for ecological balance. In contrast, other potential invasive species (*Carcinus maenas*, *Metacarcinus novaezelandiae*, and *Petrolisthes elongatus*) showed minimal range expansion, indicating no further escalation in threat level since 2010.

With the exception of the algae, introduced species were most dominant in the upper to mid estuarine sites surveyed, whereas native biodiversity was higher in the southern, more marine-influenced zones. While introduced species increased in number and distribution, particularly among cryptic fish and invertebrates, their presence did not appear to further displace native species in a measurable way over the decade examined here.

Overall, the findings indicate areas of concern—especially rising invasive species numbers—but also evidence of ecological recovery. The expansion of kelp forests, reduced coverage of tube-worm matting, and increased cryptic fish abundance in previously degraded areas point to improving estuarine conditions. Continued monitoring will be essential to track these trends and guide future management actions.

Extended Summary

The Derwent Estuary has been identified as one of Tasmania's most ecologically and economically important estuaries. Approximately 40% of Tasmania's population resides along its margins, and the estuary supports a wide range of recreational activities, including boating and fishing, as well as industry, including Nyrstar Hobart zinc smelter, Boyer paper mill, Incat shipbuilding, TasPorts, and marine transportation. Ecologically, the estuary provides vital habitat for several threatened and endemic species, including the critically endangered Spotted handfish, highlighting its importance as both biodiversity rich and a focus for conservation efforts. Due to urbanisation and historic industrial uses, many pressures affect the Derwent Estuary, including heavy metal contamination, introduced and invasive species, elevated levels of nutrients and climate change. These pressures, when combined, can significantly deteriorate estuarine habitats and the species found within this dynamic ecosystem. Subsequently, assessing biodiversity through time can provide insight into both the recovery of the estuary and its environmental conditions, and the various ecological elements (e.g., invasive species) that threaten a balanced ecosystem.

The Derwent Estuary Program (DEP) is a regional not-for-profit partnership between the Tasmanian Government, local governments, industry, scientists and the community, underpinned by a comprehensive integrated monitoring program documenting environmental conditions and trends. This project contributes to the broader DEP monitoring of the estuary by examining decadal patterns of biodiversity and abundance of fish, invertebrates and algae across intertidal to subtidal rocky reefs and adjacent sediment habitats in the Derwent Estuary. An earlier ARC and DEP funded study examined the biota at 27 sites in 2010, with this study replication that sampling in 2024, using two quantitative survey methods (underwater visual census [UVC] techniques) to assess patterns of abundance and distribution along the estuarine gradient. This report synthesises the results from this sampling, providing an overview of temporal changes observed in the estuary, and positive signs of recovery within the ecosystem. The key findings from both survey methods are presented below. For survey purposes, sites were grouped into three regions along the estuarine gradient: the upper estuary (Cadbury Point, site 1, to Cornelian Bay, site 6), the mid estuary (200 m north of Tasman Bridge East Shore, site 7, to Battery Point, site 15), and the lower estuary (Tranmere Reef, site 16, to Pearsons Point, site 27).

The first survey method utilised a standard belt transect adopted by the Australian Temperate Reef Collaboration (ATRC). A total of 40 fish, 21 cryptic fish, 37 macro-invertebrates and 71 algal species were recorded along standard subtidal rocky reefs across the Derwent Estuary. Compared to the 2010 baseline surveys, species richness fluctuated across taxa in 2024: fish richness declined, whilst cryptic fish and macro-invertebrate richness increased. Fish species richness generally followed the estuarine gradient, increasing from north to south, with the highest richness recorded at lower estuary sites such as Blackmans Bay South, Lucas Point, and Pearsons Point.

Fish community composition remained broadly consistent with 2010, with seven species overlapping amongst the most abundant in both surveys: *Dinolestes lewini, Forsterygion varium*, *Latridopsis forsteri, Notolabrus tetricus, Pempheris multiradiata*, *Pictilabrus laticlavius,* and *Trachinops caudimaculatus*. Of concern is the marked decline of *L. forsteri,* potentially due to a combination of sequential recruitment failure and increased fishing

pressure, particularly via a marked increase in recreational spearfishing. Several species exhibited minor range shifts. *P. multiradiata* and *P. laticlavius* extended further north into the mid-estuary in 2024, while the introduced *F. varium* expanded into the lower estuary. Most abundant species, except *T. caudimaculatus, F. varium*, and *Neodaax balteatus*, showed increasing abundance towards the southern part of the estuary. Cryptic fish species richness and overall abundance both increased in 2024, suggesting improved or less extreme environmental conditions and greater availability of complex habitats, which are preferred by cryptic species. Notably, richness and abundance rose substantially at several upper estuary sites – Bedlam Walls North, South, and Point South of Geilston Bay – contrasting with 2010, when higher richness was concentrated in the mid-estuary. Two species, *F. varium* and *P. multiradiata*, were consistently among the four most abundant cryptic fish species in both surveys. While both were also detected in the standard surveys, cryptic surveys offered a more comprehensive assessment of their distribution. The introduced *F. varium* tripled in abundance and extended its range into both the upper and lower estuary, indicating ongoing range shifts. Likewise, *Forsterygion gymnotum* expanded its range, occurring at nine sites in 2024, compared to only two in 2010.

Species richness of mobile macro-invertebrates was comparable to 2010, with no clear increases or spatial trends observed across the estuary. *Patiriella regularis* remained the most abundant macro-invertebrate species, with considerably higher numbers recorded in 2024 – more than double the 2010 counts at many sites. *Asterias amurensis* also showed a marked increase in abundance. However, both species exhibited minimal range shifts, with distribution largely confined to the upper and mid estuary. In the absence of any major flooding events in recent years, the upper estuary may have entered a state of relative stability, allowing opportunistic species like *A. amurensis* and *P. regularis* to flourish in high abundance. In contrast, other abundant macro-invertebrates such as *Heliocidaris erythrogramma*, *Jasus edwardsii*, *Lunella undulata*, *Cenolia trichoptera*, and *Meridiastra calcar* were predominantly recorded in the southern and mid-estuary regions. The significant numbers recorded for both *A. amurensis* and *P. regularis* are of concern, and highlight the need for ongoing monitoring of invasive species (such as this decadal study) and management interventions where practical (e.g. *A. amurensis* removal in core spotted handfish habitat). In contrast, the introduced *Carcinus maenas, Metacarcinus novaezelandiae* and *Petrolisthes elongatus* showed no significant increases in abundance, and exhibited minimal range shifts – a positive outcome considering the concerns raised in 2010 about their potential to become invasive threats.

Overall, the distribution patterns of native and introduced cryptic fish and macro-invertebrate species in 2024 were broadly consistent with those observed in 2010. Introduced species richness remained highest in the upper estuary, while native species were more diverse in the lower estuary, closer towards the marine extreme. However, notable range expansions have occurred for introduced species, with presence now recorded at all sites except White Rock, South Arm. This broader distribution has been accompanied by increased abundances—particularly in the upper estuary, where introduced cryptic fish and invertebrates now average over 300 individuals per site, compared to 100–150 in 2010. Importantly, this rise in introduced species abundance has not been matched by a corresponding decline in native species abundance, suggesting that coexistence, rather than replacement, may be occurring at some sites.

Algal species richness and spatial distribution patterns were broadly similar between surveys, with higher richness consistently observed in the southern estuary in both 2010 and 2024. However, percent cover of algae increased dramatically in 2024 for several upper estuary sites, spanning from Bedlam Walls North to Battery Point – locations that were largely dominated by tubeworm matting in 2010, representing an alternate stable state. Foliose algal cover also increased across a similar spatial extent, particularly from Bedlam Walls North to Tranmere Point. Algal species composition remained relatively stable across surveys, with dominant species in 2024 including *Ecklonia radiata, Carpoglossum confluens, Sargassum fallax, Acrocarpia paniculata,* and *Lessonia corrugata*. Notably, *E. radiata* expanded its distribution northwards into areas where it had not been previously recorded. This shift – alongside the complete disappearance of tubeworm matting between Bedlam Walls North and Battery Point – indicates a substantial ecological transition. Together, these changes suggest a positive trajectory for the estuary's recovery, marked by increased algal abundance and re-establishment of kelp-dominated communities in areas previously impacted by ecological degradation.

The second survey method recorded the abundance of fish, invertebrates and algae in a 20-minute timed swim (and intertidal search) across multiple depths and habitats, using a ranking system (1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = >1000 individuals). Overall, species richness of fish, invertebrates, and algal species remained relatively consistent between 2010 and 2024, with a slight decline observed in 2024. Richness was generally highest in reef habitats and in the lower estuary, particularly within the intertidal, 0-1 m, and 1-4.9 m depth zones. As in the standard surveys, richness tended to increase from north to south. While site-level variability was present, changes in richness between years were minimal.

Introduced species richness and spatial distribution patterns were broadly similar across surveys, although overall richness increased in 2024, particularly on reef habitats. Species recorded with only a single individual at a site (least abundant) showed high variability in both surveys, suggesting fluctuations in rare or transient taxa. Most observations in sand habitats occurred at 5–8.9 m depth, whereas reef habitats supported a broader range of species from intertidal to 4.9 m.

In total, 60 fish species, 140 macro-invertebrates, and 45 algal species were recorded during the timed surveys. *Forsterygion varium, Notolabrus tetricus, Forsterygion gymnotum, Trachinops caudimaculatus, Neoodax balteatus* were among the most abundant fish species recorded in both 2010 and 2024. Notably, *F. varium* and *N. balteatus* expanded their distribution across the entire estuary in 2024, with several new site occurrences and increases in rank abundance by several-fold. Comparatively, *T. caudimaculatus* showed a contraction in range, with its absence recorded at multiple sites where it was previously observed in 2010.

As in the standard surveys, macro-invertebrate species richness generally increased from north to south, particularly in intertidal habitats. Despite some site-level variability, year-to-year changes in richness were minimal. *Asterias amurensis, Crassostrea gigas, Patiriella regularis, Ostrea angasi, Petrolisthes elongatus, Mytilus galloprovincialis* were among the most abundant macro-invertebrate species recorded in both 2010 and 2024. As *C. gigas* and *O. angasi* can overlap in spatial and depth distribution, and have overlapping shell morphologies in some locations, a follow-up survey was undertaken to (in)validate field observations. That survey included collection of specimens from multiple depths at a range of locations where they were recorded, with identifications checked by a taxonomic expert, and further validated by tissue testing with a DNA probe previously developed for identification of *O. angasi.* The results suggested that the initial field observations were generally correct, however, in places some individuals of the two species were impossible to separate based on external shell morphology, possibly leading to some mis-identification in field surveys. Despite this, both species were present in the samples collected, with *C. gigas* dominating in the intertidal zone, and with increasing *O. angasi* numbers at depth, from a minor component at 0-1 m depth, to dominating the oyster numbers at depths below 5 m. Overall, *O. angasi* appears to be abundant within the estuary, although not forming the extensive oyster beds historically reported for this estuary. Over the decade between surveys, *A amurensis* increased in rank abundance at most sites, occurring at several new sites across all habitat types. While *A. amurensis* was most frequently observed in sand habitats, rank abundance on reef and ecotone habitats also increased substantially – by several orders of magnitude in 2024. In contrast, *C. gigas* declined by more than ten-fold at nearly all sites and was absent from all ecotone habitats in 2024. *P. regularis* maintained a similar spatial distribution to 2010, with some fluctuations in rank abundance across sites. Notably, two sites (Bellerive Yacht Box and Rosny Point South) recorded high rank abundances in 2024, with 100-1000 individuals on sediment surveys, despite no observations of *P. regularis* in 2010.

Algal species richness increased from north to south – a spatial pattern observed in 2024 across multiple depths for reef habitats; intertidal, 0-1 m, and 1-4.9 m. Algal community composition across the surveys varied, with only three species remaining among the most abundant in 2024; *Cystophora moniliformis, Ecklonia radiata,* and *Ulva spp.* Both *C. moniliformis* and *E. radiata* shifted further north, supporting the ecological shift seen in the standard surveys. *Ecklonia radiata* can be used as an indicator for water clarity, and as such improved environment conditions. We found this species to have increased in both rank abundance and an expanded depth range in 2024, particularly within 0-1 m, 1-4.9 m and 5-8.9 m subtidal zones. Notably, Bellerive Bluff and Bellerive/Howrah Bluff increased from a rank of 1-2 (≤10 individuals) in 2010, to near-complete coverage (rank 4-5; 101-1000+ individuals) in 2024. This expansion in kelp coverage at deeper depths, potentially due to improved water quality and greater light penetration, coupled with the disappearance of widespread tube-matting previously recorded between Bedlam Walls and Battery Point, suggests an overall positive ecological shift and signs of recovery in the estuary.

For introduced algal species, *Aodes nitidissima* remained in a tight distribution in proximity to the Tasman Bridge, while both *Undaria pinatiffida* and *Grateoloupia turuturu* extending their range further up the estuary. The introduced red algae *Grateoloupia turuturu* (first recorded in Tasmania in 2006 and suspected to have originated from Japan) was found to have increased to very high densities in the immediate subtidal zone at many locations, particularly seaward of Bellerive Bluff on the eastern shore.

Overall, the findings of this repeated survey indicate areas of concern—especially the rising numbers of invasive species—but also evidence of ecological recovery within the Derwent Estuary. The expansion of kelp cover, reduced coverage of tube-worm matting, and increased cryptic fish abundance in previously degraded areas point to improving estuarine conditions. Continued monitoring will be essential to track these trends and guide future management actions.

1. Introduction

The Derwent Estuary covers an area of 198 km^2, extending from the northern-most point of New Norfolk to Iron Pot Light at its mouth. Home to a diverse range of species, including the threatened Spotted Handfish (*Brachionichthys hirsutus*), and the Derwent River seastar (*Marginaster littoralis*), a species now presumed to be extinct (O'hara et al. 2018) but requiring confirmation. This estuary is predominantly made up of sand and silt, alongside other habitats including wetlands, seagrass meadows and near-shore rocky reefs (DEP 2020). As a temperate estuarine system adjacent to a major urban centre, the Derwent serves as the focal point for the Hobart community with numerous recreational and commercial uses. The estuary is an important and productive ecosystem, providing key habitat for numerous species. However, due to its proximity to Hobart and catchment activities including farming, forestry, a paper mill and aquaculture, the estuary continues to face cumulative pressures, including urban run-off, siltation, sewage treatment plant nutrient discharges, legacy heavy metal contamination, climate change and invasive species, all of which add to the degraded conditions of the Derwent (DEP 2020; DEP 2021). Like many temperate estuarine systems globally, the Derwent is also likely responding to broader environmental changes such as warming waters and varying flood levels from the riverine extremes, which may influence salinity gradients, marine species distributions and estuarine connectivity. Recent work has highlighted gaps in understanding the ecological consequences of estuarine outflows, including contaminant and nutrient export, particularly in systems along Australia's southeast coast (Rasmussen et al. 2024).

Historically, the Derwent Estuary has recorded high concentrations of metals, as a result of past industrial activities and proximity to Hobart. Currently, the largest source of metals in the estuary is from contaminated groundwater (Macleod & Coughanowr 2019). The Nyrstar zinc smelter located at Lutana began discharging effluent containing metals when it was established in 1917, and the paper mill in Boyer also discharged metals, particularly mercury, into the estuary in the past (DEP 2020). Once in the water environment, metals and other contaminants pose persistent toxic health risks, often evidenced by the accumulation of metals in fish and shellfish tissues (de Souza Machado et al. 2016; DEP 2021). Management and remediation work is ongoing within the Derwent Estuary, including the implementation of stormwater catchment systems and groundwater interception walls, each allowing for metal removal processes (Nyrstar Hobart 2017). As a result, recent studies show declines in total zinc in ambient waters across surveys from 2007 to 2019 (DEP 2021). However, metals still remain in the tissue of all wild seafood species collected throughout the Derwent in 2019, and the Derwent remains a heavily degraded estuary. Assessing biodiversity changes through time will provide a clearer picture of the nature of the estuary, and any positive recoveries that may be occurring since 2010.

The 2010 biological baseline survey of Derwent Estuary reefs and adjacent sediment habitat documented clear spatial gradients in biodiversity, with fish and algal species richness increasing southward toward the lower estuary and more marine and wave-influenced-influenced sites (Barrett et al. 2012). Macroinvertebrate communities were also strongly structured by habitat type. Several sites exhibited signs of ecological degradation, including high prevalence of introduced species and a lack of native algal cover. Introduced species are a significant issue of concern within the Derwent, with previous work identifying *Asterias amurensis* and *Patiriella regularis* as particularly invasive (Ross et al. 2004; Ross et al.

2006). The baseline surveys firmly established several introduced species as inhabiting the mid-estuary, from Bedlam Walls to Battery Point and Bellerive Bluff, including both introduced sea stars, as well as the introduced crabs *Petrolistes elongatus* and *Carcinus maenus*. Assessing how these introduced populations have changed in the last decade is critical to conservation efforts and sustainable management in the Derwent.

Furthermore, ecosystem changes within habitats are critical to monitor. The Derwent follows a biological gradient typical of other estuaries, with a seagrass/filamentous algal mix on shallow, silty reefs in the upper estuary, to a diverse and complex algal assemblage in the south (Potter et al. 2010; Alves et al. 2020). The baseline survey identified several ecological features indicating a degraded ecosystem, including the 100% cover of tube-worm matting observed in the mid-estuary at Rosny Point, Battery Point and further upstream. Historically, algal assemblages have failed to re-establish at these sites, likely due to the restrictive and all-encompassing nature of the polychaete matting (Barrett et al. 2012). Monitoring sites where this alternative stable state is present could further our understanding of the recovery progress within the estuary.

1.1 Objectives and approach

This study replicates the biological surveys completed in 2010, with the aims of identifying and quantifying biodiversity changes through time, relative to the initial study, in addition to providing a framework for a decadal monitoring program going forward. This ongoing monitoring will inform our knowledge on the native species within the Derwent Estuary and how they are responding to changing water quality and environmental conditions, as well as describing changes in distribution and abundance of introduced pest species found in this system.

The initial study, conducted over a decade ago, aimed to quantify the distribution and abundance of reef-associated biodiversity within the estuary, thoroughly survey for rare species including *M. littoralis*, and quantitatively describe the patterns of introduced species. Here, we present the results of the second survey undertaken in 2023 and 2024; and draw comparisons to the first survey in 2010. This study aimed to:

1. Provide further data on the spatial distribution and abundance of species and benthic communities,
2. Quantitatively describe changes in historically abundant and newly dominant species, and,
3. Assess population changes through time for key introduced species.

The findings of this repeated survey are essential for monitoring changes in reef community dynamics over time in a changing environment, evaluating the effectiveness of current management actions, informing targeted restoration efforts, and guiding future monitoring programs in one of Tasmania’s most ecologically and economically important estuaries.

2. Methods

This study replicates the methodology of surveys undertaken in the Derwent Estuary in 2009 and 2010, as part of an ongoing monitoring program to survey reef-associated biota and identify changing patterns in spatial and temporal distribution.

Multiple methods were utilised to describe the distribution of reef-associated biodiversity across 27 sites in the estuary. For survey purposes, sites were grouped into three regions along the estuarine gradient: the upper estuary (Cadbury Point, site 1, to Cornelian Bay, site 6), the mid estuary (200 m north of Tasman Bridge East Shore, site 7, to Battery Point, site 15), and the lower estuary (Tranmere Reef, site 16, to Pearsons Point, site 27).

Transect-based methods were conducted on rocky reefs in April 2023, and March – May 2024, at various depths, typically at 5 m where possible, but shallower at locations where reefs did not reach this depth. Additionally, timed surveys were undertaken during the same period to record the diversity and rank abundance of both common and rare species. This method allowed a greater area to be surveyed for biodiversity values than the transect method, trading off quantitative strength for increased species inventory and an understanding of depth-based trends at many sites. While these were primarily rocky reef and shoreline focussed, they also included ecotone habitat (where reef grades to sediment) and sediment habitat at many locations. Due to site conditions and time constraints, surveys could not be completed at all sites to the same extent of replication. Details of sites, depths and habitats sampled are in Table 1.

2.1 Standard subtidal reef surveys

The standard survey method involves the underwater visual census (UVC) of fish, mobile macro-invertebrates and algae densities, conducted according to the Australian Temperate Reef Collaborating (ATRC) methodology.

Surveys were conducted on SCUBA by a 2-4 personnel dive team at 19 sites. At each site, two 100 m transects were laid out in opposite directions, starting at the boat anchor, and divided into two 50 m segments (totalling 4 x 50 m transect blocks for each depth surveyed). Divers recorded fish observations along 5 m bands on either side of the transect (Figure 1), with a total of 4 x 10 m x 50 m fish transects surveyed at each site. Fish abundance and size of individual fish was recorded.

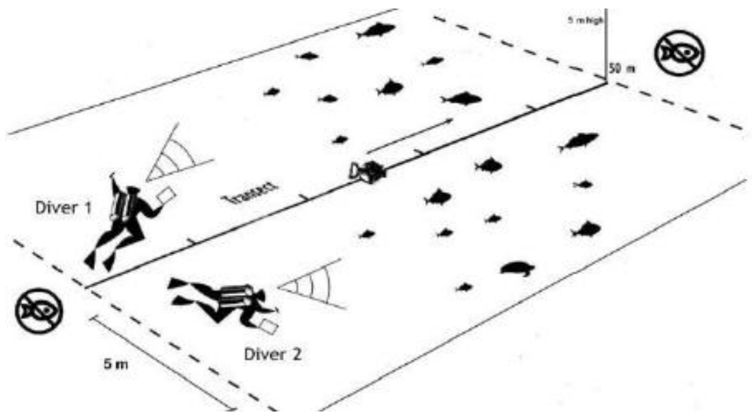

Figure 1: Stylised representation of method 1 survey technique

Cryptic fish and mobile macro-invertebrates were surveyed along the same transect line, within a 1 m band on one side of the transect (Figure 2). Cryptic fish were identified, counted and sized where possible, and mobile macro-invertebrates were identified and counted. A total of 4 x 1 m x 50 m transects were typically surveyed at each site. At some sites, there was insufficient reef for 4 x 50 m transects, so these were restricted to 2 x 50 m (see Table 1).

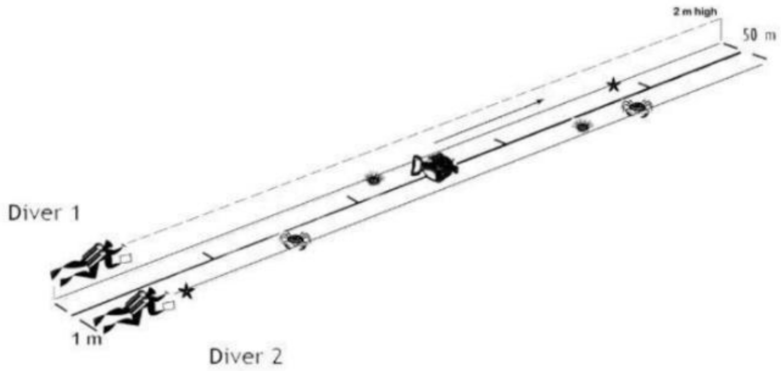

Figure 2: Stylised representation of method 1 survey technique.

The cover of macroalgae, sessile invertebrate species and substrata was quantified by placing a grided 0.25 m^2 quadrat at 10 m intervals along the transect lines. Covers were assessed by identifying and counting species that occurred directly under 50 intersection grid points. Percentage cover could then be quantified.

2.2 Timed intertidal and subtidal surveys

Timed intertidal and subtidal surveys were undertaken to record the diversity and rank abundances of common and rare species across various depth ranges at 24 sites.

Surveys were conducted on SCUBA by a 2-4 personnel dive team. A survey involved a 20-minute search, with divers recording fish, macro-invertebrates, large brown and green algae species, and introduced or 'key' species of red algae. Surveys were typically conducted along reef systems, but where possible, soft sediment and ecotone searches (comprising of patch reef and open sediments) were completed to capture the habitat of known rare species such as the spotted handfish. Surveys were undertaken between April and June 2024 at different depth ranges (intertidal, 0 – 0.9 m, 1 – 4.9 m, 5 – 8.9 m, 9 – 15 m) in reef, sand, and ecotone habitats depending on what habitat/depth range was available at each site. Species presence was recorded as a ranked abundance on a log10 scale in the following categories: 1 (only one specimen observed), 2 (2 – 10 individuals), 3 (11–100 individuals), 4 (101 – 1000 individuals) and 5 (> 1000 individuals). The first 10 minutes focussed on more common species, followed by targeted searches for rarer species in the last 10 minutes. This involved searching crevices and turning over a minimum of ten boulders (where possible).

Intertidal searches were undertaken at 19 sites and were restricted to rocky shoreline habitat. Any sites not surveyed (Table 1) was due to a lack of appropriate intertidal habitat. Where possible, a minimum of ten boulders/rocks were turned at each site to identify and count the abundance of cryptic species.

2.3 Data analysis

Data from the standard subtidal reef surveys were obtained from (for 2010 survey data), and entered into (for 2024 survey data) the National Reef Monitoring Network database hosted by the AODN (IMOS) (https://imos.org.au/facility/autonomous-underwater-vehicles/national-reef-monitoring-network) for both survey periods and analysed using RStudio. Data from the 2024 timed intertidal and subtidal surveys were collated with the 2010 dataset and similarly analysed using RStudio. All data were cleaned, summarised, and visualised using a combination of 'tidyverse' packages, with site-level comparisons conducted to assess changes in species richness, abundance, and spatial distribution across depths and habitats. The most abundant species identified for each survey method and survey period were analysed across sites to evaluate spatial and temporal shifts in their abundance and distribution between 2010 and 2024.

2.4 Targeted Oyster Identification

As it was found that in some locations *Ostrea angasi* and *Crassostrea gigas* were not always able to be readily differentiated based on external morphological features during diver-based ecological surveys, a follow-up study was undertaken at a selected range of sites and depth ranges where oyster species had been encountered during the main surveys. At each site and depth combination, approximately 10 individuals were collected where possible and returned for lab-based identification by a taxonomic expert based on characteristic internal structures of each species. To confirm morphological IDs, DNA was extracted from adductor muscle of a sub-sample of oysters using the QIAGEN DNeasy Blood & Tissue kit. Extracted DNA was diluted to 1 ng/uL and an *O. angasi* specific taqman qPCR test was performed in triplicate for each sample following the methods presented in Coutts et al. (2022). A positive result required amplification of all three technical replicates while a negative result required no amplification in all three technical replicates.

Table 1: Details for standard and timed surveys conducted in the Derwent in 2010 and 2024. Positions are recorded in decimal degrees using WGS 84.

SITE DETAILS				STANDARD SURVEYS			TIMED SURVEYS			
Site No.	**Site Name**	**Lat**	**Long**	**Depth (m)**	**No. of transects (2010)**	**No. of transects (2024)**	**Depth**	**Habitat**	**No. of searches (2010)**	**No. of searches (2024)**
1	Cadbury Point	-42.7885	147.281	1	2	2	Intertidal	Reef	2	2
							1.1 – 4.9		2	2
2	Dowsings Point	-42.8184	147.2977				Intertidal	Reef	2	2
							0 – 1	Ecotone	1	1
								Reef	1	1
3	Bedlam Walls North	-42.832	147.3273	4	2	2	Intertidal	Reef	2	2
							1.1 – 4.9	Reef	2	2
4	Bedlam Walls South	-42.8379	147.3312	4	2	2	Intertidal	Reef	2	2
							1.1 – 4.9	Reef	2	2
5	Point South of Gielston Bay	-42.8443	147.3376	3	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Ecotone	2	2
								Reef	3	3
							5 – 8.9	Sand	1	1
6	Cornelian Bay	-42.8518	147.3279	1	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	1	1
							1.1 – 4.9	Reef	2	2
								Sand	1	1
7	200 m North Tasman Bridge East Shore	-42.861	147.3501	2	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Ecotone	2	2
								Reef	2	2
							5 – 8.9	Sand	2	1
8	Collegiate Rowing Club	-42.8636	147.3362				Intertidal	Reef	2	2
							0 – 1	Reef	2	2
9	Rosny Point North	-42.8719	147.3504	2	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Reef	2	2
							5 – 8.9	Sand	3	2
10	Naval Cadets	-42.8724	147.3355				Intertidal	Reef	2	2
							0 – 1	Reef	2	2
11	Bellerive Yacht Box	-42.8757	147.3619				5 – 8.9	Sand	2	2
12	Rosny Point South	-42.8762	147.3543				5 – 8.9	Sand	2	2
13	Bellerive Bluff	-42.882	147.3652	4	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Reef		1
								Ecotone	3	3
							5 – 8.9	Ecotone	1	1
								Sand	2	2
							9 – 15	Sand	1	1
14	Bellerive/Howrah Bluff	-42.8825	147.3854	4	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	2	2

							1.1 – 4.9	Reef	2	2
							5 – 8.9	Sand	1	1
							9 – 15	Ecotone	2	2
15	Battery Point	-42.8897	147.3394	2	2	2	Intertidal	Reef	2	2
							0 – 1	Reef	2	3
							5 – 8.9	Sand	1	1
16	Tranmere Reef	-42.8999	147.4095				5 – 8.9	Reef	1	1
17	Tranmere Point	-42.9304	147.4093	3	4	4	Intertidal	Reef	3	2
							0 – 1	Reef	2	2
							1.1 – 4.9	Ecotone	1	1
								Reef	1	2
								Sand	1	1
							5 – 8.9	Reef	1	1
18	The Grange, Taroona	-42.9326	147.3616	4	4	4	Intertidal	Reef	2	2
							0 – 1	Reef	2	2
							1.1 – 4.9	Reef	2	2
							5 – 8.9	Ecotone	2	2
19	Crayfish Point	-42.9521	147.356	3	4	4	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Reef	2	2
							5 – 8.9	Reef	2	2
								Sand	1	1
20	Alum Cliffs	-42.9666	147.3419	5	4	4	Intertidal	Reef	2	2
							0 – 1	Reef	3	3
							1.1 – 4.9	Reef	2	2
							5 – 8.9	Ecotone	1	1
								Sand	1	1
21	Mary-Ann Bay	-42.9726	147.3996				5 – 8.9	Sand	2	2
22	White Rock, South Arm	-42.9774	147.3923	4	4	4	Intertidal	Reef	3	2
							0 – 1	Reef	2	1
							1.1 – 4.9	Reef	2	3
							5 – 8.9	Ecotone	1	1
								Sand	1	1
23	Opossum Bay	-42.9901	147.4018				5 – 8.9	Sand	2	2
24	Blackmans Bay Blowhole	-42.9984	147.3297	4	4	4	Intertidal	Reef	2	2
							0 – 1	Reef	3	2
							1.1 – 4.9	Reef	2	2
							5 – 8.9	Ecotone	1	1
								Sand	1	1
25	Blackmans Bay South	-43.0118	147.3311	5	4	4				
26	Lucas Point	-43.0383	147.3389	5	4	4				
27	Pearsons Point	-43.0534	147.3421	5	4	4				

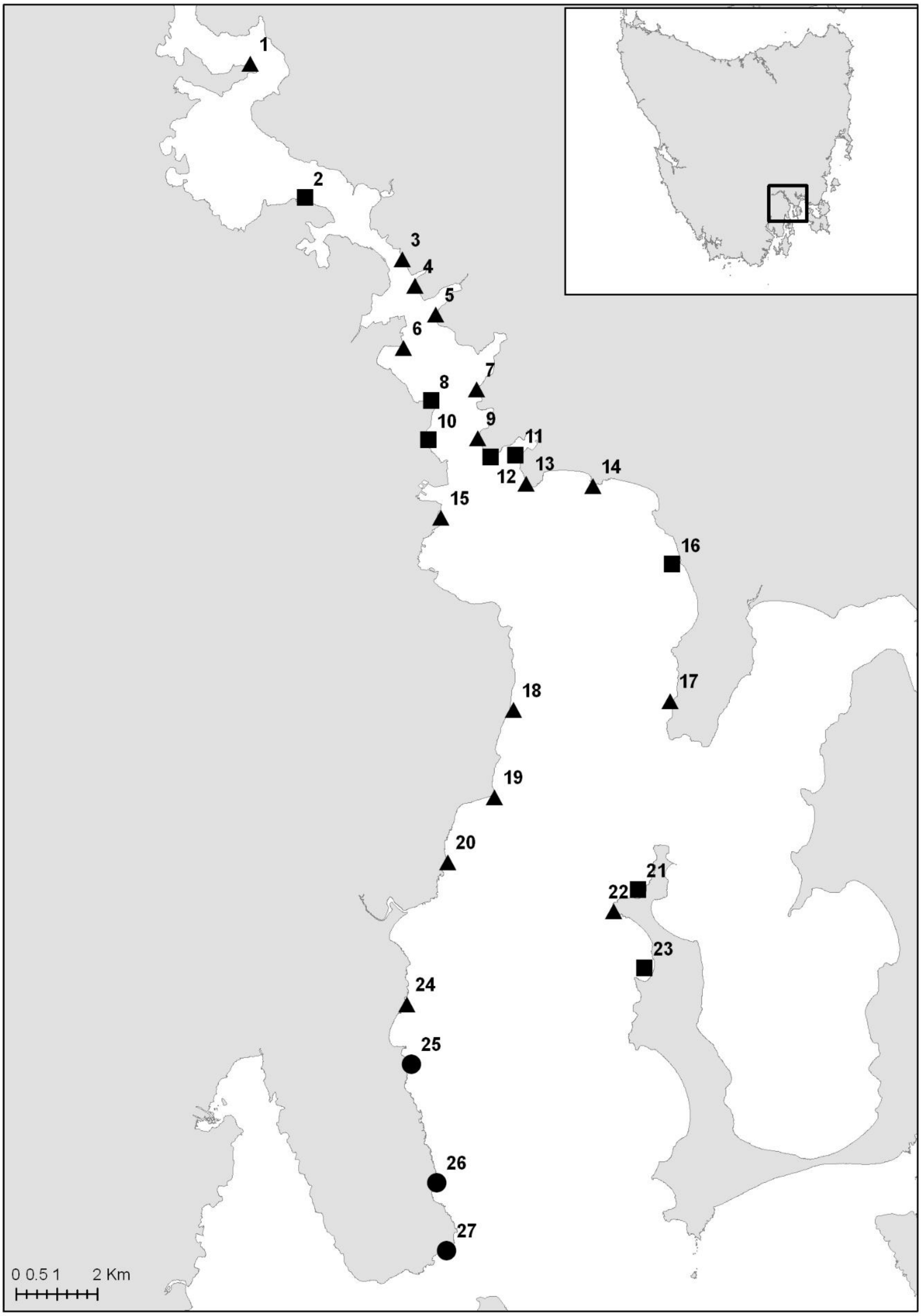

Figure 3: General map showing locations of sites surveyed in the Derwent in February-April in 2010, and March-June 2024. All sites were surveyed using the same methods in both survey periods. ● standard surveys; ■ timed surveys; ▲ standard and timed species surveys.

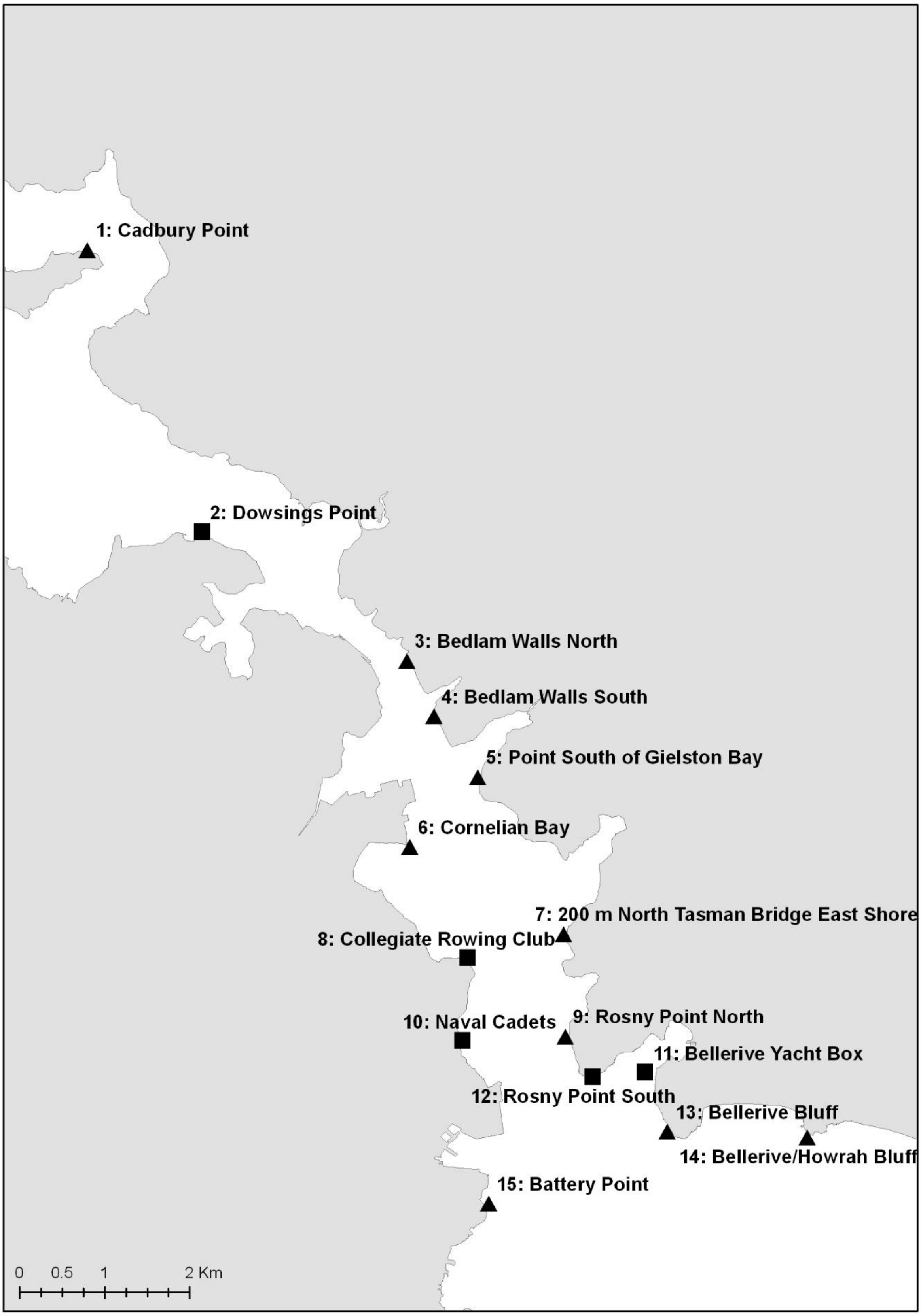

Figure 4: Detailed map showing site positions surveyed in the northern Derwent in February-April in 2010, and March-June 2024. All sites were surveyed using the same methods in both survey periods. ■ timed surveys; ▲ standard and timed species surveys.

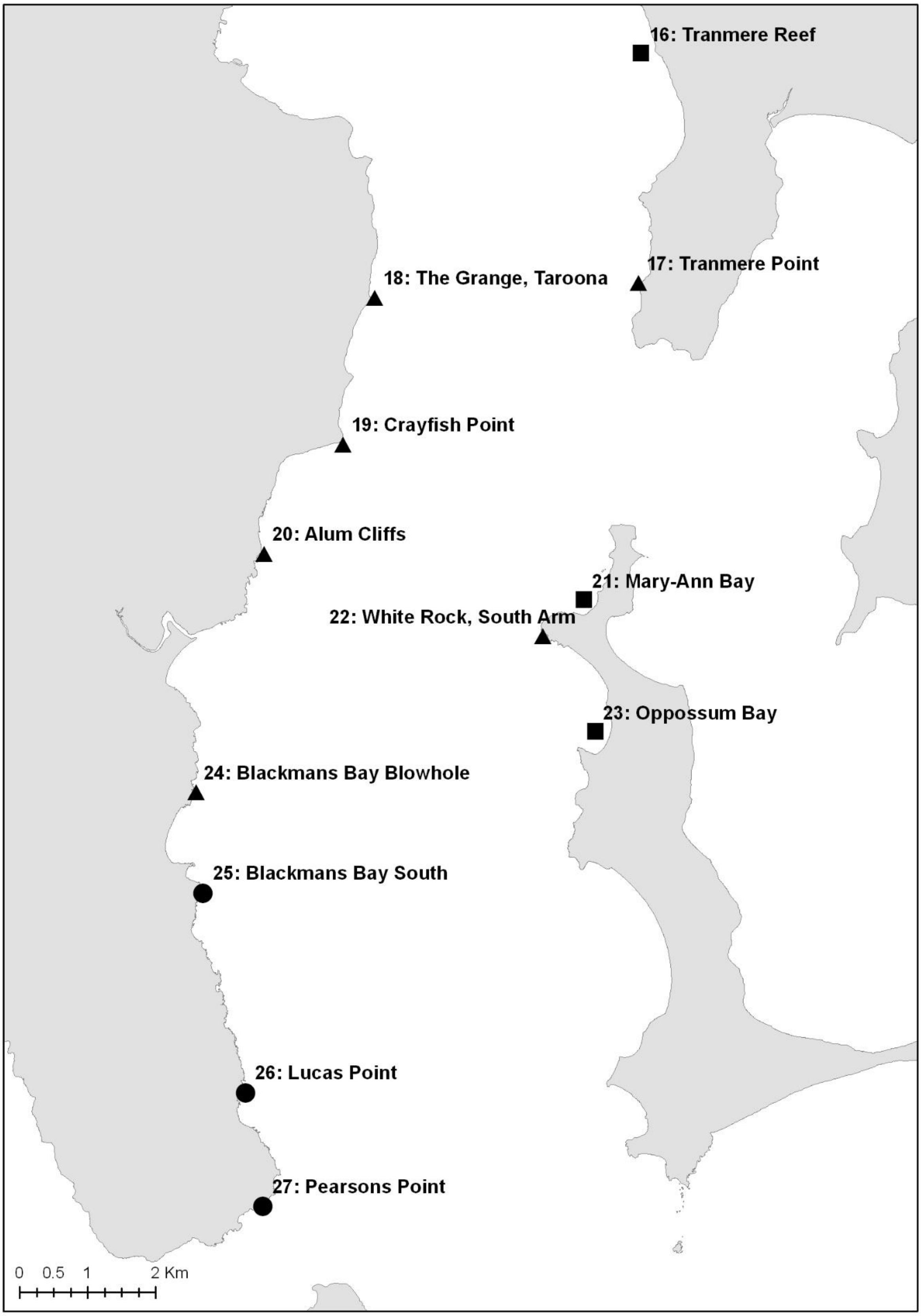

Figure 5: Detailed map showing site positions surveyed in the southern Derwent in February-April in 2010, and March-June 2024. All sites were surveyed using the same methods in both survey periods. ▲ standard and timed surveys; ● standard surveys; ■ timed surveys.

3. RESULTS

A substantial dataset was collected through the 2024 repeat sampling and combined with the baseline dataset from 2010 to allow temporal comparisons. Together, these datasets provide a comprehensive overview of spatial and temporal trends in biodiversity across the Derwent Estuary. The following results summarise observed changes in species richness, abundance, and distribution across fish, invertebrate, and algal communities, assessed across multiple depths and habitat types.

3.1 Standard subtidal surveys

Fish

Forty species of fish were recorded during the 2024 standard survey, a slight decrease from the 54 counted in the 2010 surveys. Species richness was generally consistent across the region, ranging from 4-6 species for most sites (Figure 6). Sites 1 and 3 (Cadbury Point and Bedlam Walls North) in the upper estuary had the lowest recorded species richness, ranging from 1-3 species, whereas sites 24, 25, 27, and 27 (Blackmans Bay Blowhole, Blackmans Bay South, Lucas Point, and Pearson Point) located in the lower estuary had the greatest richness (6-12 species). This pattern of gradually increasing richness from upper to lower is similar to the 2010 surveys, however there is an overall decline in the number of species recorded, with fewer species found in the current survey. A slight increase in richness was observed in the upper and mid- estuary when compared to the 2010 surveys (sites 4 to 9), however the opposite was evident in the lower sites, with a decline in species richness from site 17 (Tranmere Point) onwards.

The most abundant fish species were largely consistent across survey periods, though overall abundances generally decreased in the 2024 survey. Seven species – *Dinolestes lewini, Forsterygion varium* (an introduced species), *Latridopsis forsteri, Notolabrus tetricus, Pempheris multiradiata*, *Pictilabrus laticlavius,* and *Trachinops caudimaculatus* – remained among the top ten most abundant in both 2010 and 2024. *T. caudimaculatus* was the most abundant species across both surveys, although its numbers declined substantially in 2024, with only 100-500 individuals recorded per transect, compared to over 1000 individuals on multiple transects in 2010 (Figure 7g). A similar decline was observed in other species, including *D. lewini* (Figure 7a), and *L. forsteri* (Figure 7c). The decline in *L. forsteri* was over an order of magnitude, and across multiple sites where large resident schools had been previously sighted, including site 18 (The Grange). Minor range shifts are also apparent, with *P. multiradiata* and *P. laticlavius* (Figure 7e and 7f) occurring further north into the mid-estuary in 2024, and the introduced *F. varium* (Figure 7b) extending into the lower estuary. In 2024, *N. tetricus* abundance generally increased further down the estuary, rising steadily from site 13 onwards, although dips were observed at sites 19 and 27 (Figure 7d). In contrast, its distribution in 2010 was more variable, peaking at sites 19, 20 and 25. Notably, 45 individuals were recorded on a single transect at site 9 (Rosny Point North) in 2024, despite the species being entirely absent from that site in 2010.

Several species that were abundant in 2010 were rarely recorded in 2024, if at all. *Acanthaluteres vittiger* was only observed at three of the eight sites where it was previously recorded in 2010 and was newly recorded at two upper estuary sites (sites 4 and 6) where it had not been detected in the earlier survey (Figure 8a). In contrast, *Favonigobius lateralis* and *Pseudocaranx georgianus* (Figure 8b and 8c) were not recorded at any sites in 2024.

Conversely, three species that were rarely observed in 2010 became among the top abundant species in 2024. *Acanthaluteres spilomelanurus* showed the highest numbers in the mid-estuary at sites 13 and 14, despite being absent from those sites in 2010 (Figure 8d). *Atypichthys strigatus* was recorded for the first time in the estuary, with 61 individuals recorded in 2024 – mostly in the lower estuary (Figure 8e). This was the first time this species was present, having not previously been observed in 2010. *Neoodax balteatus,* while present in 2010 across much of the mid and lower estuary, showed a substantial increase in abundance in 2024 (Figure 8f). This included new observations from upper and mid-estuary sites (sites 1, 6, and 9) where it had not previously been observed.

While not among the most abundant species, the introduced species *Forsterygion gymnotum,* has potential ecological implications and warrants ongoing monitoring (Figure 9). Overall abundance varied little across survey periods, with 40 individuals recorded in 2010 and 39 in the 2024 survey. However, its site distribution shifted noticeably. In 2010, site 3 recorded the highest abundance, averaging 17 individuals, while fewer than 2 individuals were observed at other sites. Comparatively, the 2024 survey showed a more even distribution across five sites, each averaging between 3-6 individuals.

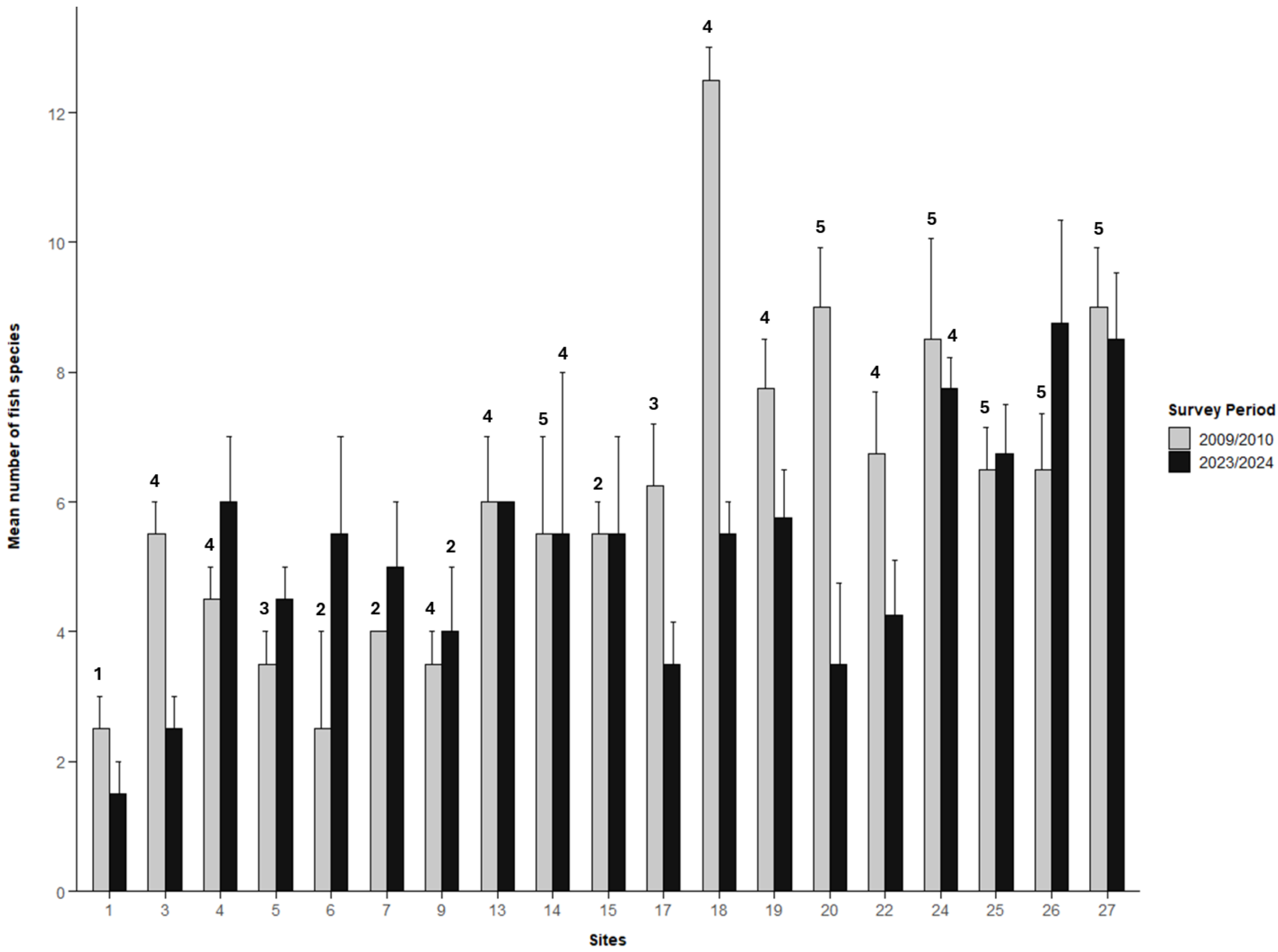

Figure 6: Fish species richness (mean ± SE) per transect (500 m^2) in the Derwent in 2010 (grey) and 2024 (black). Transect depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

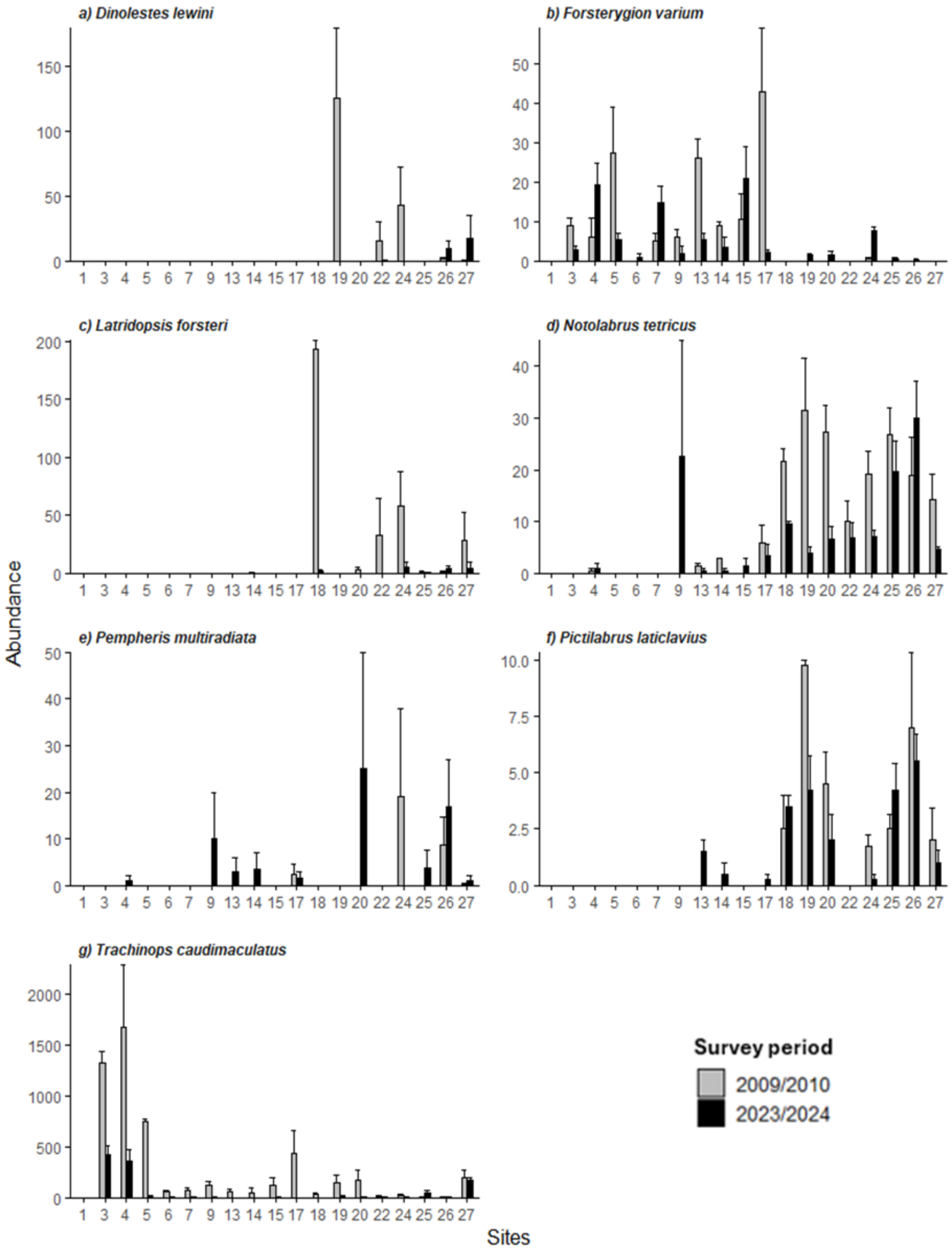

Figure 7: Abundance (mean ± SE) of the most abundant species per transect (500 m^2) in the Derwent in 2010 (grey) and 2024 (black). The seven species shown were among the top 10 most abundant in both survey periods, and are presented alphabetically.

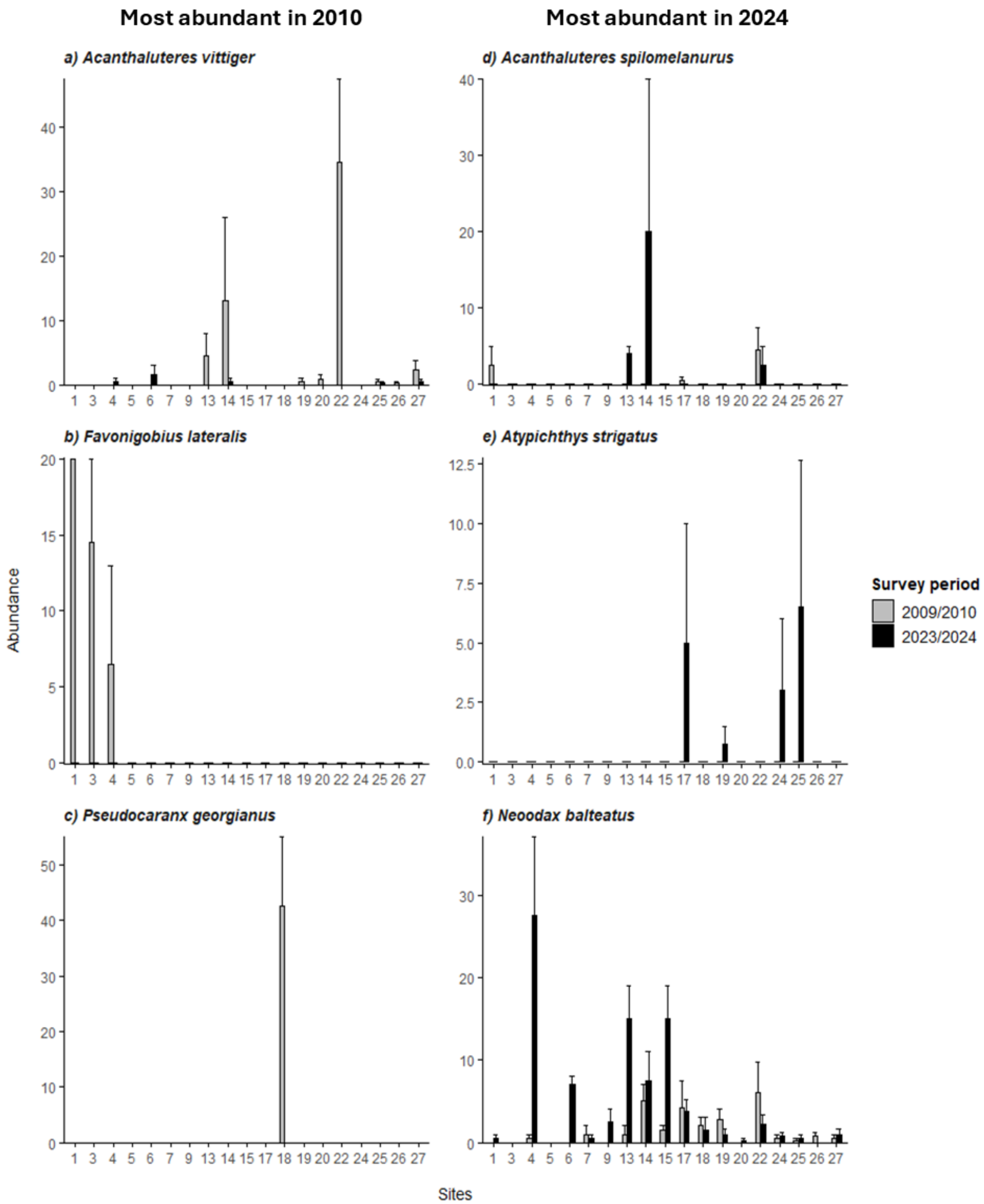

Figure 8: Abundance (mean ± SE) of fish species uniquely among the top 10 most abundant in 2010 (a, b, c) and 2024 (d, e, f), per transect (500 m²) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods (indicated by grey and black fill) are shown to highlight temporal shifts in occurrence and abundance. Species are presented alphabetically.

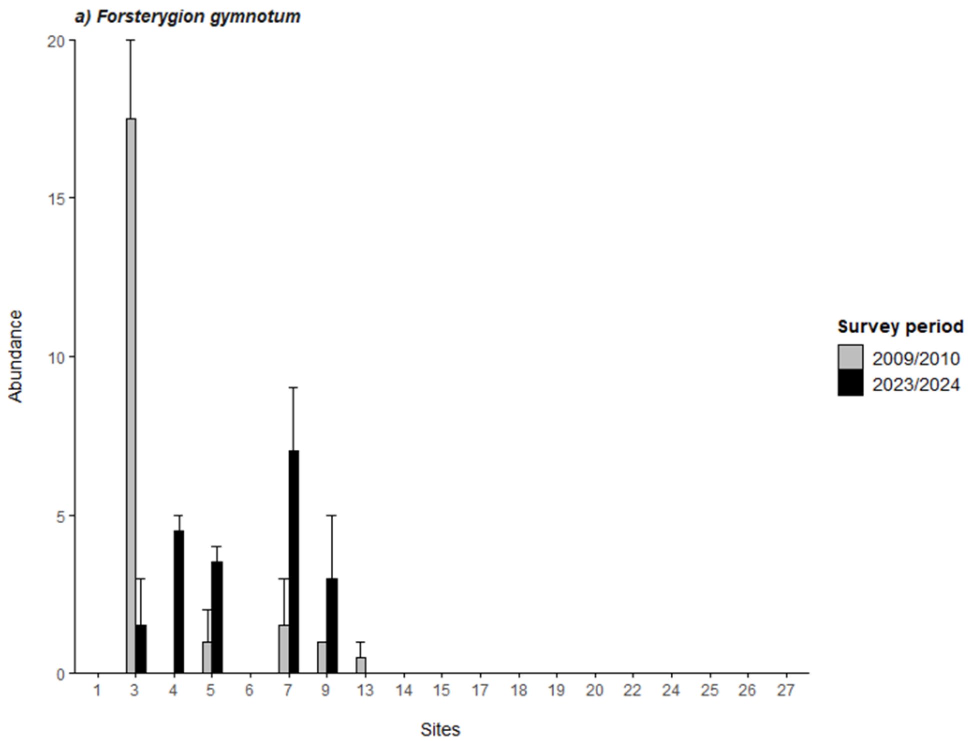

Figure 9: Abundance (mean ± SE) of the introduced *Forsterygion gymnotum* per transect (500 m^2) in the Derwent in 2010 (grey) and 2024 (black). Previously recorded as *Grahamina gymnota*.

Cryptic fish and mobile macro-invertebrates

Twenty-one cryptic fish and 37 mobile macro-invertebrates were recorded in the Derwent Estuary in 2024, an increase from the 15 and 35 species, respectively, counted in 2010. Both cryptic fish species richness and overall abundance showed considerable increases in 2024 (Figure 10). Most sites in 2024 recorded 3-6 species per transect, compared to only five sites in 2010 with a mean exceeding 2 species. The increase in species richness was more pronounced in the upper estuary, with fewer cryptic fish species recorded from site 17 southward. This contrasts with the 2010 distribution, where greater species richness was observed in the mid-estuary. Site 1 in the north, along with sites 19 and 22 in the south, had the lowest species richness, with only one species recorded at both site 1 and 19, and no cryptic fish at site 22. In 2024, cryptic fish abundance was more sporadic, with no clear spatial trends. This is in contrast to 2010 when higher numbers were recorded in the mid-estuary. Several sites recorded over 40 individuals on average, compared to much lower means in 2010.

We assessed the top four abundant cryptic fish species across each survey period, identifying two species that remained consistent across surveys. *Forsterygion varium* increased substantially in 2024, with 797 individuals, compared to 221 individuals in 2010 (Figure 11a). This introduced species expanded its range into both the upper and lower estuary, where it was previously more common in the mid estuary. *Pempheris multiradiata* also saw an increase in abundance in 2024, with higher numbers recorded at several mid-estuary sites

(Figure 11b). Site 18 in the lower estuary (The Grange, Taroona) had the highest abundance, averaging almost 30 individuals.

Gobiid spp. and *Scorpaena papillosa* (Figure 12a and 12b) were both abundant in 2010 but declined in numbers in 2024. A minor range shift was observed for *Gobiid* spp., with decreased numbers in the mid-estuary, and greater presence at upper estuary sites. *S. papillosa,* previously recorded at 11 sites in 2010, was only present at five sites in 2024, with increased numbers observed only at site 27. By comparison, *Forsterygion gymnotum* and *Trinorfolkia clarkei* (Figure 12c and 12d) were most abundant in 2024. A significant range expansion was recorded for the introduced *F. gymnotum,* which was previously found only at sites 9 and 13, but was recorded at nine sites in 2024. Similarly, *T. clarkei* was recorded at several sites in 2024 where it had not been detected in 2010, including sites in the upper, mid and lower estuary.

Species richness of cryptic macro-invertebrates was relatively consistent throughout the estuary, with means of 3-6 species recorded for most sites (Figure 13). In 2010, species richness gradually increased along a southern distribution, with only a single species recorded at site 1, compared to an average of 6-9 species in the lower estuary sites. Site 1 remained the site with lowest species richness in 2024, however no clear spatial trend was observed across the estuary, with site 24 in the lower estuary and site 14 in the mid-estuary both recording the greatest species richness (8.5 and 7.5, respectively). A slight decline in species richness across surveys is evident in the lower estuary, where all sites averaged more than five species in 2010 (with up to 9 species at site 25). In 2024, species richness ranged from 2-4 species at sites 22, 26, 27, while sites 20, 24, and 25 recorded 6-8 species.

The introduced echinoderm *Patiriella regularis* remained the most abundant macro-invertebrate across both surveys, although considerably higher counts were recorded in 2024 (Figure 14g). All sites where the species was present recorded mean abundances exceeding 200 individuals per site, with peaks close to and exceeding 400 at sites 3, 7 and 9 – more than doubling the numbers recorded at most sites in 2010. However, two sites had considerably lower mean abundances of *P. regularis*, with only 0.25 and 7.5 individuals per site (site 24 and 17, respectively), indicating some localized variation in distribution. Its range remained largely unchanged, with most occurrences still concentrated in the upper estuary. Similarly, *Asterias amurensis*, another introduced echinoderm, exhibited substantial increases in abundance with minimal range shifts (Figure 14a). Average abundances were recorded as between 50 and 200 individuals per site in 2024, a stark increase from the 2010 averages of 5-10 individuals per site.

Range shifts were observed for several other macro-invertebrates, all of which were among the most abundant for both surveys. The native *Heliocidaris erythrogramma* increased in abundance in the mid-estuary, and at site 17 (upper limit of the lower estuary) while becoming less common in other lower estuary sites where it was previously recorded in 2010 (Figure 14c). *Jasus ewardsii* which was primarily concentrated in the lower estuary in 2010, showed an overall increase in abundance but was also found further north in the mid-estuary (Figure 14d). Interestingly, *Lunella undulata* was recorded only at two lower estuary sites in 2024 (sites 18 and 19), both of which had low to no presence in 2010, when the species was more abundant at further south (Figure 14e). Other native species like *Cenolia trichoptera* and *Meridiastra calcar* (Figure 14b and 14f) had minimal changes across time, with both species still concentrated at the same sites in the south in 2024, and relatively similar abundances.

Amblypneustes ovum, *Cabestana spengleri,* and *Maoriclpus roseus* (Figure 15a, 15b, and 15c) were all among the most abundant species in 2010, but were rarely recorded in 2024. In contrast, *Coscinasterias muricata, Haliotis rubra,* and *Neothyonidium* spp. (Figure 15d, 15e, and 15f) experienced significant increases in abundance, resulting in their inclusion among the top ten abundant species in 2024. Minimal range shifts occurred for *C. muricata* and *H. rubra,* while recordings of *Neothyonidium* spp. at site 25 appear to represent a new sighting.

While not among the most abundant species, three other introduced species are worth monitoring across surveys, due to their potential ecological implications (Figure 16). Unlike *P. regularis* and *A. amurensis,* the introduced *Carcinus maenas, Metacarcinus novaezelandiae* and *Petrolisthes elongatus* did not show significant increases in abundance. All three species exhibited relatively little change from 2010 to 2024, although distribution varied slightly for *C. maenas* and *M. novaezelandiae,* both of which only occurred at site 6 in 2024, where they had not previously been detected.

In general, the patterns of native versus introduced cryptic fish and macro-invertebrate species in 2024 mirrored those observed in 2010. Introduced species richness was greater and more prevalent in the upper estuary, while native species had greater richness in the lower estuary (Figure 17). However, in 2010, introduced species were concentrated between sites 3 and 18. In 2024, this range expanded to include all sites except site 22. With this broader distribution, there has also been an increase in their numbers, particularly in the upper and mid-estuary, where introduced cryptic fish and invertebrates now average 300 or more individuals per site, compared to 100-150 individuals per site in 2010. Sites 7 and 9, for instance, recorded means above 600 introduced individuals, more than doubling the previous averages of 150 – 260 individuals per site. Although richness increased for introduced species in the lower estuary sites, abundance still remained low, suggesting that the range extension for some of these introduced species is still in its initial phase. In contrast, we can see minimal changes in the abundance of native species in the upper estuary. Increases in native abundance can be seen at multiple sites (particularly sites 6, and 14–19). Notably, the rise in introduced species abundance does not correspond with any clear declines in native species abundance across sites in the estuary.

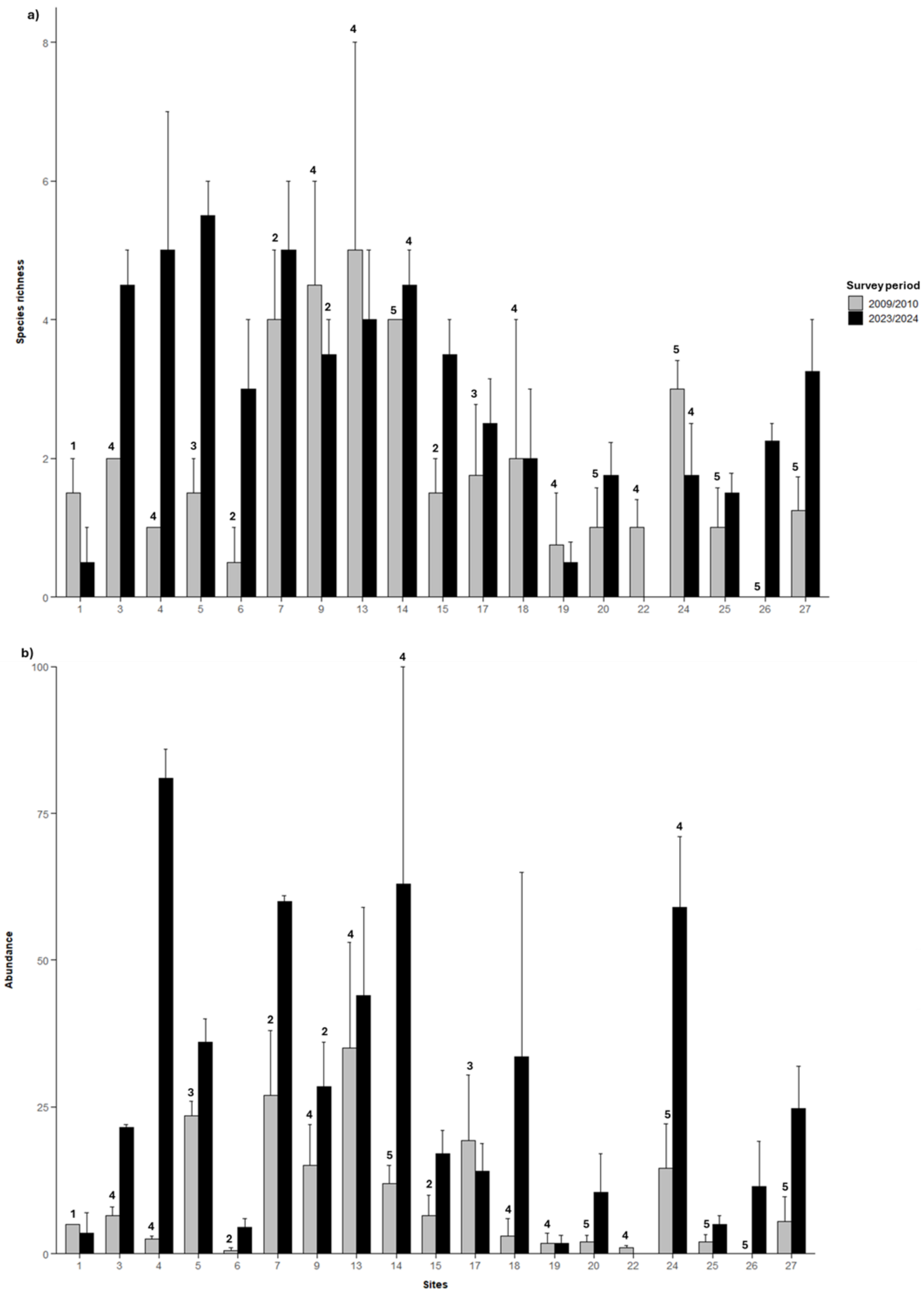

Figure 10: a) Species richness (mean ± SE) and b) abundance (mean ± SE) of cryptic fish in 2010 (grey) and 2024 (black). Transect depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths.

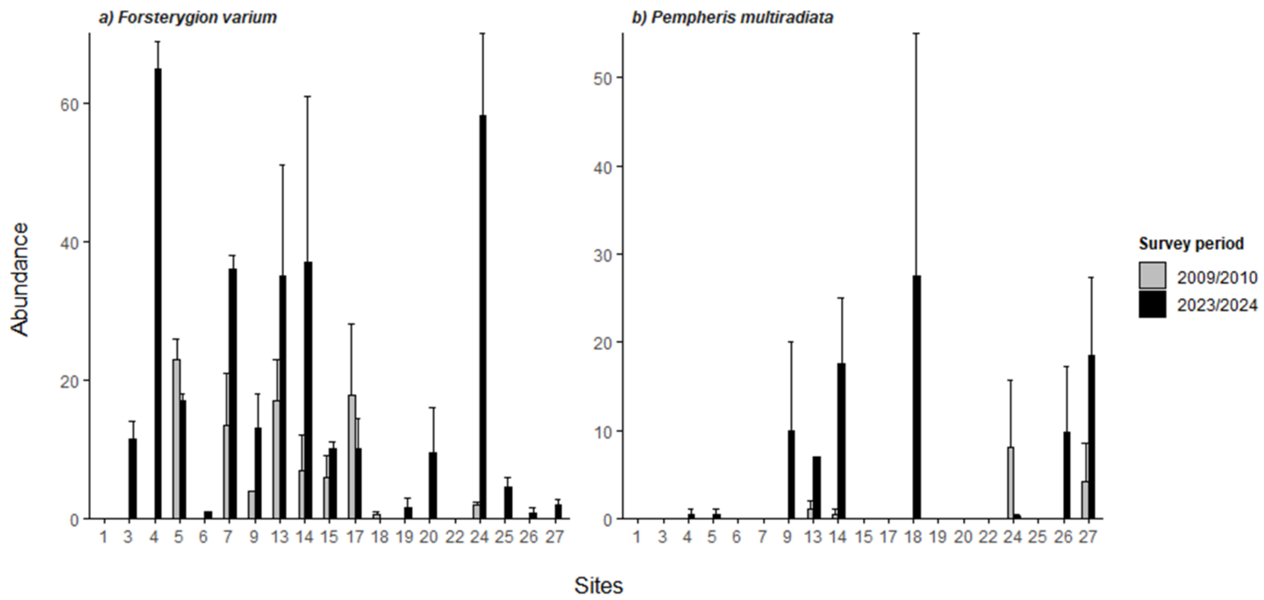

Figure 11: Abundance (mean ± SE) of the most abundant cryptic fish species per transect (500 m^2) in the Derwent in 2010 (grey) and 2024 (black). The two species shown were among the top 4 most abundant in both survey periods, and are presented alphabetically.

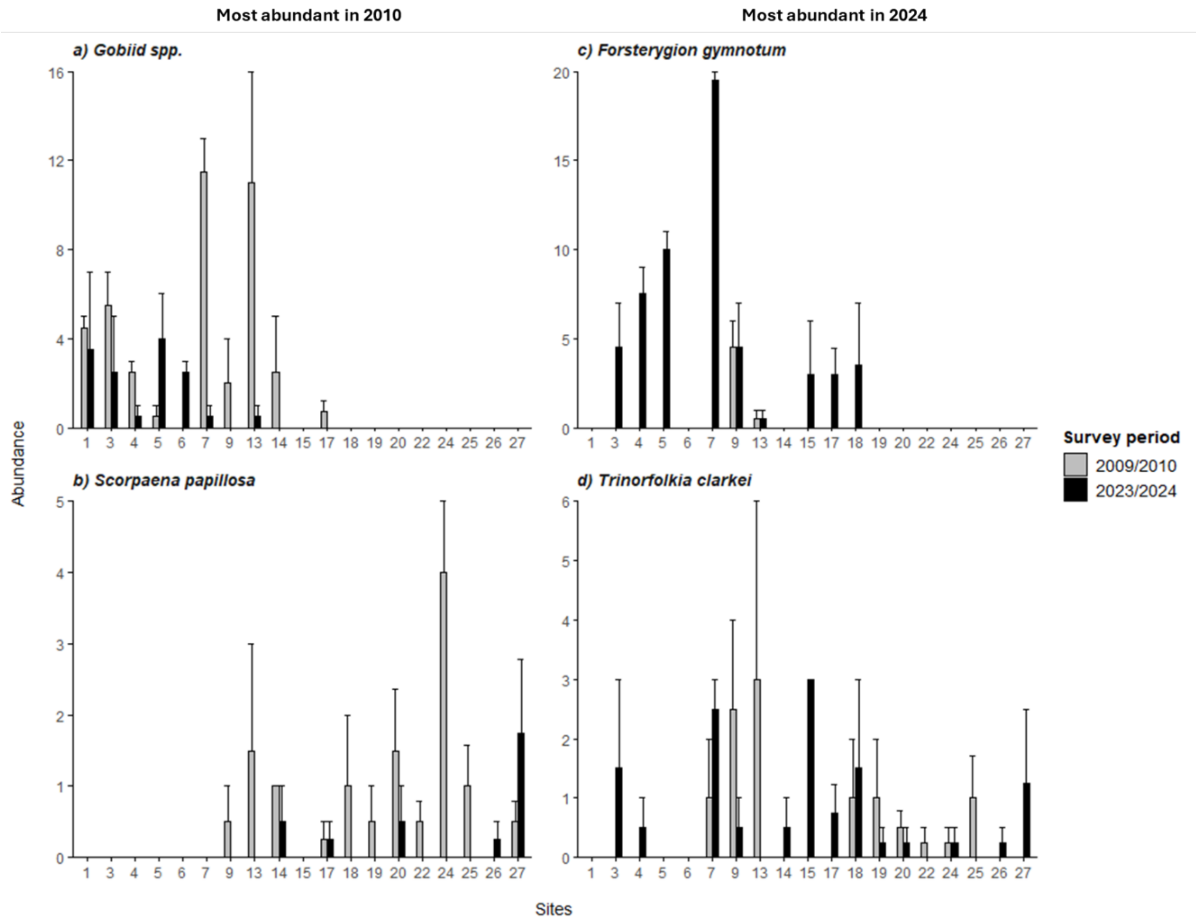

Figure 12: Abundance (mean ± SE) of cryptic fish species uniquely among the top 4 most abundant in 2010 (a, b) and 2024 (d, e), per transect (500 m²) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

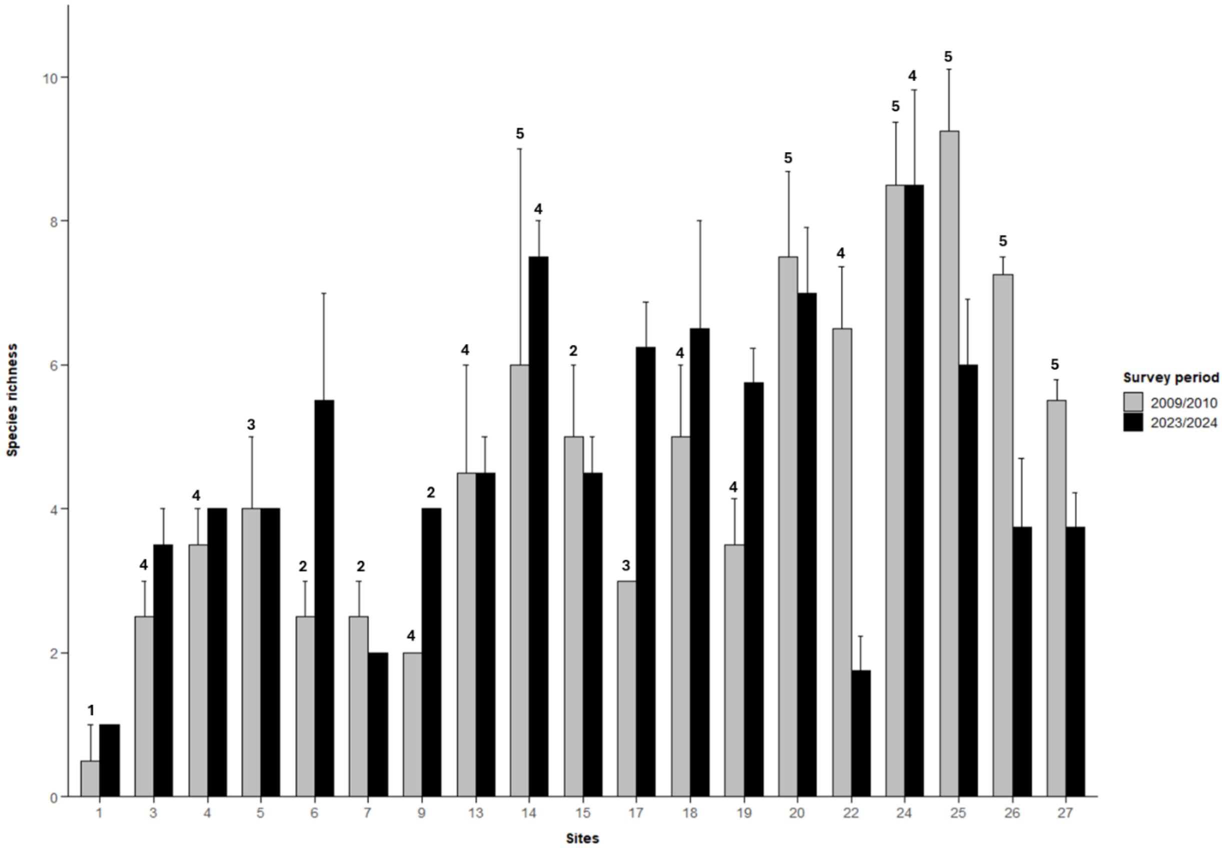

Figure 13: Species richness (mean ± SE) of mobile macro-invertebrates in 2010 (grey) and 2024 (black). Transect depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

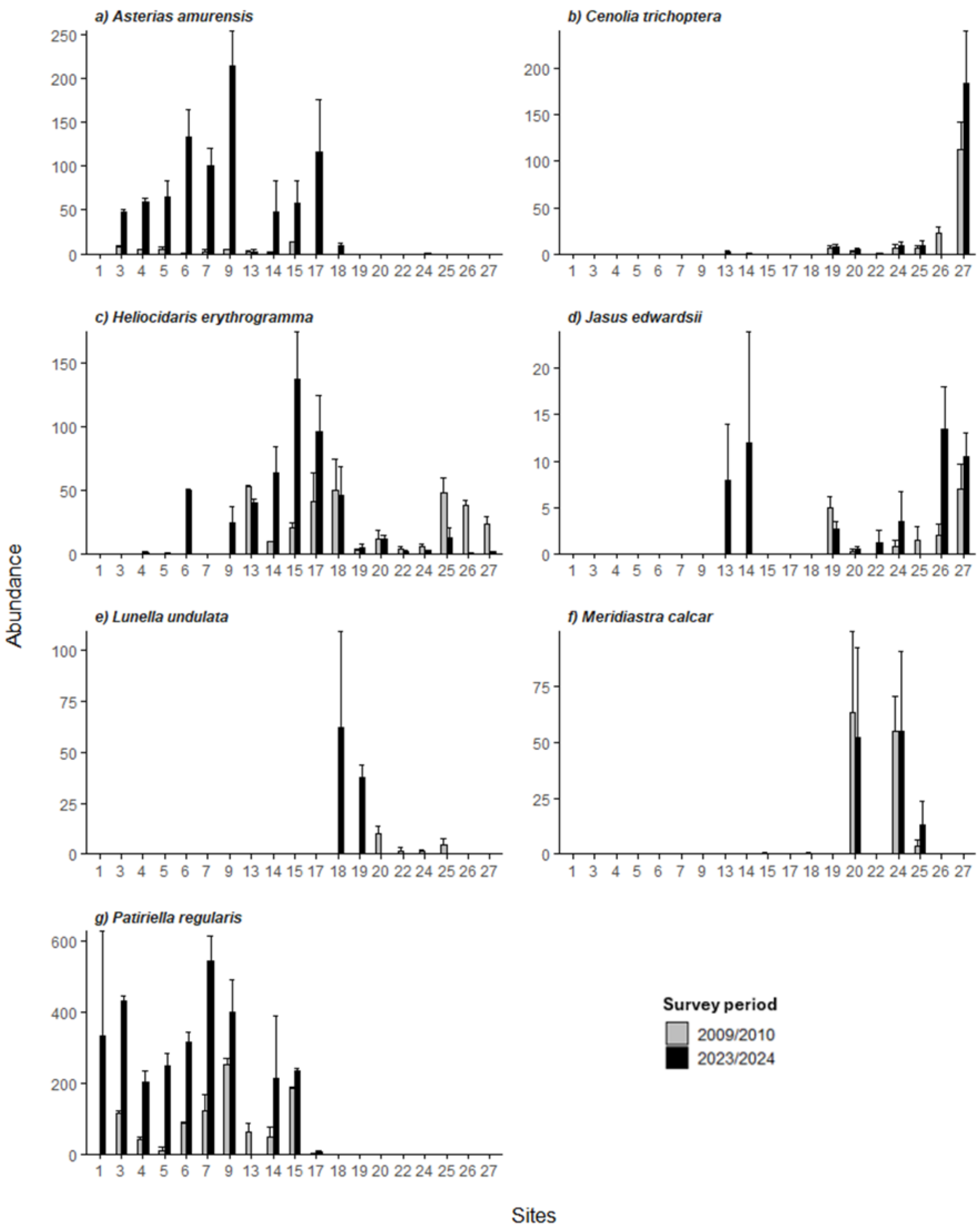

Figure 14: Abundance (mean ± SE) of the most abundant mobile macro-invertebrate species per transect (500 m^2) in the Derwent in 2010 (grey) and 2024 (black). The seven species shown were among the top 10 most abundant in both survey periods, and are presented alphabetically.

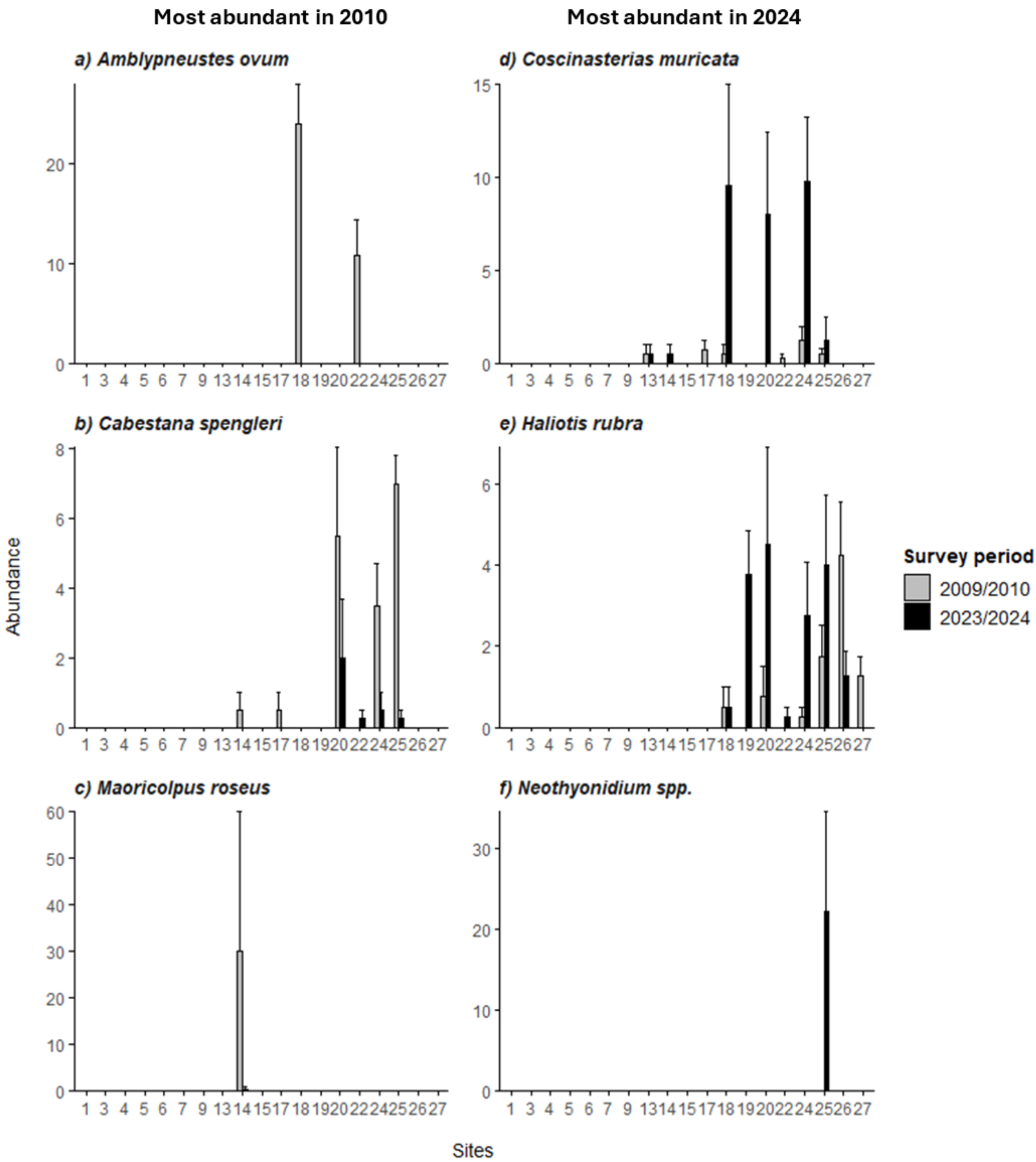

Figure 15: Abundance (mean ± SE) of mobile macro-invertebrate species uniquely among the top 10 most abundant in 2010 (a, b, c) and 2024 (d, e, f), per transect (500 m²) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

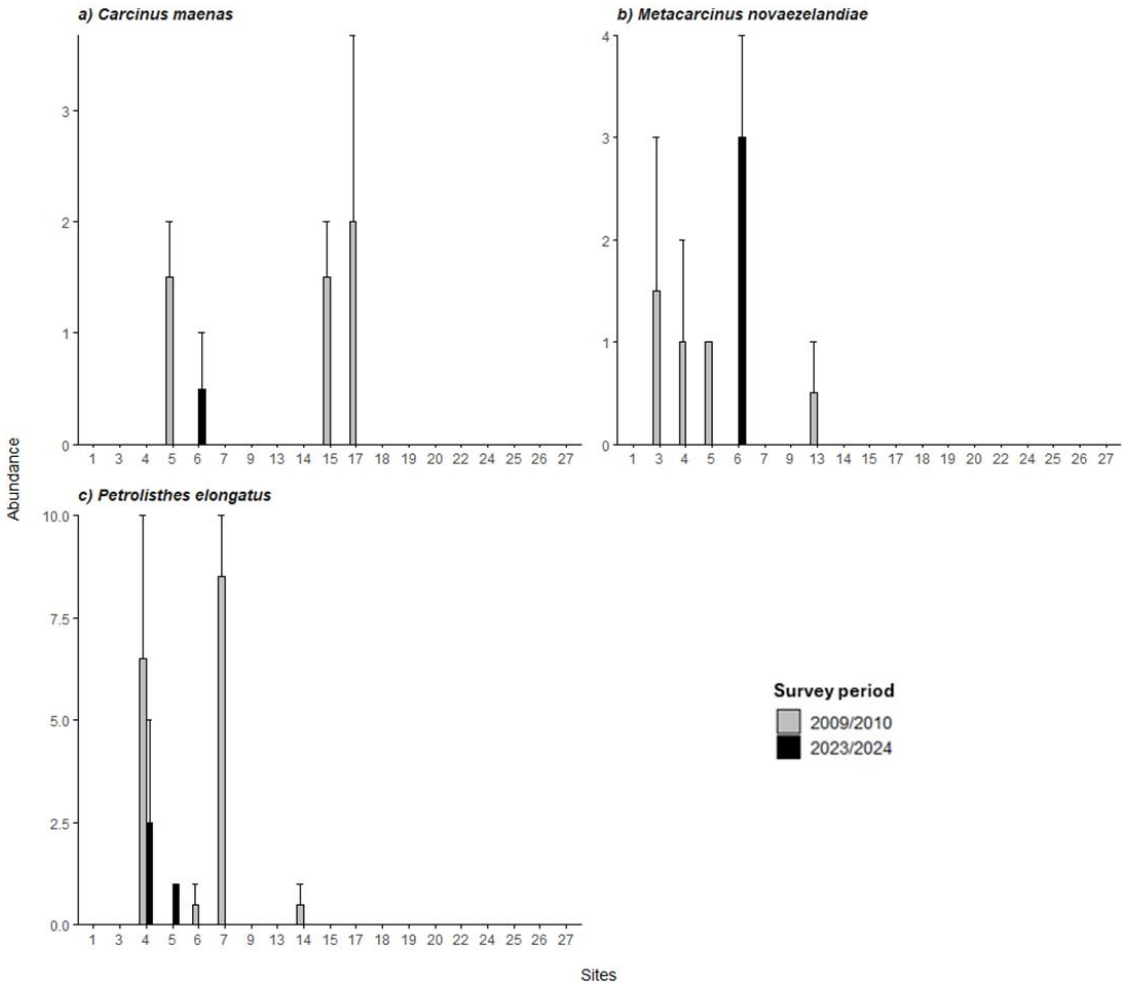

Figure 16: Abundance (mean ± SE) of three introduced macro-invertebrate species per transect (500 m2) in the Derwent in 2010 (grey) and 2024 (black).

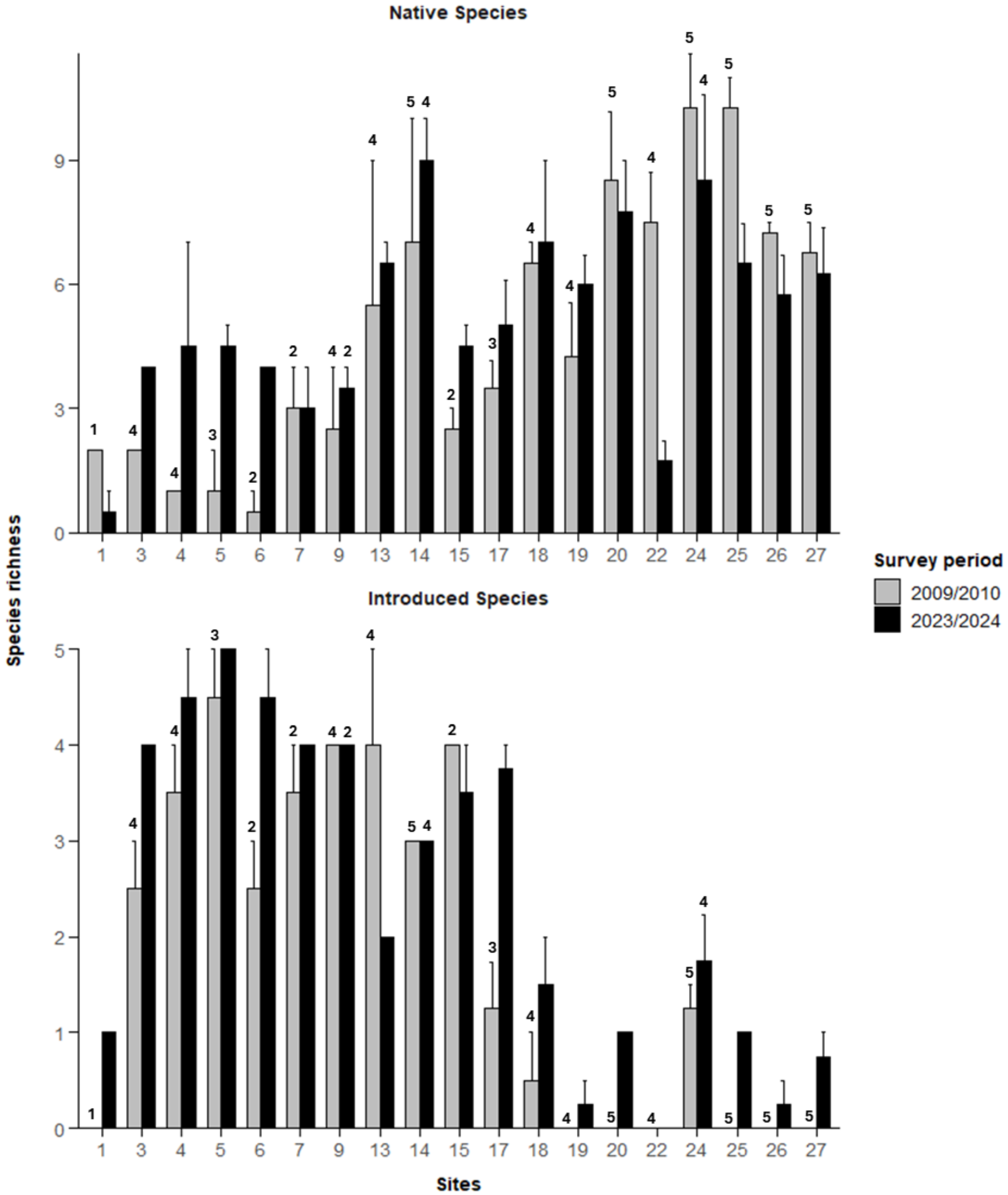

Figure 17: Species richness (mean ± SE) of native and introduced cryptic fish and cryptic invertebrates in 2010 (grey) and 2024 (black). Transect depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

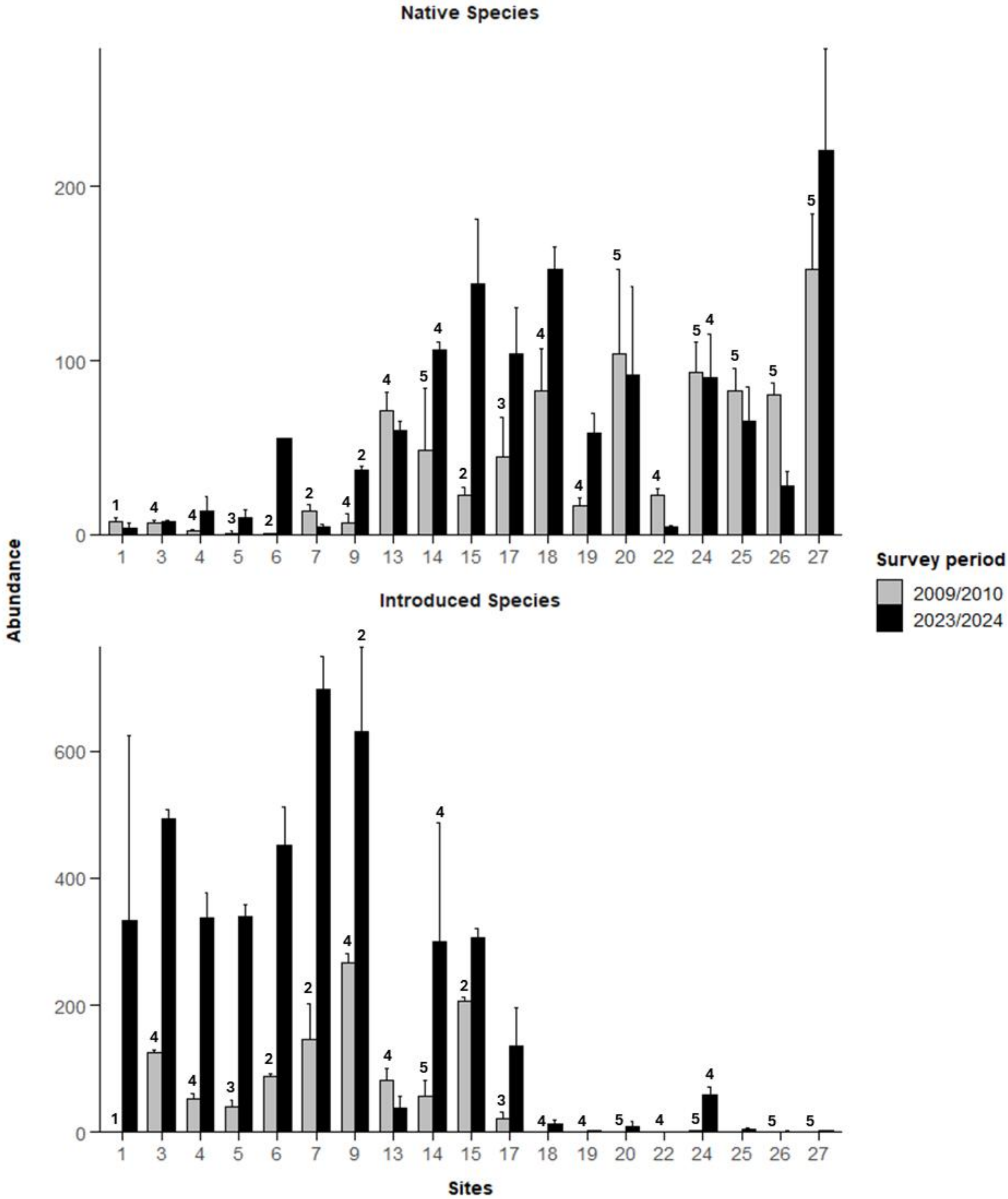

Figure 18: Abundance (mean ± SE) of native and introduced cryptic fish and cryptic invertebrates in 2010 (grey) and 2024 (black). Transect depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

Algae recorded on transect-based surveys

Sixty-eight algal species were recorded in 2024, with 50 species overlapping with the 2010 survey. Species richness and spatial distributions were generally similar between survey periods, with greater richness observed in the lower estuary (Figure 19). Percent cover in the upper and mid-estuary (sites 1-16) increased compared to 2010, with almost all sites exceeding 50% coverage, despite lower species richness at these sites. Foliose algae followed a similar pattern, with increased richness in the lower estuary during both surveys (Figure 20). In 2024, foliose species were recorded in higher numbers at sites 3 – 17, including several sites (sites 3 – 6) where they were not previously observed. Percent cover at these upper estuary sites also increased, averaging between 40 and 100%.

The mean percentage cover of brown algae remained relatively consistent between surveys, although an increase was observed in the mid-estuary, particularly from sites 9 to 17 (Figure 21a). Green algae followed a similar trend, with generally minor differences between surveys, except for sites 6 and 15, where considerably greater coverage was recorded in 2024 (Figure 21c). In contrast, foliose red algae exhibited a shift in spatial distribution, with increased presence and coverage in several upper and mid-estuary sites (2 – 14), and decreased coverage further south in the lower estuary (sites 18 – 24; Figure 21b). Sessile invertebrate cover showed the most pronounced change between surveys, with a marked decrease in coverage across the upper and mid-estuary sites, where most averaged less than 20% in 2024, compared to 75% or greater in 2010 (Figure 21d). In the south, sessile invertebrate coverage varied minimally, with only sites 18, 20, and 22 in the lower estuary showing an increase in 2024.

Ecklonia radiata and *Carpoglossum confluens* (Figure 22c and 22b) were both consistently the most abundant brown algae across surveys, with increased coverage in 2024 for *E. radiata* across a majority of sites, and relatively consistent coverage for *C. confluens* from 2010 to 2024. *E. radiata*'s spatial distribution extended further north into sites 9, 13, 14, and site 17, where minimal to no coverage was observed in 2010. Minor differences across surveys were observed for the other three species recorded as most abundant in 2010 and 2024, with some small variations in site distributions. For example, *Sargassum fallax* had fluctuating percent cover across sites, but was observed at sites 13, 15, and 17 in 2024, despite not being present in 2010 (Figure 22e). Conversely, *Lessonia corrugata* was not recorded in 2024 at sites 19, 25, or 26, despite its presence at all three sites in 2010 (Figure 22d). *Acrocarpia paniculata* showed a similar pattern to 2010, with presence concentrated in the lower estuary and most sites recording an average of ≤15% cover (Figure 22a).

Dictyopteris muelleri was among the top abundant species in 2010 but showed a decline in 2024, along with a shift in its spatial distribution (Figure 23a). It was recorded at sites 14, 17, 22, 25 and 27 in 2024, where it had not been observed previously. In contrast, *Halopteris paniculata* emerged as one of the top abundant brown algae species in 2024, with new occurrences at sites 7, 18, and 25 (Figure 23b).

We assessed the top six abundant red algal species across each survey period, identifying four species or groups that remained consistent across surveys. Due to the difficult nature of identifying red algal species, many unidentified species (e.g., unidentified algae (crustose coralline) were placed into their orders for reporting purposes (e.g., *Corallinales* spp.).

Peyssonnelia spp. and *Corallinales* spp. (Figure 24a and 24c) remained the two most abundant red algal taxa across both survey periods, with minimal shifts in their overall spatial distributions. Both were more abundant in the lower estuary, although *Peyssonnelia* spp. showed increased percent cover at several mid-estuary sites in 2024, including sites 9 – 15. However, percent cover for *Peyssonnelia* spp declined in general, evident particularly at sites further south in the lower estuary (sites 17, 18, 20 and 22). In contrast, several lower estuary sites showed increased percent cover of *Corallinales* spp., with sites 19, 25, and 26 averaging over 30% in 2024, compared to 20% or lower in 2010. *Lenormandia marginata* similarly exhibited minimal spatial variation, with occurrences restricted to site 19 and further south for both surveys, and with little change in percent cover (**Error! Reference source not found.**b). *Rhodophyta* spp., which includes Unidentified algae (red turf) and (filamentous red), had considerable variation across survey periods (Figure 24d). No patterns across time were discernible, although most coverage averaged below 25%, regardless of survey period, except for sites 1 and 15.

Plocamium angustum and *Pollexfenia lobata* (

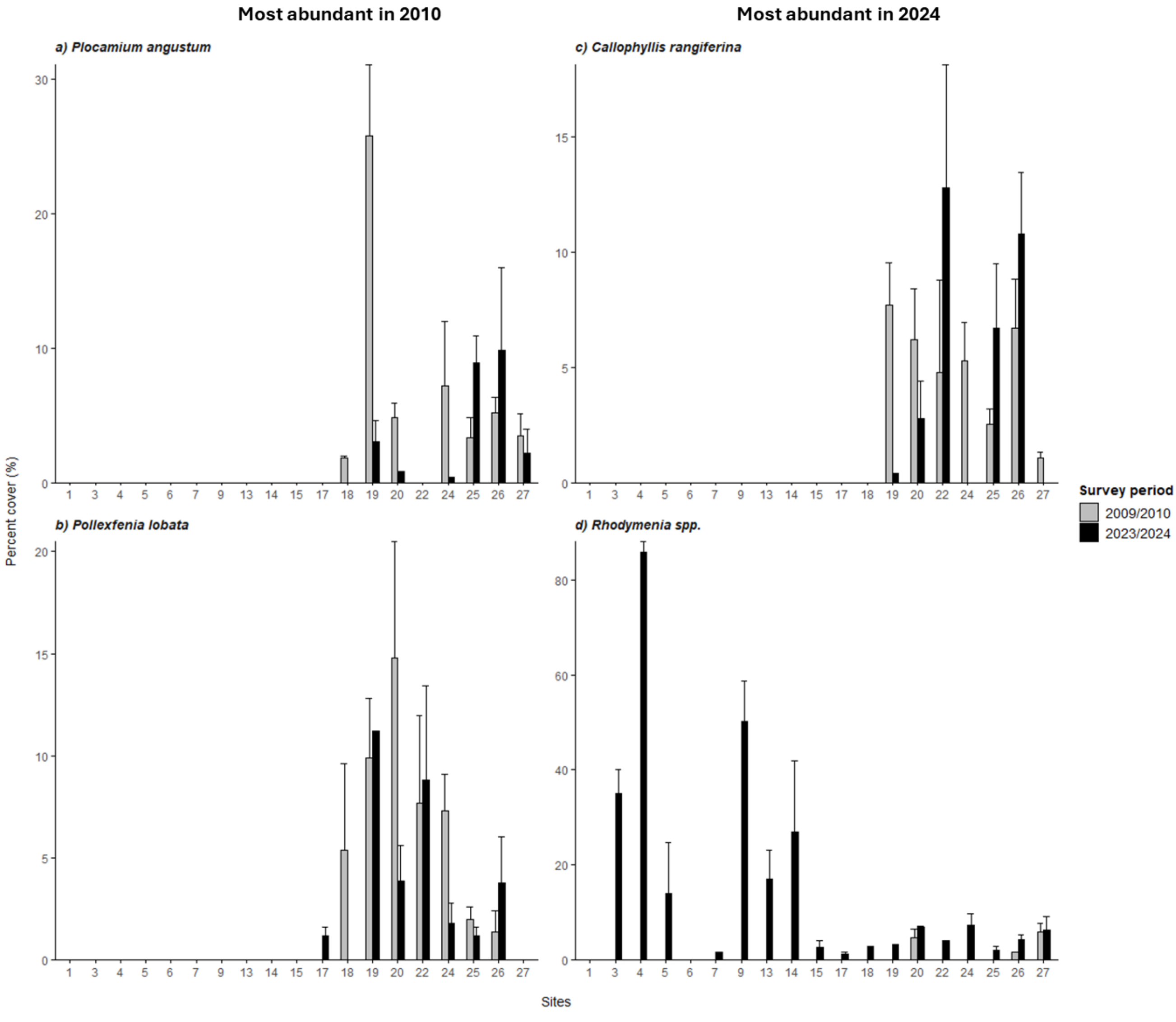

Figure 25: Percent cover (mean ± SE) of red algae species uniquely among the top 6 most abundant in 2010 (a, b) and 2024 (c, d) in the Derwent. While each species peaked in percent cover during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

a and 25b) were both among the top six most abundant species in 2010, with minimal range shifts observed in 2024. Overall, most sites showed a decline in percent cover for both species. However, minor increases were recorded for *P. angustum* at sites 25 and 26, and for

P. lobata at sites 19, 22, and 26. Mean coverage in 2024 remained at or below 10% across all sites for both species, with the exception of site 19 for *P. lobata* (11%). In comparison, *Callophyllis rangiferina* and *Rhodymenia* spp. (

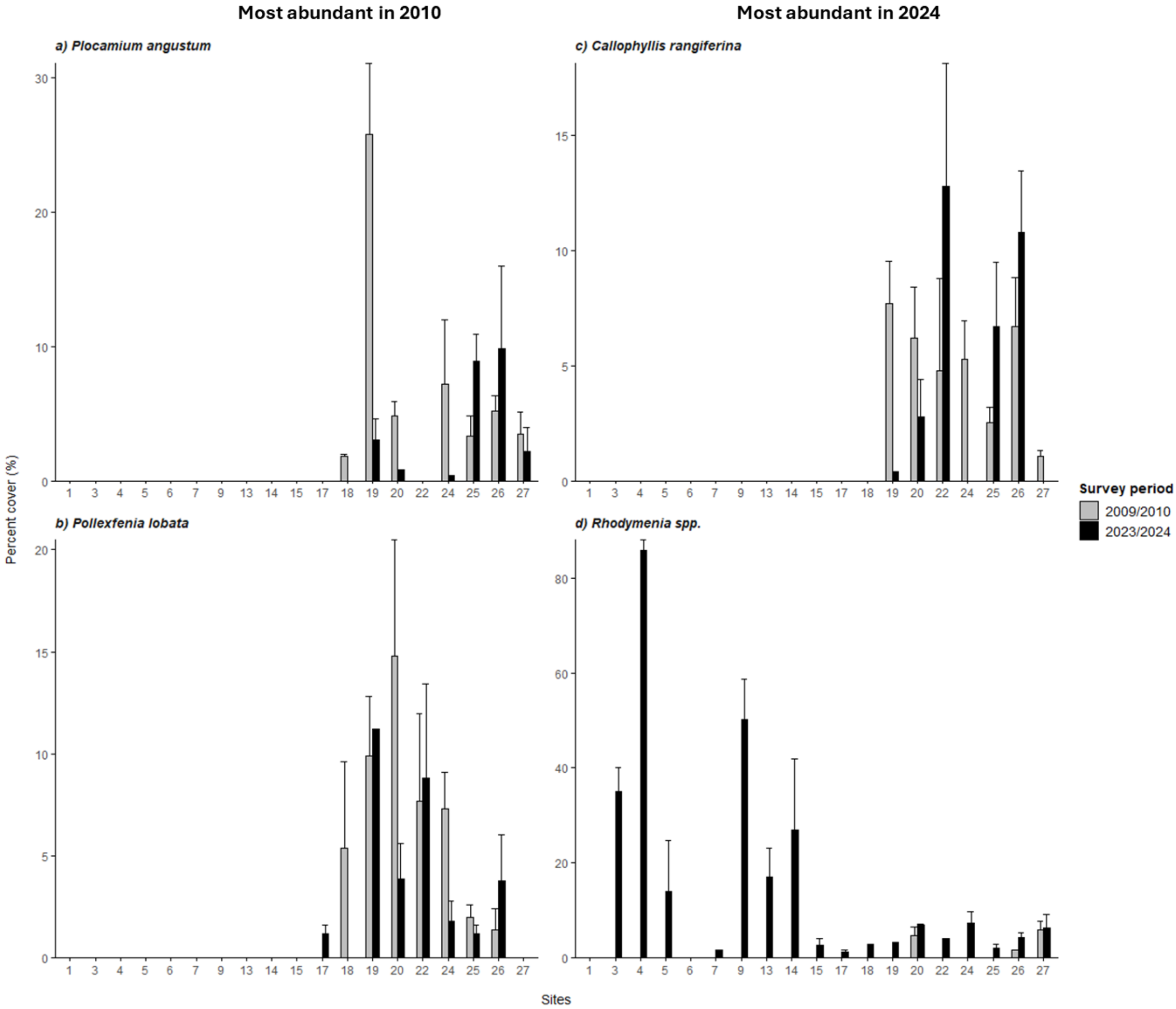

Figure 25: Percent cover (mean ± SE) of red algae species uniquely among the top 6 most abundant in 2010 (a, b) and 2024 (c, d) in the Derwent. While each species peaked in percent cover during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

c and 25d) were both unique to the top six abundant species in 2024, showing a notable increase since 2010. Coverage of *Rhodymenia* spp. was quite high in 2024, averaging above 20% for four sites (3, 4, 9, 14) and over 80% at site 4. Most of the *Rhodymenia* in the upper to mid-estuary in 2024 was identified as *R. leptophylla*, which despite reaching covers in excess of 80% at site 4, and more that 50% at site 9 in 2024, was absent at many of these locations in 2010. This represents a major system change given the dominance of this species in 2024 relative to 2010.

In contrast, the increase in *Callophyllus rangiferina* was in the lower estuary, with less marked change relative to 2010, with an average cover of around 15% at sites 22 and 26, in 2024.

Of the three introduced seaweeds (two red and one brown), only *Grateloupia turuturu* increased in percent cover and spatial distribution in 2024, occurring at six new sites across the mid and lower estuary (Figure 26b). Both *Aeodes nitidissima* and *Undaria pinnatifida* (Figure 26a and 26c) were rarely observed in 2024, present at only sites 7 and 9 (*A. nitidissima*) and sites 19, 22, and 25 (*U. pinnatifida*).

Sessile invertebrates recorded on transect based surveys

Eighteen species of sessile invertebrates were recorded in 2024, including 11 that overlapped with the 2010 survey, and seven new, unique species.

Mytilus galloprovincialis showed a notable increase in coverage in 2024, occurring at nine sites, including four with 25 – 50% coverage and five with up to 10% (Figure 27b). This marks a substantial increase in both abundance and spatial distribution compared to 2010, when it was present at only three sites. *Porifera* spp. showed an overall decline in percent cover from 2010, with most sites recording under 20% in 2024 (Figure 27d). However, its range expanded into the upper and mid-estuary, with new occurrences from sites 3 – 13, indicating a northward shift in distribution despite the reduced abundance. Similarly, *Ostrea angasi* became more prevalent in the upper and mid-estuary, with new occurrences at sites 3, 5, 7, 13, 14, and 17 – none of which recorded the species in 2010 (Figure 27c). Despite this shift, percent cover remained relatively consistent across surveys, generally ranging between 5 – 10%, and never exceeding 15%. The peak cover was reported at site 9, adjacent to the Tasman bridge on the eastern shore, with species identification validated during a subsequent targeted survey (see later). In contrast, *Bryozoa* spp. showed no notable range extension, remaining concentrated in the lower estuary sites (sites 25 – 27) in 2024, although in greater abundance compared to 2010 (Figure 27a).

Animalia spp., a cover-all category for unidentified sessile invertebrates, primarily composed of Unidentified invertebrate (tube matting) was the most abundant sessile invertebrate in 2010, averaging over 50% cover for all sites where it was present (Figure 28a). However, *Animalia* spp. was not recorded at any sites in 2024, suggesting key ecological changes in the upper estuary. Likewise, *Pyura gibbosa,* which was previously abundant in 2010, declined in cover by 2024 – no longer occurring at site 24, and instead shifting further north into sites 19 and 20 (Figure 28b). In contrast, *Ascidiacea* spp. increased in percent cover in 2024, albeit at low levels (1-2% per site; Figure 28c). A shift in spatial distribution was also evident, with greater occurrence at site 19 and sites 25 – 27, and a lack of presence at site 20 where it had previously been recorded. The introduced *Crassostrea gigas* was also among the most abundant sessile invertebrates in 2024, but its spatial range narrowed considerably (Figure 28d). Previously recorded at four sites (each with $\leq$5% cover), it was only found at site 1, where it reached an average cover of 14%.

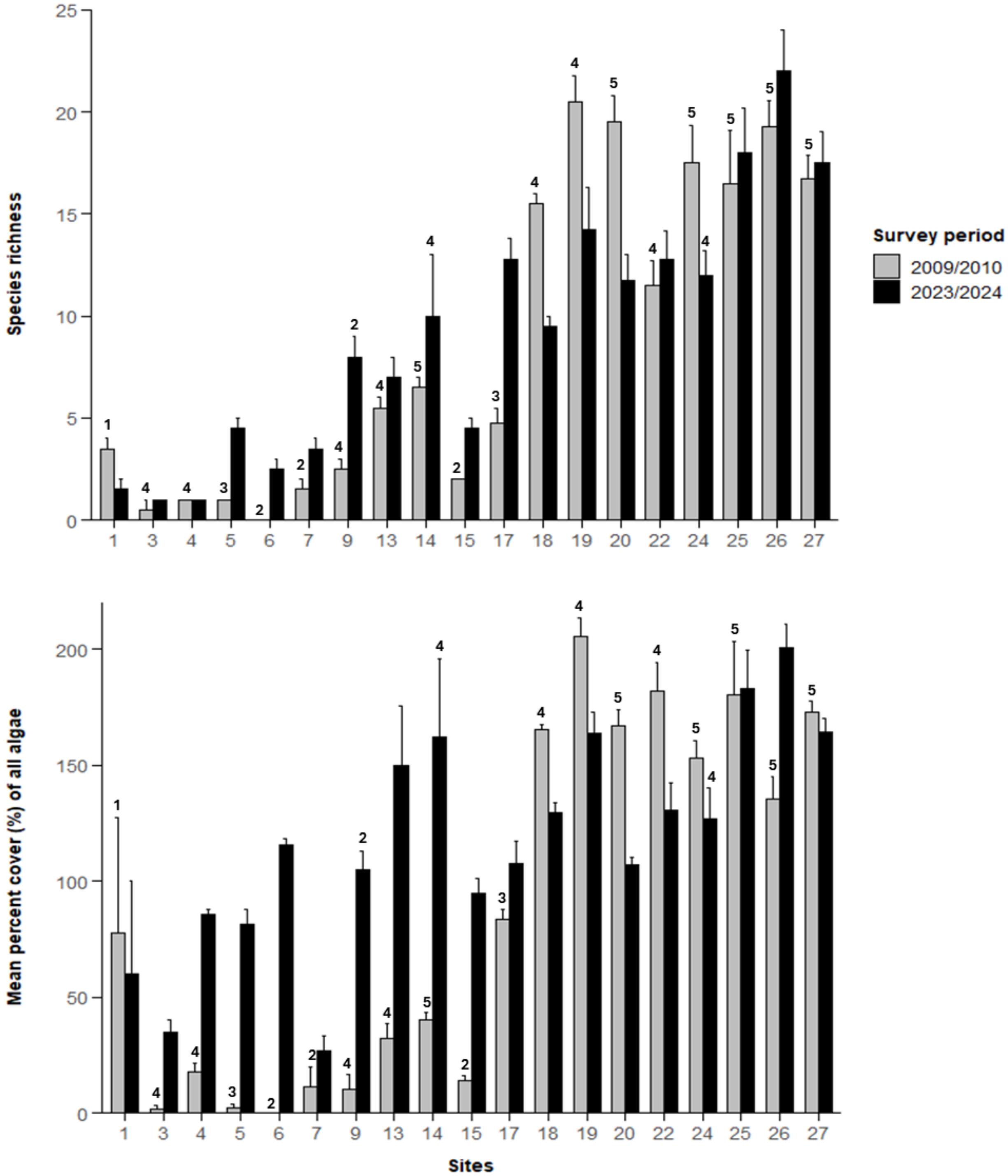

Figure 19: Species richness (mean ± SE) and percent cover (mean ± SE) of algae in 2010 (grey) and 2024 (black). Survey depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

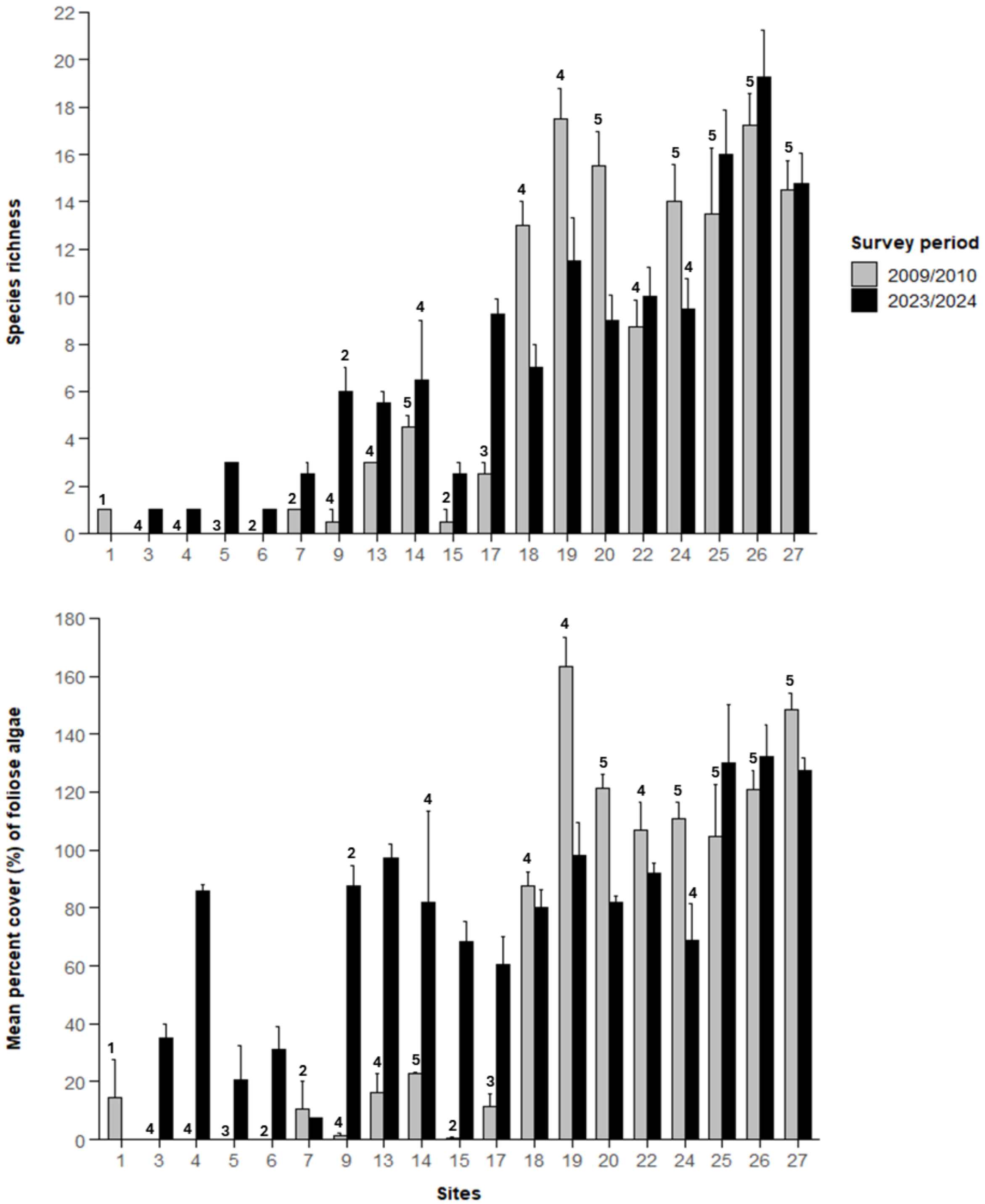

Figure 20: Species richness (mean ± SE) and percent cover (mean ± SE) of foliose algae in 2010 (grey) and 2024 (black). Survey depths at each site are indicated by the number above the grey bars, with sites 9, 14, and 24 differing in depths across years.

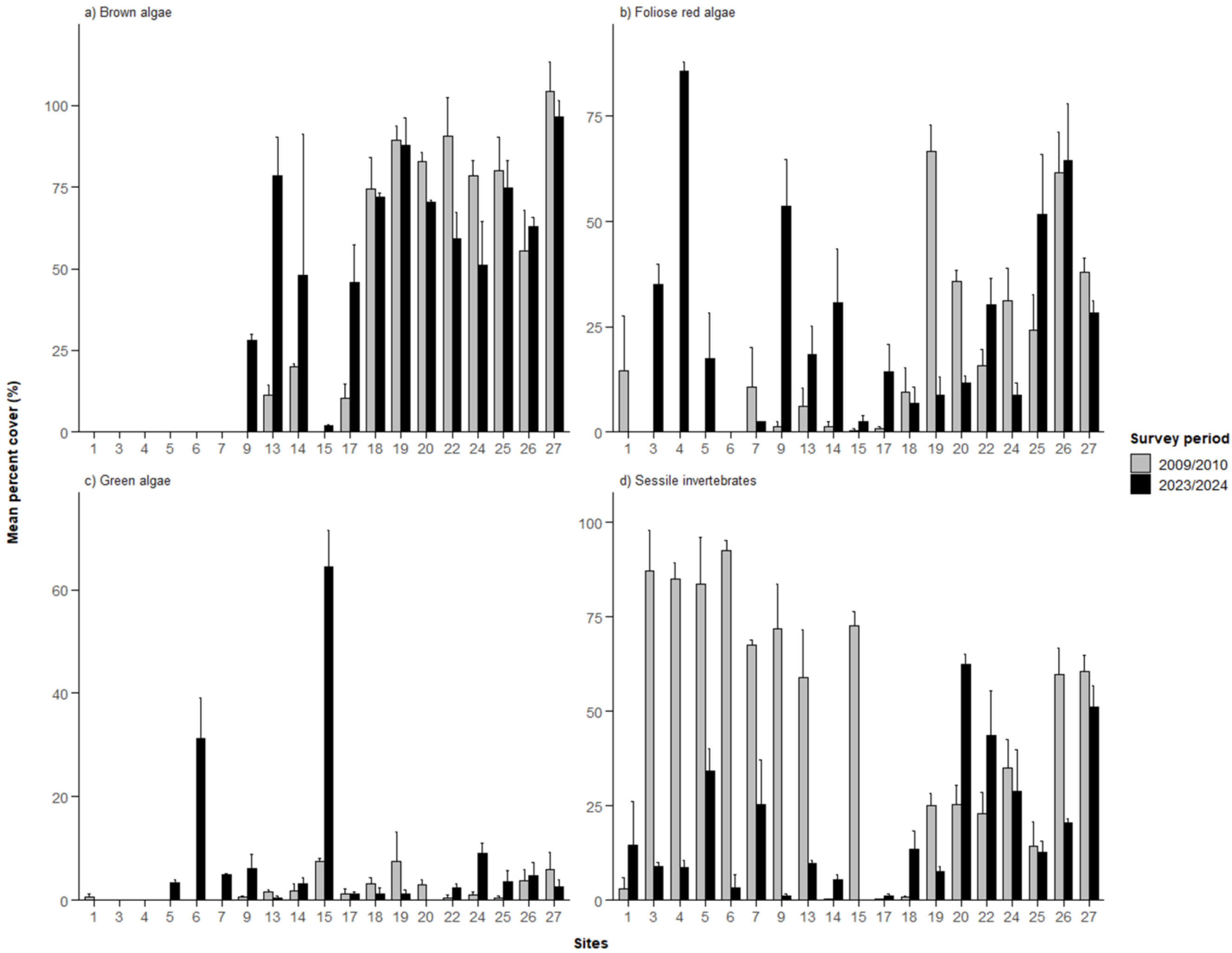

Figure 21: Percent cover (mean ± SE) of brown (a), foliose red (b), green (c) algae, and sessile invertebrates (d) in the Derwent across survey periods (2010: grey, 2024: black).

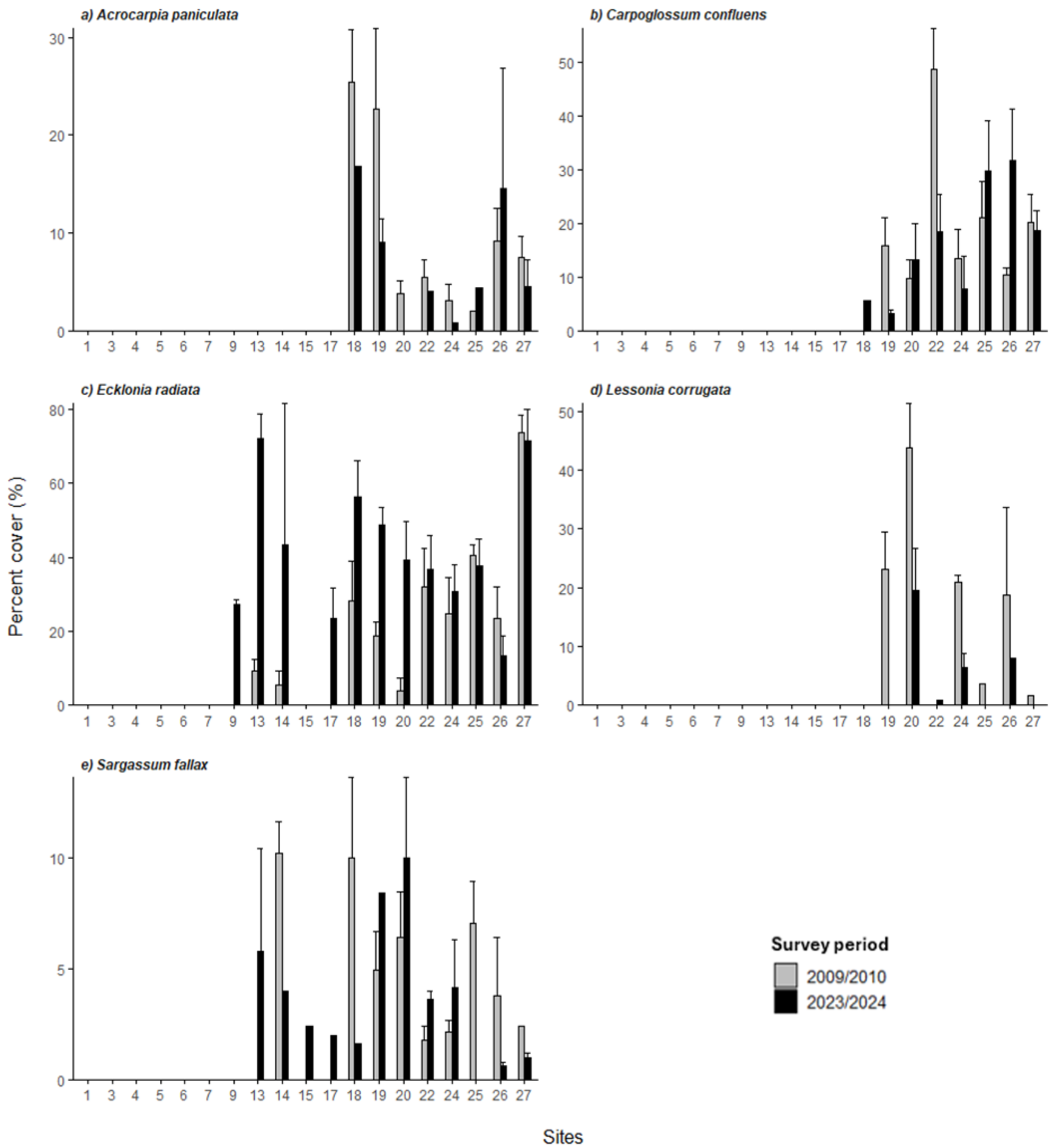

Figure 22: Percent cover (mean ± SE) of the most abundant brown algae in the Derwent in 2010 (grey) and 2024 (black). The five species shown were among the top 6 most abundant in both survey periods, and are presented alphabetically.

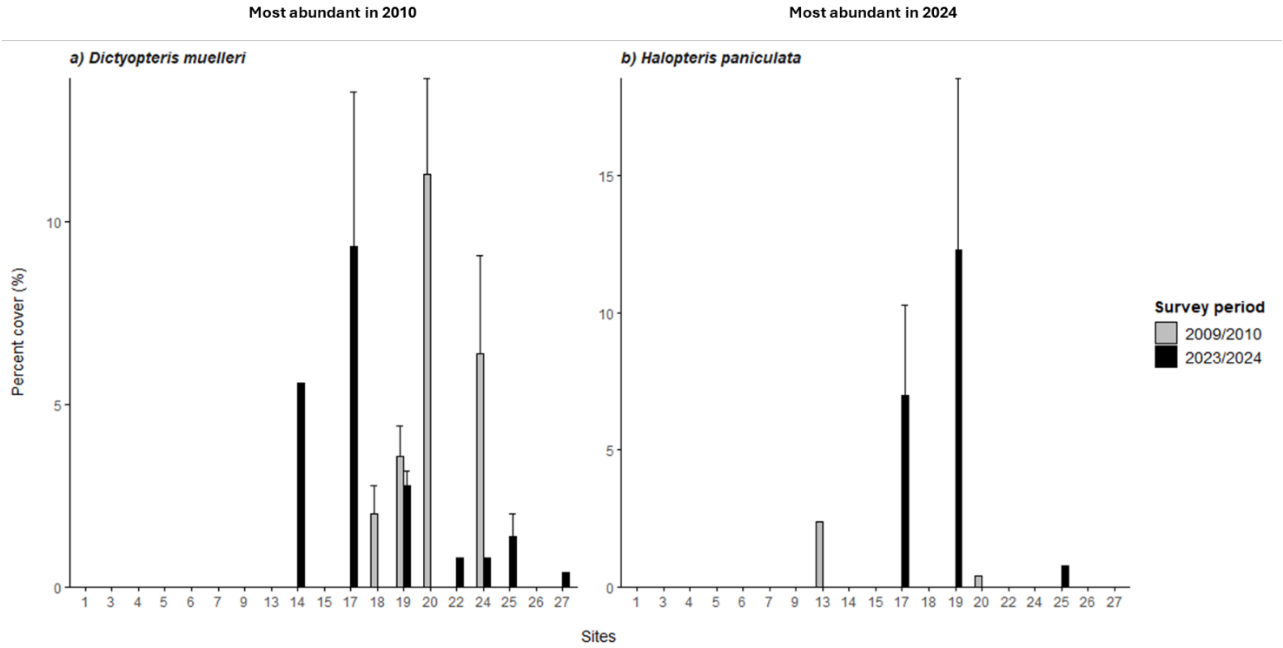

Figure 23: Percent cover (mean ± SE) of brown algae species uniquely among the top 6 most abundant in 2010 (a) and 2024 (b) in the Derwent. While each species peaked in percent cover during one period, changes across both survey periods are indicated by grey and black fill.

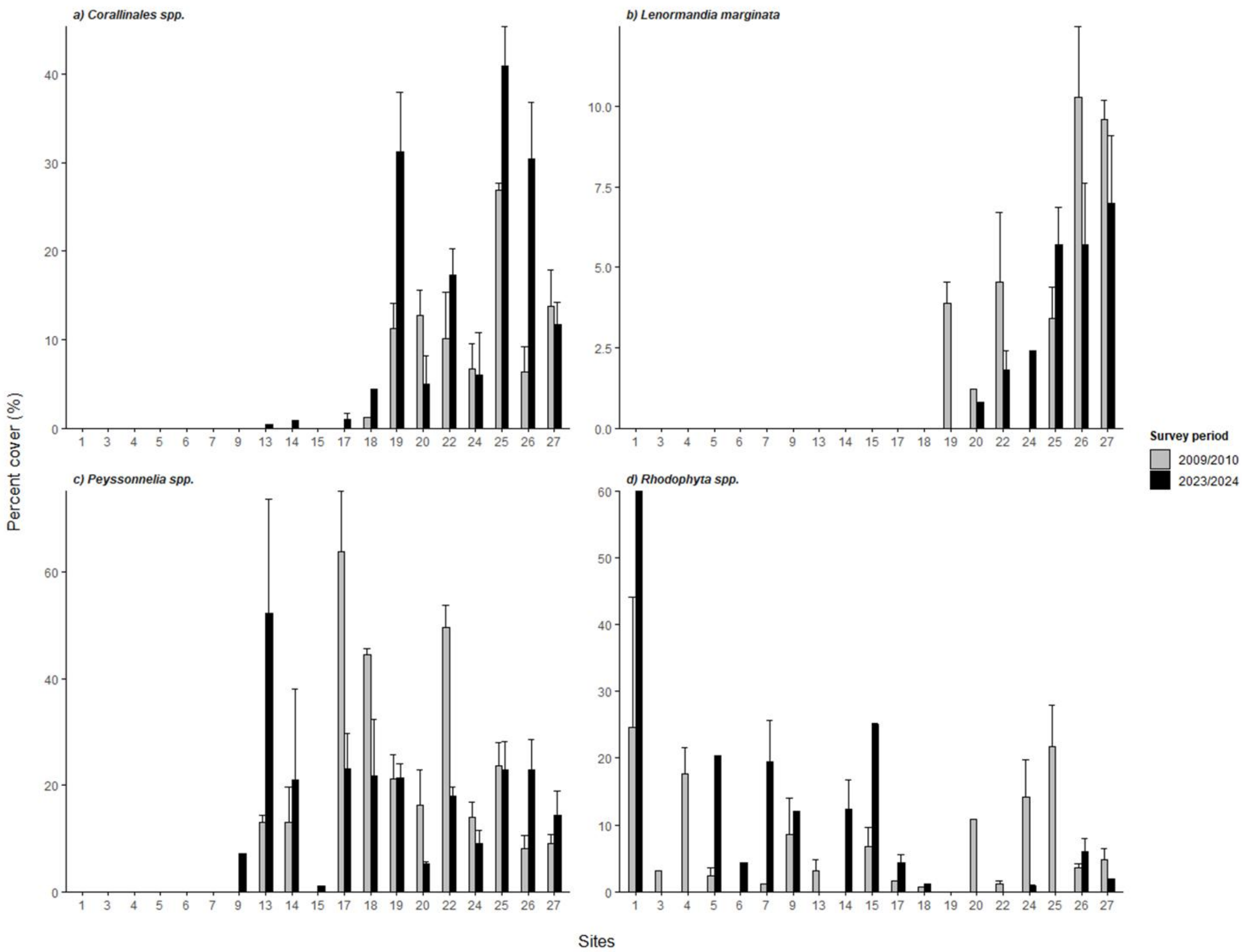

Figure 24: Percent cover (mean ± SE) of the most abundant red algae in the Derwent in 2010 (grey) and 2024 (black). The four species shown were among the top 6 most abundant in both survey periods, and are presented alphabetically. Here, *Rhodophyta spp*., comprises unidentified algae (red turf) and filamentous red algae.

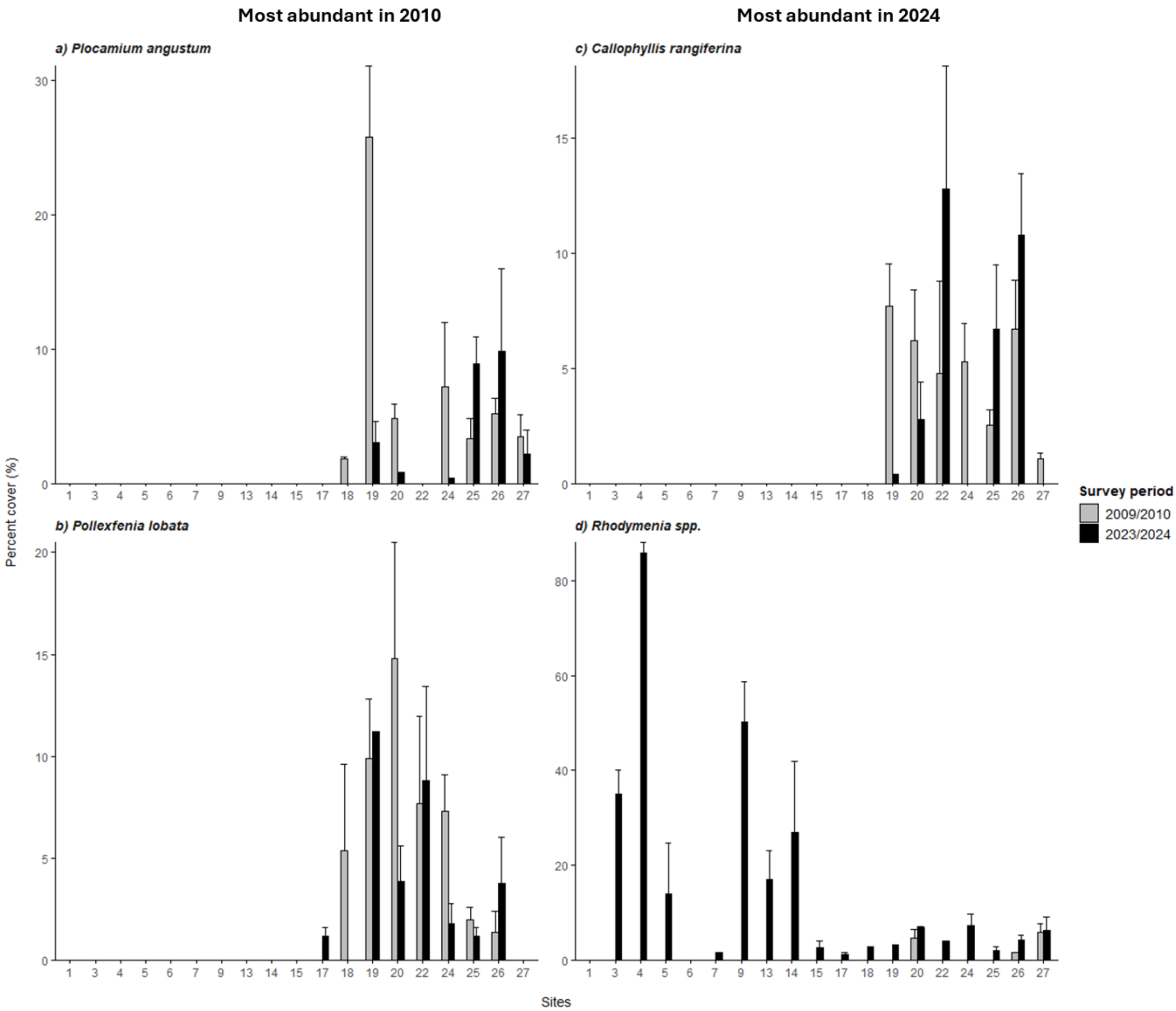

Figure 25: Percent cover (mean ± SE) of red algae species uniquely among the top 6 most abundant in 2010 (a, b) and 2024 (c, d) in the Derwent. While each species peaked in percent cover during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

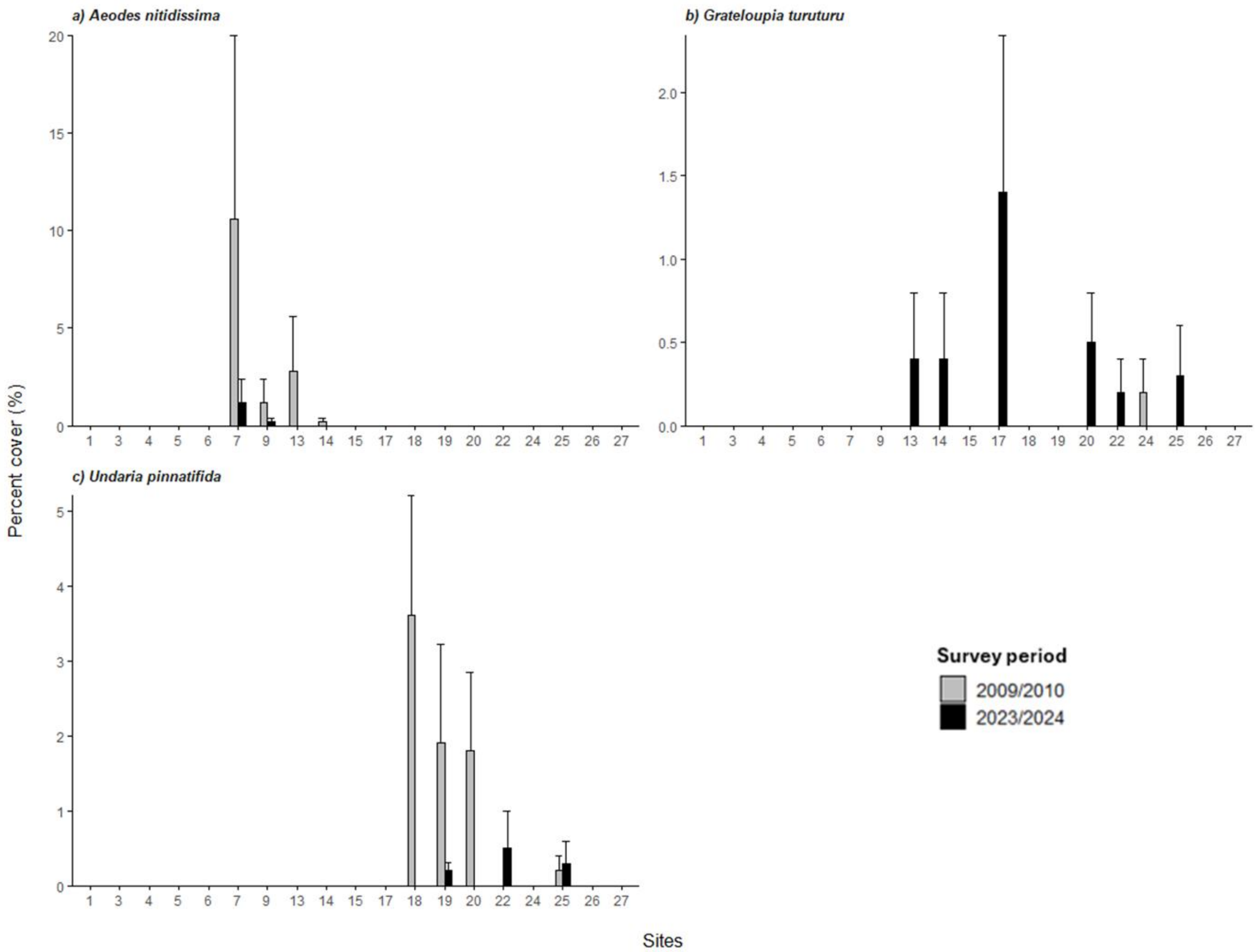

Figure 26: Percent cover (mean ± SE) of three introduced algae species in the Derwent in 2010 (grey) and 2024 (black). Species are presented alphabetically.

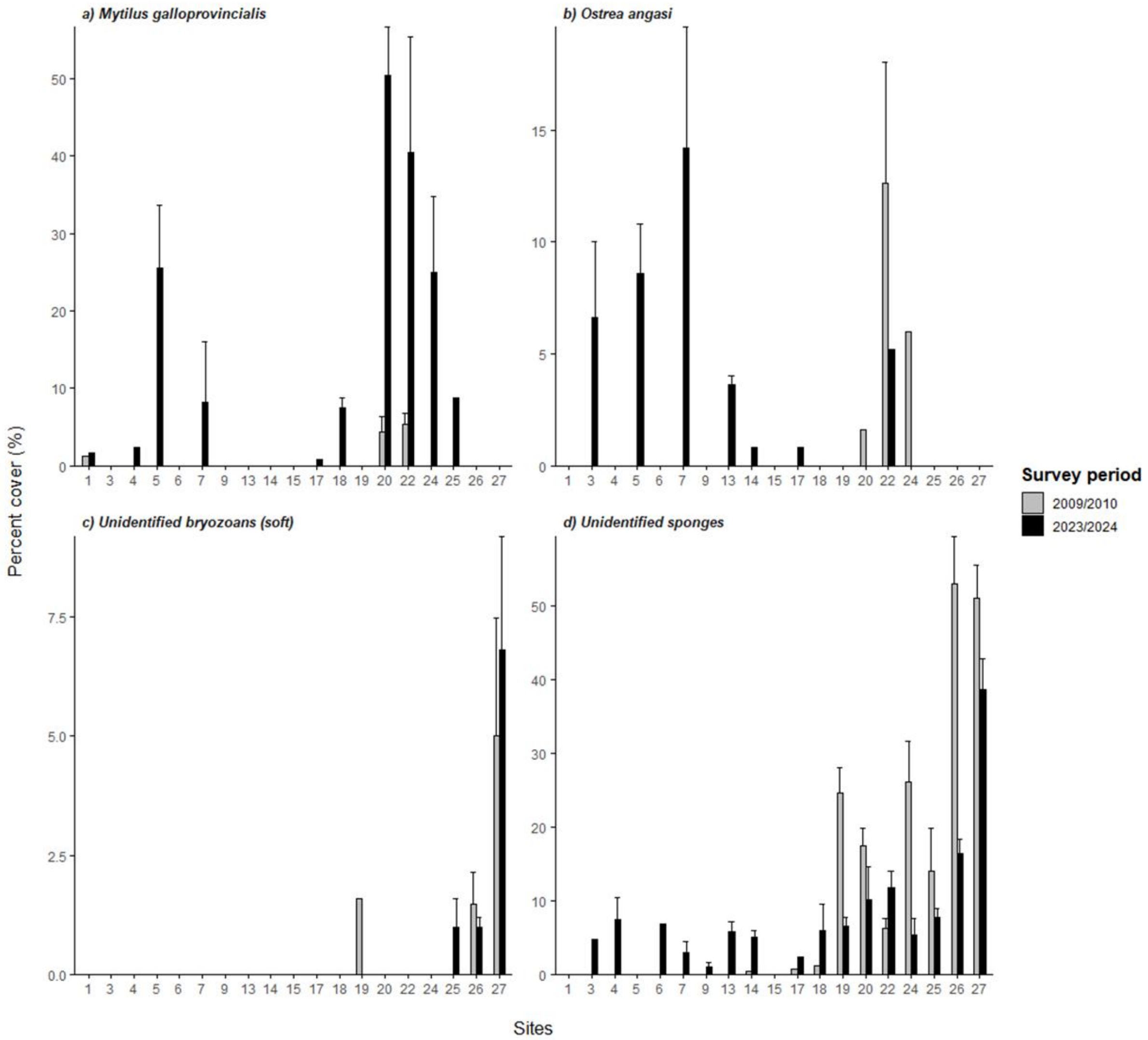

Figure 27: Percent cover (mean ± SE) of the most abundant sessile invertebrates in the Derwent across survey periods (2010: grey, 2024: black). The four species shown were among the top 6 most abundant in both survey periods, and are presented alphabetically.

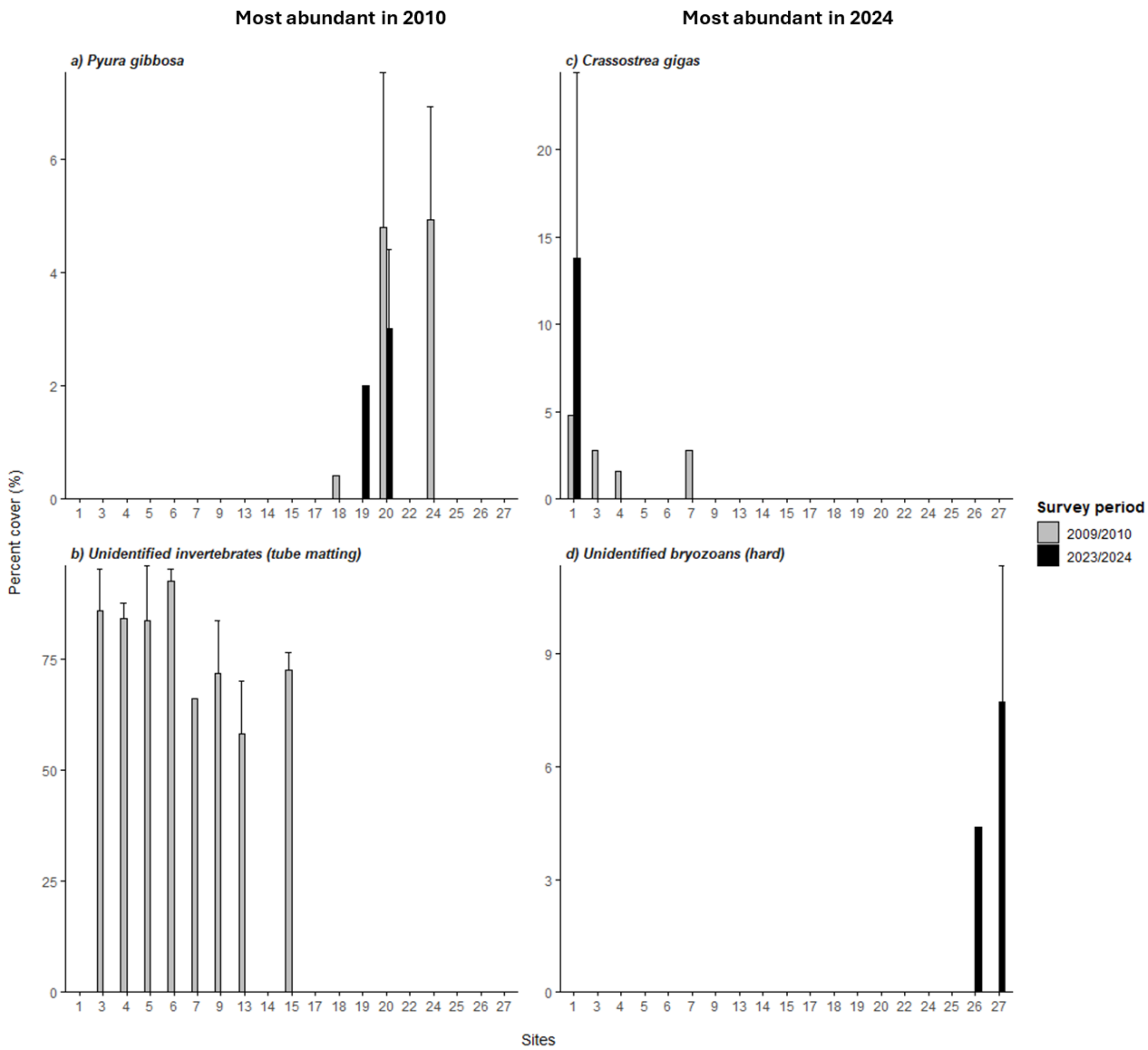

Figure 28: Percent cover (mean ± SE) of sessile invertebrate species uniquely among the top 6 most abundant in 2010 (a, b) and 2024 (c, d) in the Derwent. While each species peaked in percent cover during one period, changes across both survey periods are indicated by grey and black fill. Species are presented alphabetically.

3.2 <u>Timed intertidal and subtidal surveys</u>

General patterns

Overall, species richness of fish, invertebrates, and algal species remained relatively consistent across survey periods, with a slight decline observed in 2024. Richness was generally highest in reef habitats, and followed a similar pattern across intertidal, 0-1 m, and 1-4.9 m zones (**Error! Reference source not found.**). Species counts tended to increase from north to south, as seen in the standard surveys, with the highest richness recorded in the lower estuary.

Introduced species richness in 2024 mostly mirrored that recorded in 2010, with a slight overall increase, particularly on reef habitats (Figure 30). The highest counts of introduced species were observed in the upper and mid-estuary at 0-1 m and 1-4.9 m. In the intertidal zone, distribution followed a similar curve, with reduced counts in two upper estuary sites (sites 1 and 2) and in the lower estuary, and relatively stable higher counts throughout the mid-estuary – although some sites varied in this pattern.

Species considered least abundant or rarely encountered (defined as species recorded with only a single individual at a site) had considerable variability across the estuary (**Error! Reference source not found.**). Overall, species richness declined slightly but followed similar spatial patterns to the 2010 baseline. Richness tended to increase in the lower estuary, between 1-8.9 m depth, across both reef, ecotone and sand habitats. Majority of recordings from sand habitats were concentrated in the 5-8.9 m zone, versus reef habitats, where most observations were from intertidal to 4.9 m.

Species richness was assessed across rank abundance scores (1-5) for taxonomic groups in Reef, Ecotone, and Sand habitats (**Error! Reference source not found.**) and at different depth zones (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, and 9-15 m; **Error! Reference source not found.**). No clear trend through time could be determined, nor any obvious pattern for taxonomic groups.

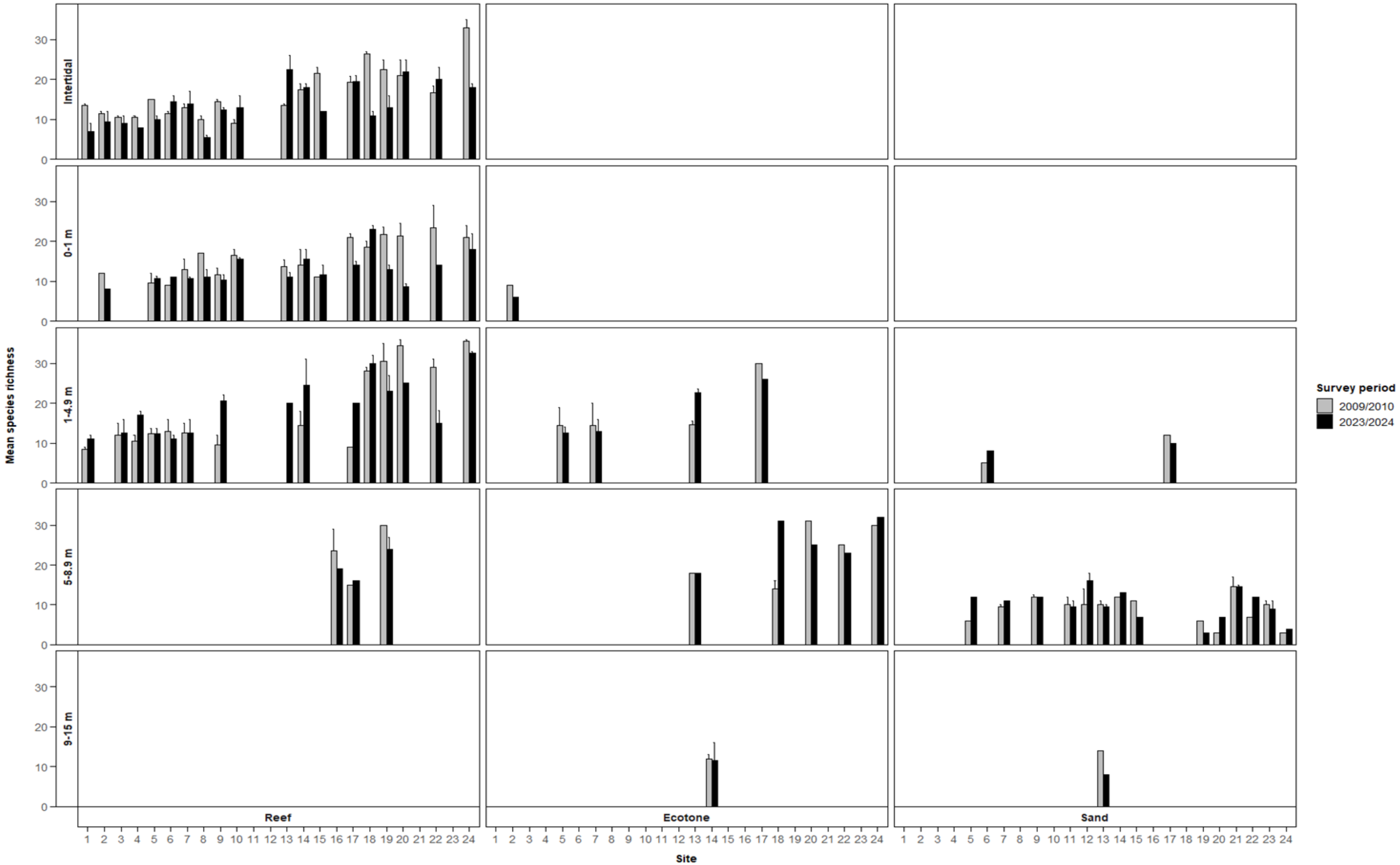

Figure 29: Species richness (mean ± SE) of all fish, invertebrate and algal species recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

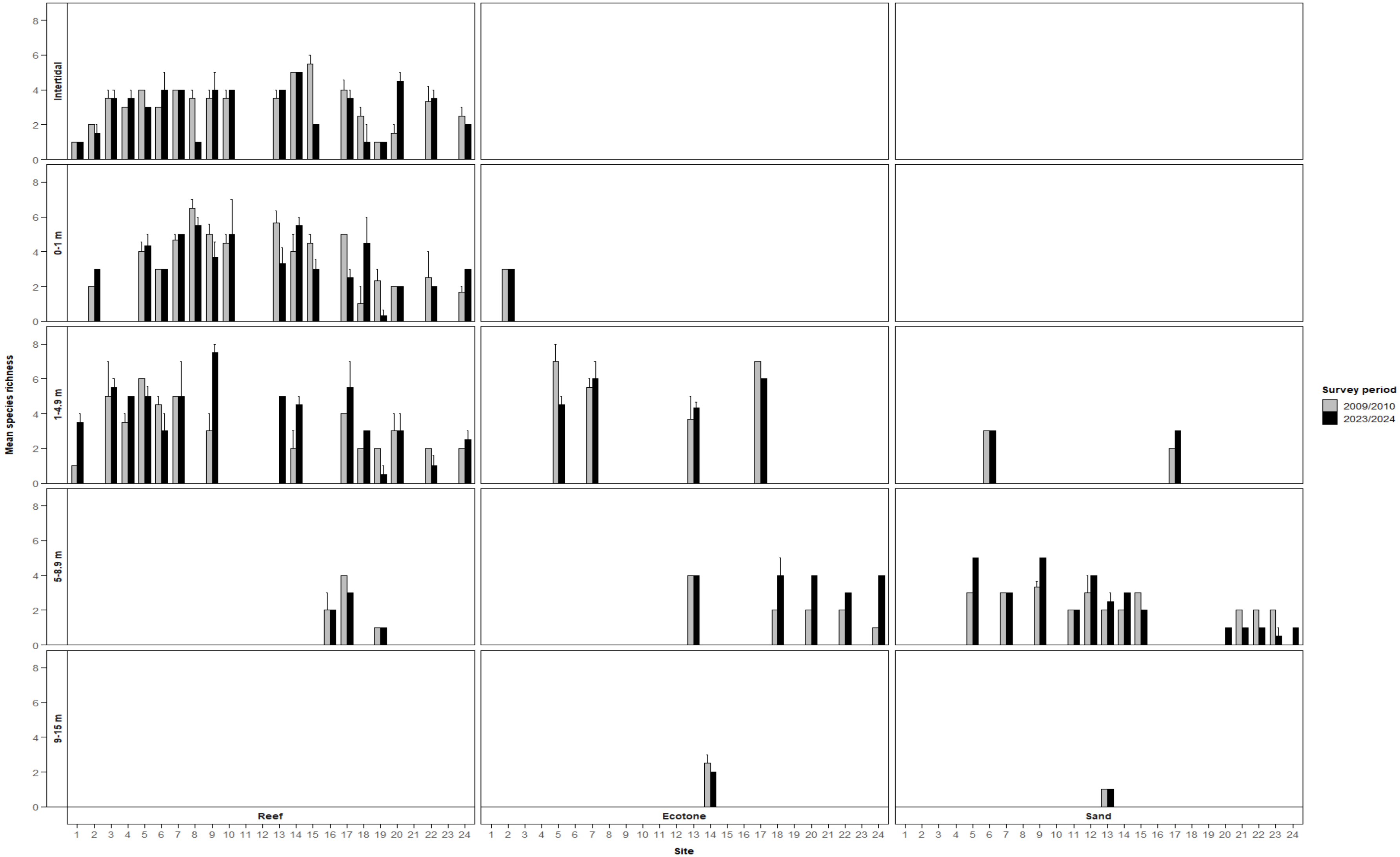

Figure 30: Species richness (mean ± SE) of introduced species recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

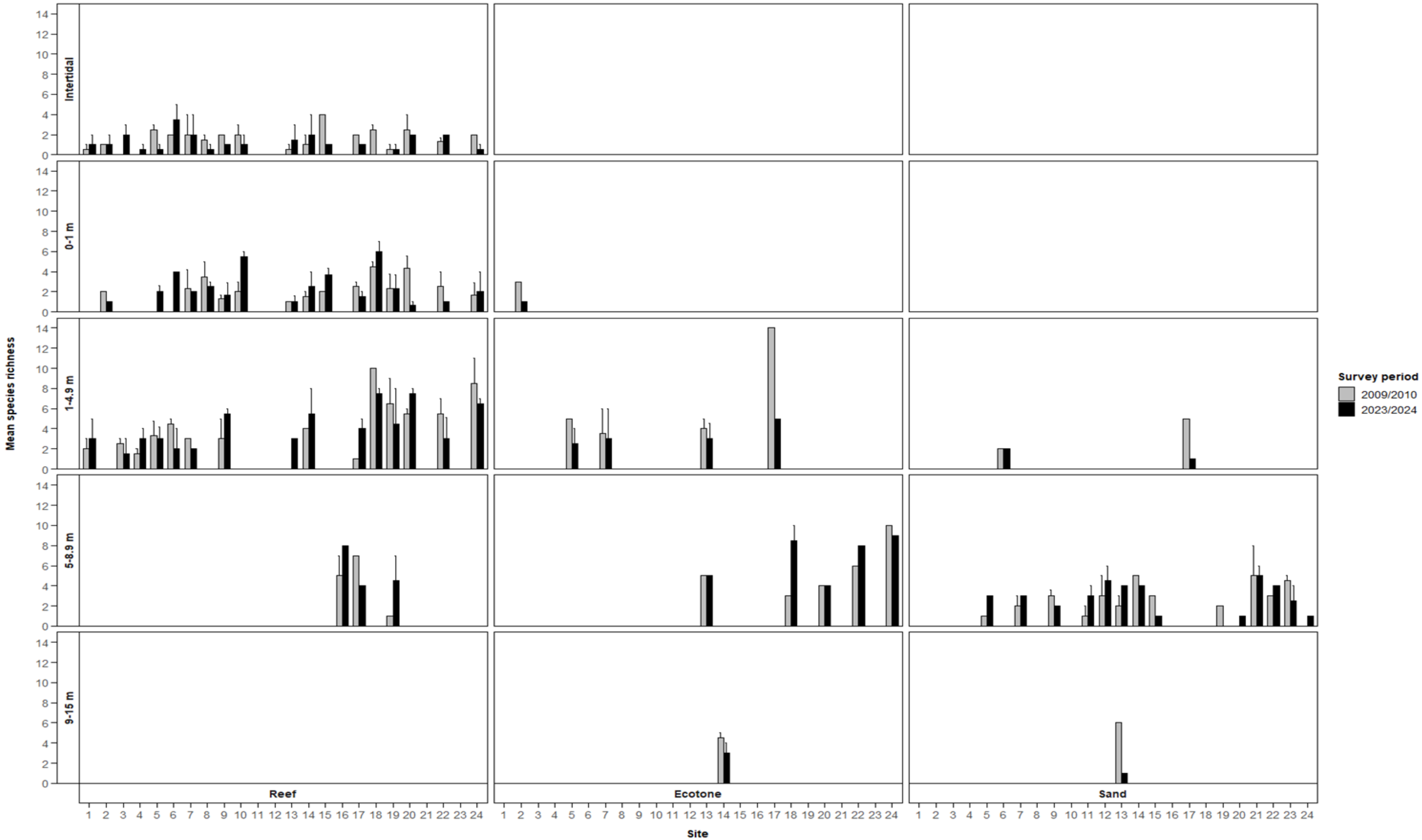

Figure 31: Species richness (mean ± SE) of the least abundant species (only 1 individual found) recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

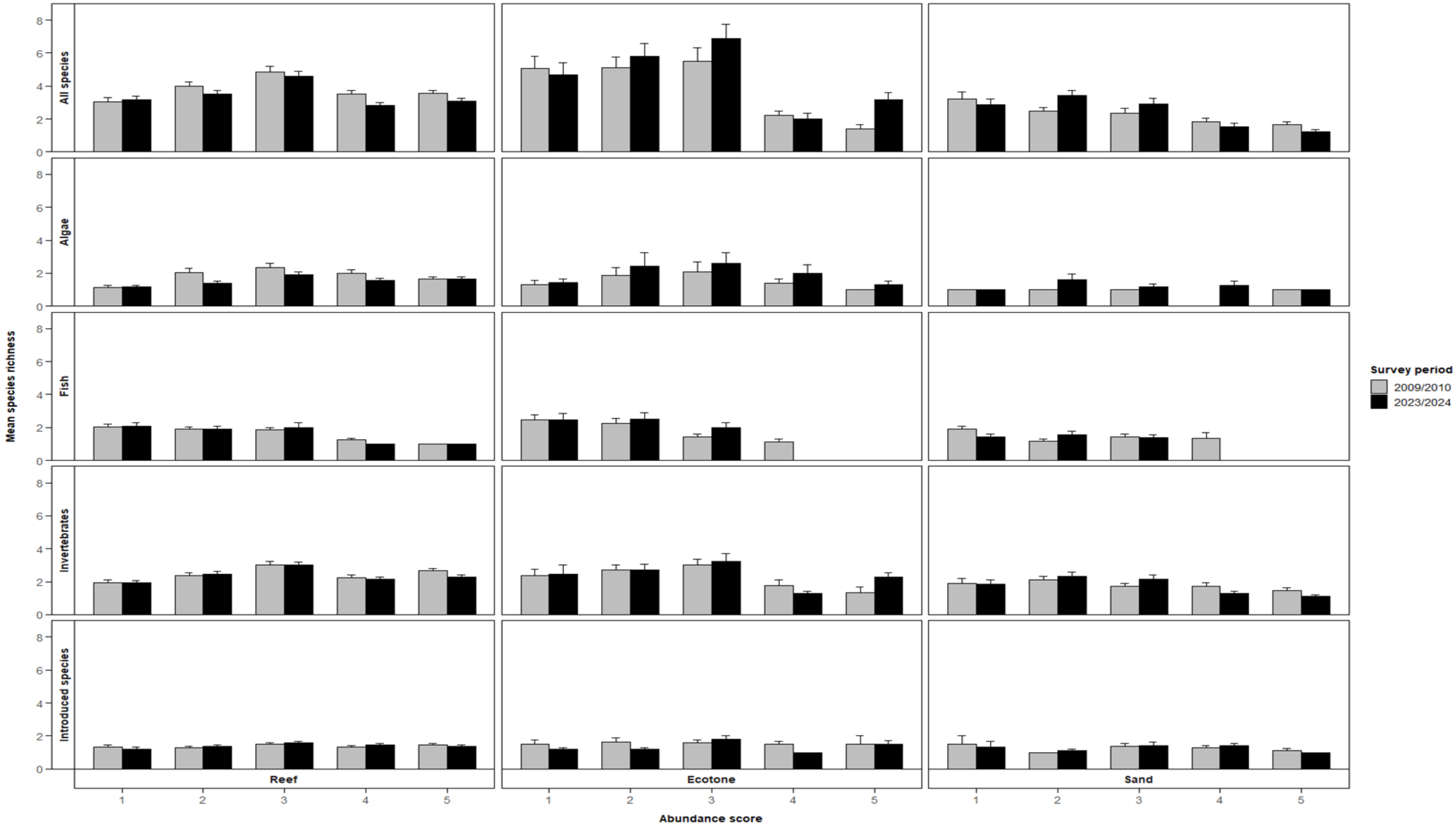

Figure 32: Species richness (mean ± SE) across abundance scores (1-5) for all taxa, recorded during timed swims in Reef, Ecotone, and Sand habitats of the Derwent in 2010 (grey) and 2024 (black). Abundance scores represent estimated individuals per species per swim: 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = >1000.

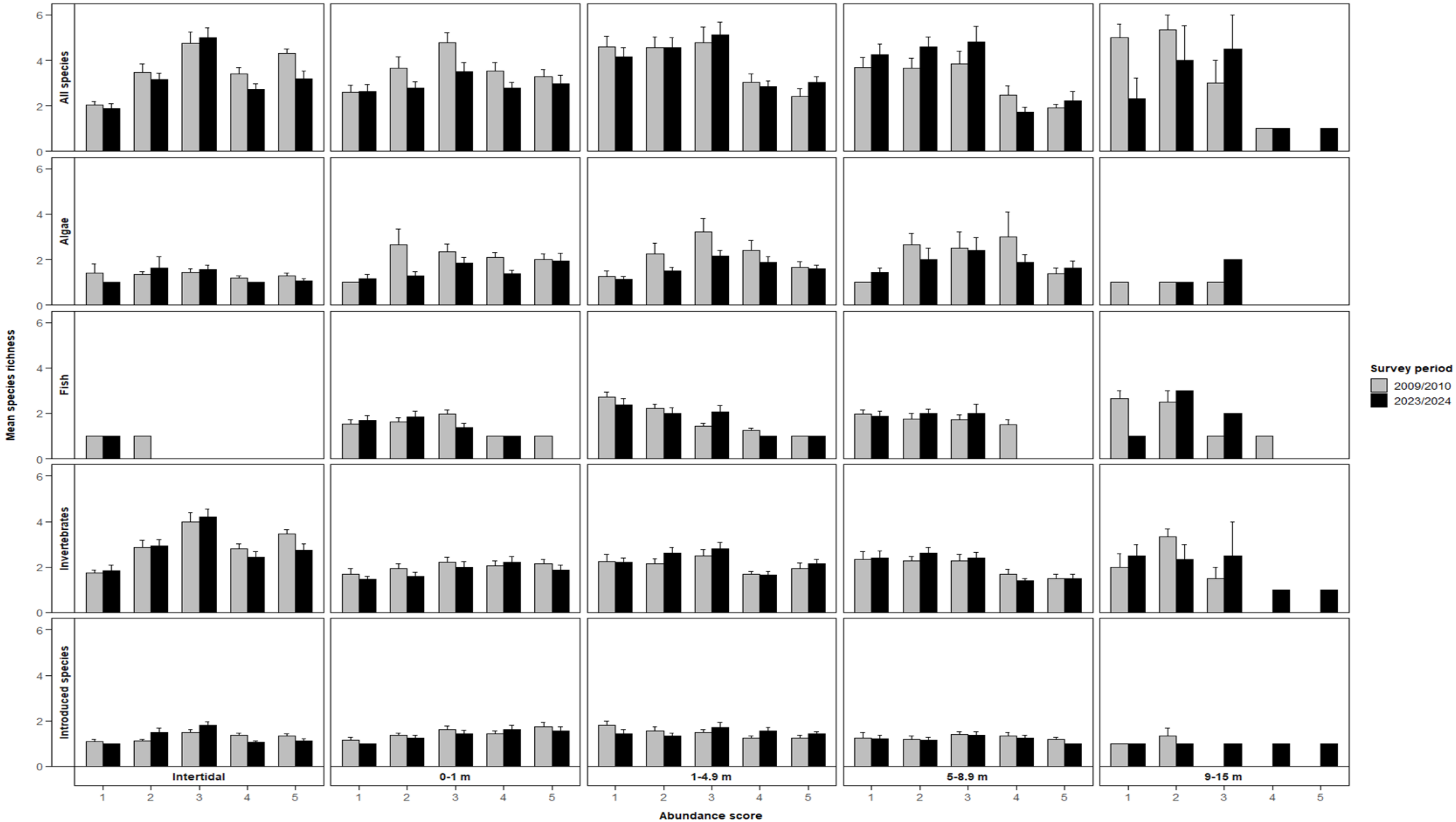

Figure 33: Species richness (mean ± SE) across abundance scores (1-5) for all taxa, recorded during timed swims in different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m) of the Derwent in 2010 (grey) and 2024 (black). Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+.

Fish

Sixty fish species were counted during the timed surveys, 12 less than 2010. Species richness in reef habitats largely mirrored the spatial patterns observed in 2010 (Figure 34). At 0-1 m depth, richness peaked in the mid-estuary and declined toward both the upper and lower estuary sites. At 1-4.9 m depth, richness generally increased from upper to lower estuary, although some variability was evident in the lower estuary sites. For instance, site 22 had less than half the species richness in 2024 compared to 2010. The majority of fish observations over sand habitats occurred at depths of 5-8.9 m, following a similar spatial distribution to 2010. Most observations were clustered in the mid-estuary, with a species richness comparable to 2010. However, a notable decline was observed in the lower estuary, where often only one species was recorded in 2024, despite previous records of five or more species at those sites.

Five fish species were overlapping as the most abundant in 2010 and 2024 timed surveys (Figure 35). *Forsterygion varium* was the most abundant fish species in reef and ecotone habitats in 2024 and was found at most sites with no clear spatial patterns determined (Figure 35b). Although *F. varium* was recorded at more reef sites overall, its highest rank abundance (rank = 3) was most frequently observed in ecotone habitats, spanning the upper, mid, and lower estuary. This is in comparison to *Trachinops caudimaculatus*, which was previously the most abundant fish in the 2010 timed surveys (Figure 35e). This species declined considerably in 2024, becoming absent across several sites where it was once observed. *Neoodax balteatus* exhibited a range shift into the upper estuary reef habitats, with rank abundance of 1-2 at several sites between Bedlam Walls and Naval Cadets, which had no records in 2010 (Figure 35c). Likewise, new and increased observations occurred over sand, with up to 100 individuals (rank = 3) recorded at both sites 9 and 12 (Rosny Point North and South). *Forsterygion gymnotum* similarly shifted further north in 2024, with most observations occurring on reef habitats between Bedlam Walls and Rosny Point in the upper and mid-estuary, and two recordings on ecotone habitats (Figure 35a). Abundance of *Notolabrus tetricus* varied minimally, with the species present across all three habitats (Figure 35d). Its highest rank abundance (=3) was recorded at several lower estuary sites on ecotone habitat. Notable declines occurred at site 16 (Tranmere Reef) over reef habitat, with previous observations of 101-1000 individuals (rank = 4) reducing to only 2-10 individuals (rank = 2).

Parablennius tasmanianus, previously among the most abundant fish in 2010, showed a marked decline in 2024 (Figure 36a). Several sites where it was recorded in 2010 were absent of the species during the most recent survey. In 2024, most observations were clustered between Bedlam Walls and Rosny Point, with a notable absence from other mid and lower estuary sites. In contrast, *Pempheris multiradiata* showed an extended distribution in 2024, occurring across the entire estuary in reef and ecotone habitats (Figure 36b). The species was recorded in higher relative abundance compared to the previous survey, when it was largely confined to the area between Tranmere Reef and Alum Cliffs.

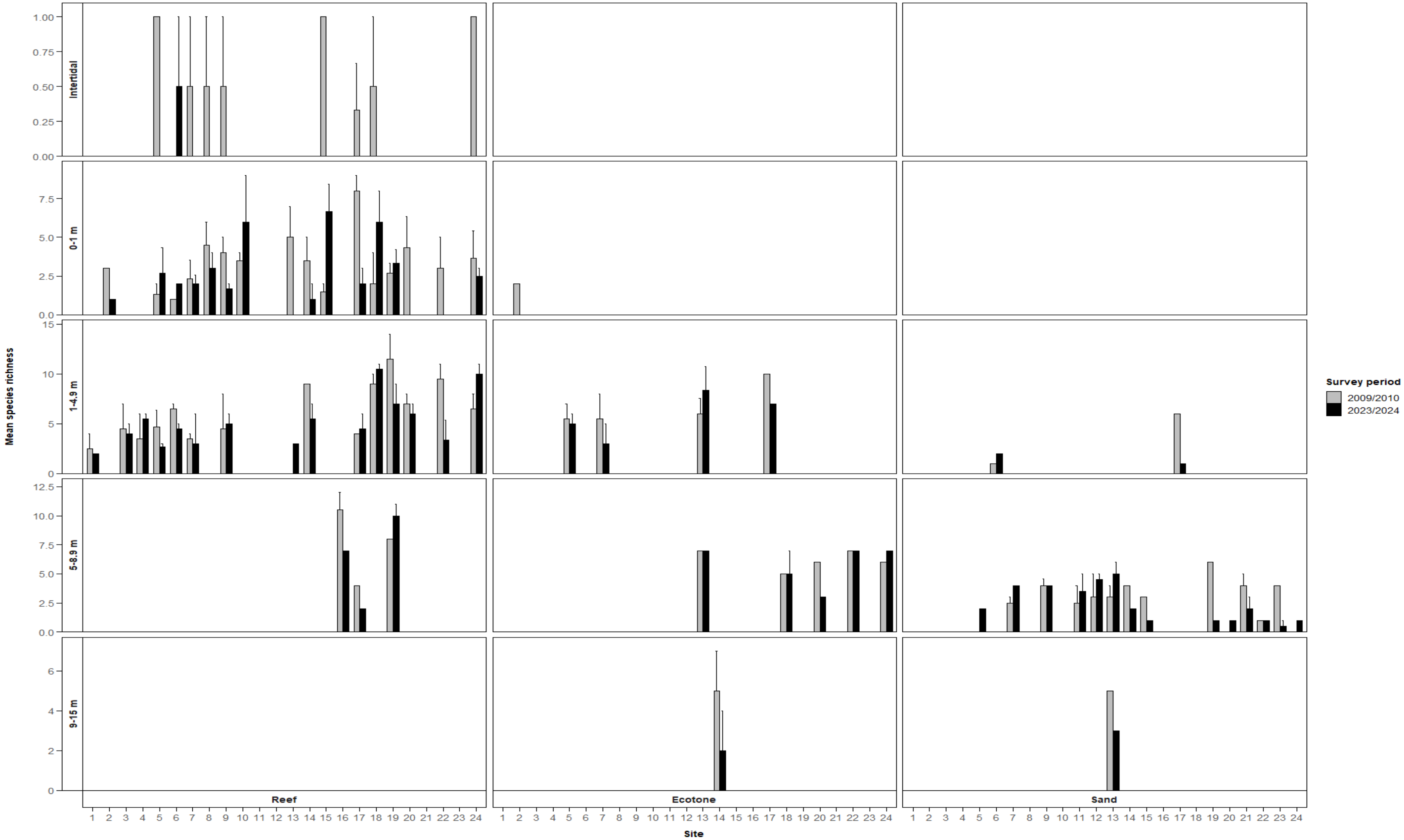

Figure 34: Species richness (mean ± SE) of fish species recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

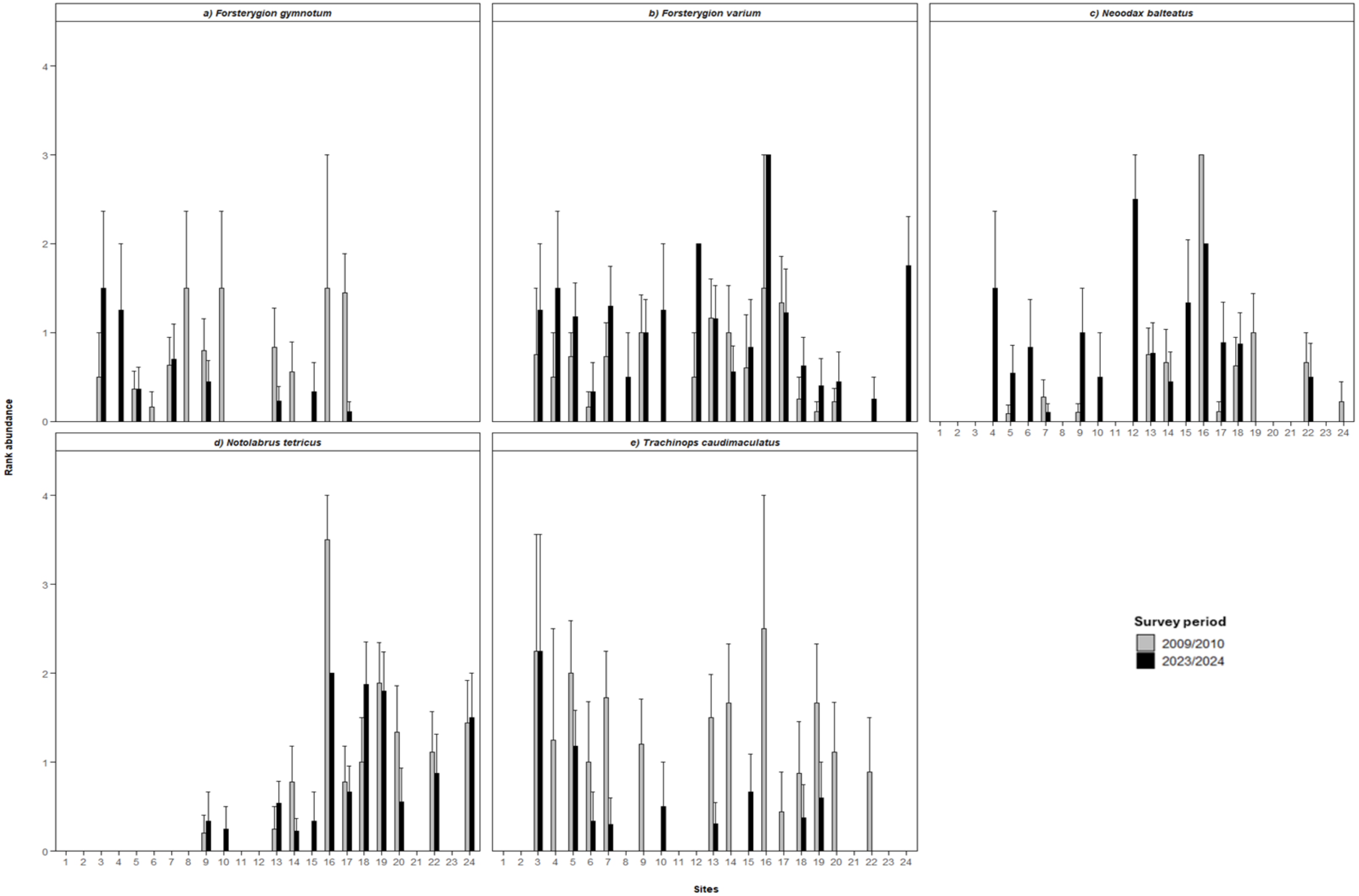

Figure 35: Rank abundance (mean ± SE) of the most abundant fish species in Derwent in 2010 (grey) and 2024 (black). The five species shown were among the top 6 most abundant in both survey periods, and are presented alphabetically. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 1).

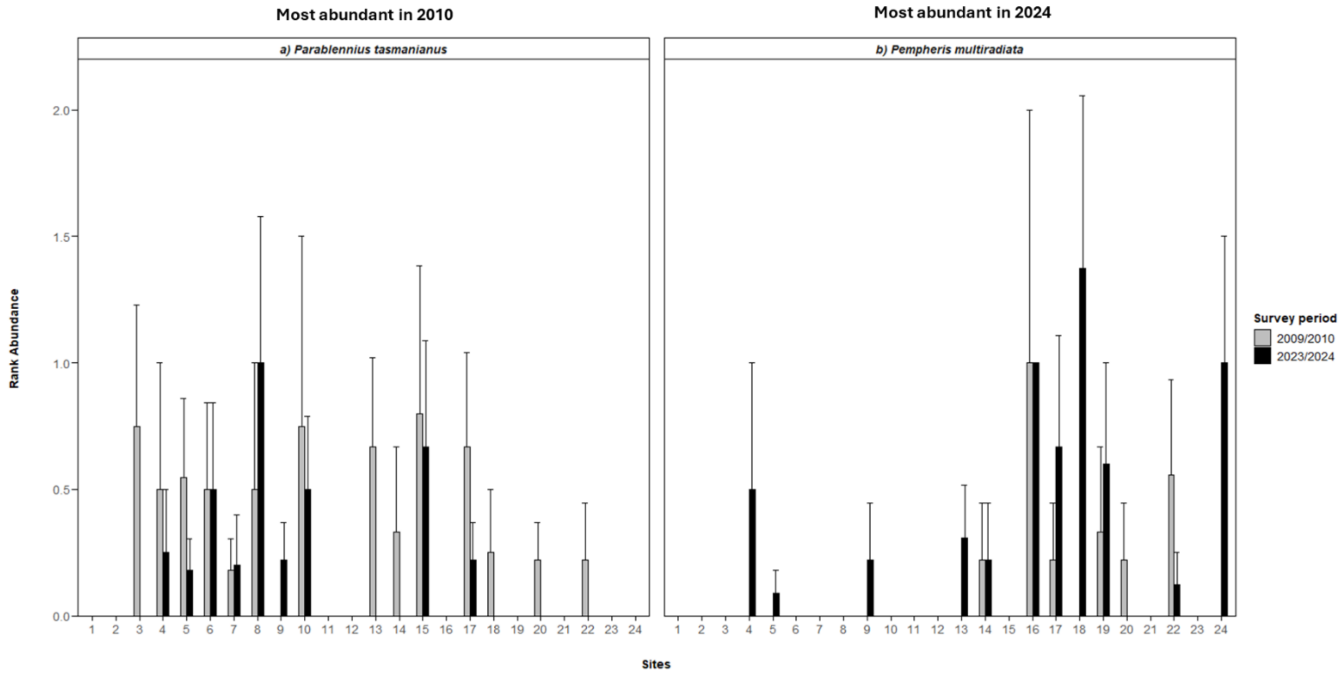

Figure 36: Rank abundance (mean ± SE) of fish species uniquely among the top 6 most abundant in 2010 (a) and 2024 (b) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill. Species are presented alphabetically. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 2).

Macro-invertebrates

One hundred and forty species of macro-invertebrates were recorded in 2024. As observed in the standard surveys, invertebrate species richness increased from north to south, particularly in intertidal habitats (Figure 37). A similar but more even distribution was evident at 0-1 m and 1-4.9 m depths, although slight declines were recorded at several lower estuary sites – specifically, sites 20, 22 and 24 at 0-1 m, and site 22 at 1-4.9 m. Most observations at 5-8.9 m depth occurred over sand habitats, with minimal variation from the 2010 surveys. Overall, no major changes in invertebrate species richness were detected between survey periods, with only minor site-level fluctuations occurring across the estuary.

We assessed the top eight abundant invertebrate species across both survey periods and how they changed through time. Several species remained among the most abundant species (Figure 38). *Asterias amurensis* increased in rank abundance at most sites, occurring at several new sites across all habitat types (Figure 38a). Previously, the highest abundance was predominantly observed in sand habitats, which remained consistent in 2024. However, rank abundance over both reef and ecotone habitats increased by several orders of magnitude in 2024 as well. In contrast, *Crassostrea gigas* declined by more than ten-fold at nearly all sites and was absent from all ecotone habitats in 2024 (Figure 38b). *Mytilus galloprovincialis* had relatively similar abundance across survey periods, although their spatial distribution extended south, particularly for ecotone habitats, with three lower estuary sites recording high relative abundance (=5; Figure 38c). Likewise, *Petrolisthes elongatus* maintained a similar spatial distribution and abundance patterns to 2010, although a slight decline in relative abundance is evident across most sites, particularly within the mid to lower estuary (Figure 38f). For example, Collegiate Rowing Club (site 8) declined by two orders of magnitude, as did Battery Point (site 15). *Ostrea angasi* had considerable variability, with no clear spatial patterns (Figure 38d) although it was typically more abundant on deeper reef and ectone transects, such as the Tranmere reef 5-10 m transect where it was particularly abundant. Over the past decade it appears that several sites in the upper estuary may have increased in relative abundance, although at levels that are not readily differentiated from background spatial variation. In 2024, *Patiriella regularis* appeared to decline on reef habitats throughout the mid-estuary but was newly recorded at two reef sites in the upper estuary (Figure 38e). A few upper and mid-estuary sites also showed increases in abundance of the species on ecotone habitats; particularly sites 2 and 7 (Dowsings Point and 200 m North of the Tasman Bridge), both of which increased multiple orders of magnitude to > 1000 individuals (rank = 5).

Myxicola infundibulum and *Unidentified barnacles* were among the most abundant invertebrates in 2010 but not 2024 (Figure 39a and 39c). Previously, *M. infundibulum* had high relative abundance (=5) over sand habitats, while *Unidentified barnacles* were recorded exclusively on reef habitats, particularly in the upper and mid-estuary. In 2024, both species showed a marked decline in occurrence and abundance, with no observations of *Unidentified barnacles*. This may be due to more successful species identification in 2024. In contrast, both *Heliocidaris erythrogramma* and *Elminius modestus* showed marked increases in rank abundance across the entire estuary, emerging as among the most abundant species in 2024 (Figure 39b and 39d).

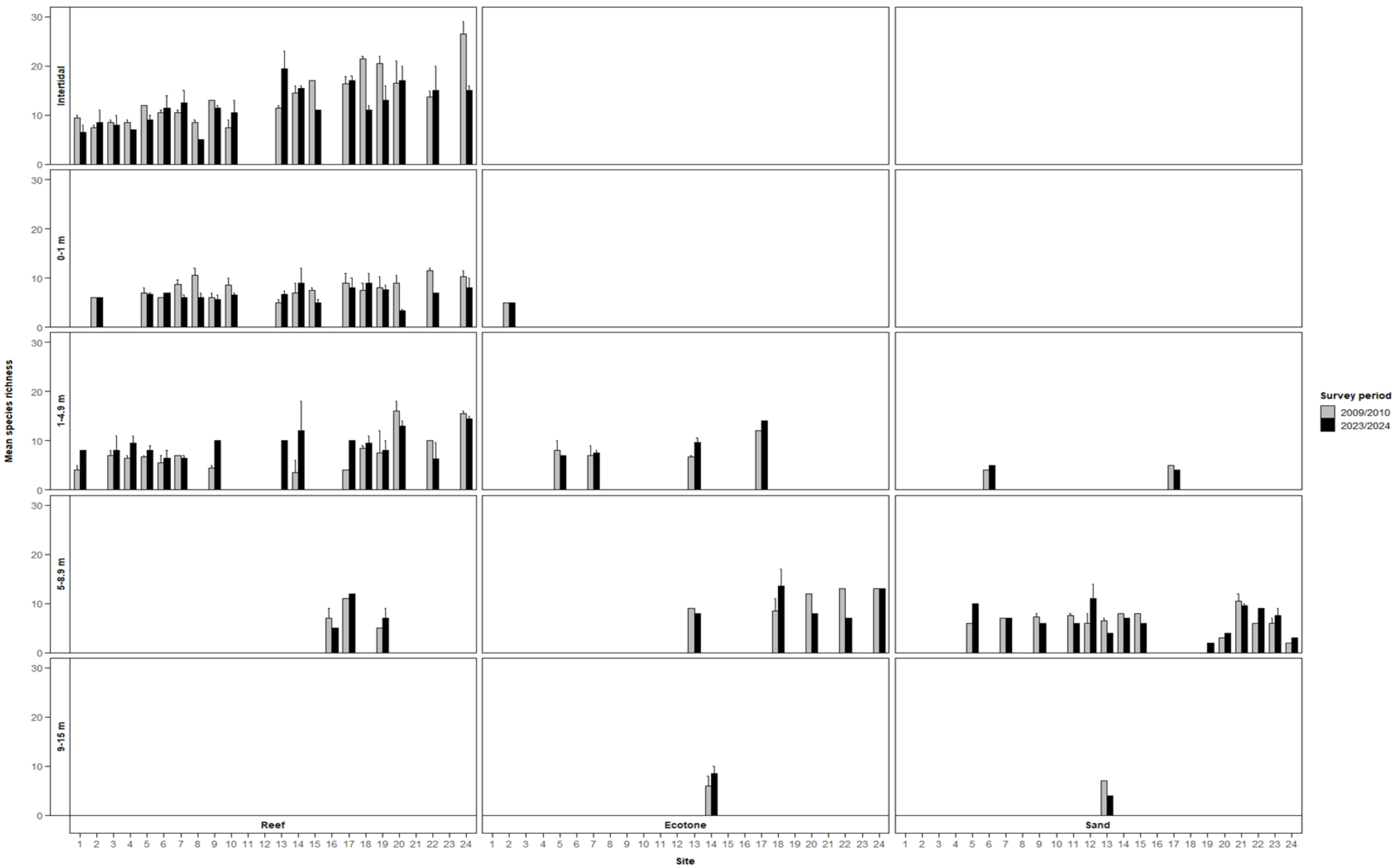

Figure 37: Species richness (mean ± SE) of invertebrate species recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

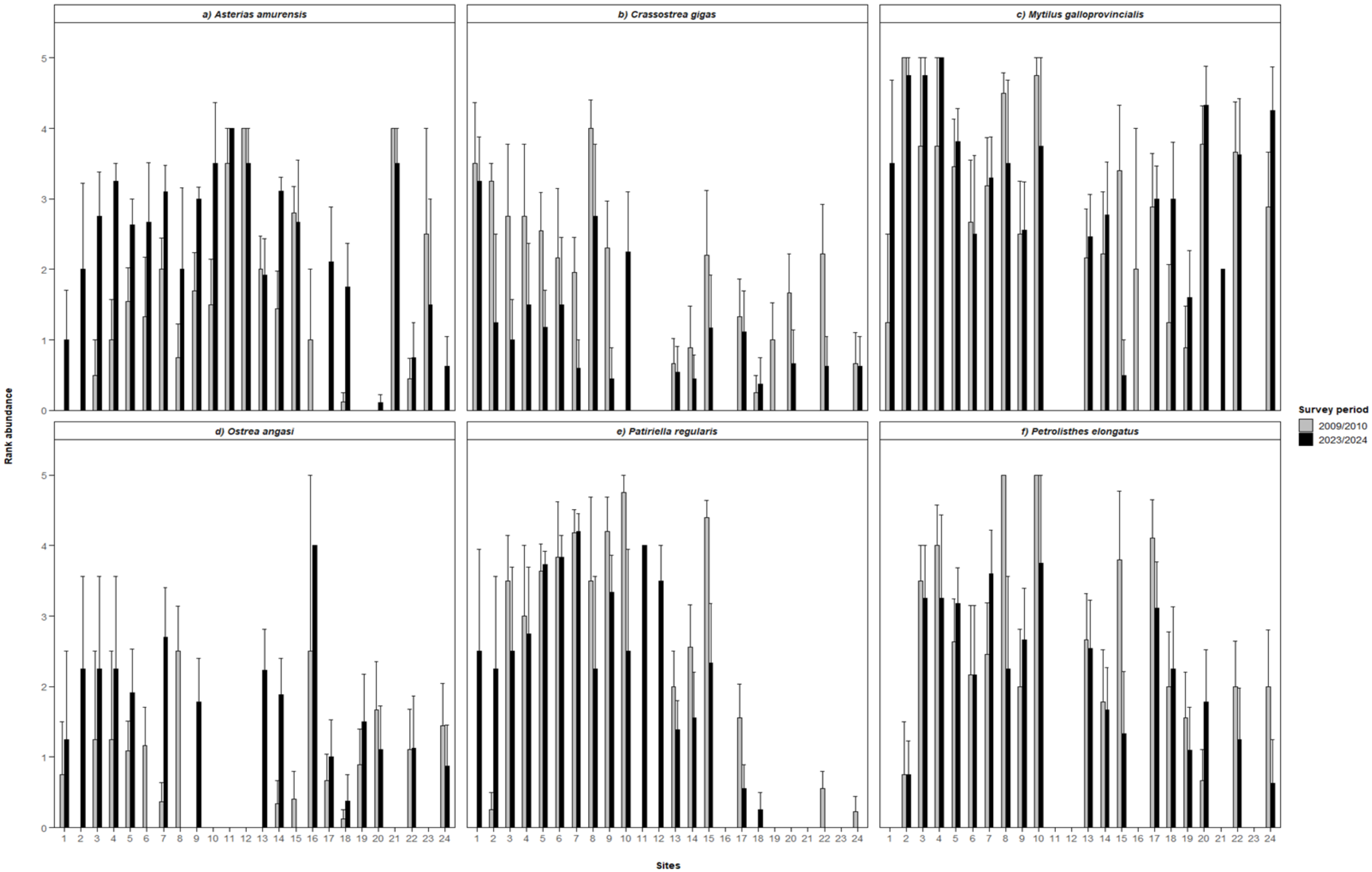

Figure 38: Rank abundance (mean ± SE) of the most abundant invertebrate species in Derwent in 2010 (grey) and 2024 (black). The six species shown were among the top 8 most abundant in both survey periods, and are presented alphabetically. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 3).

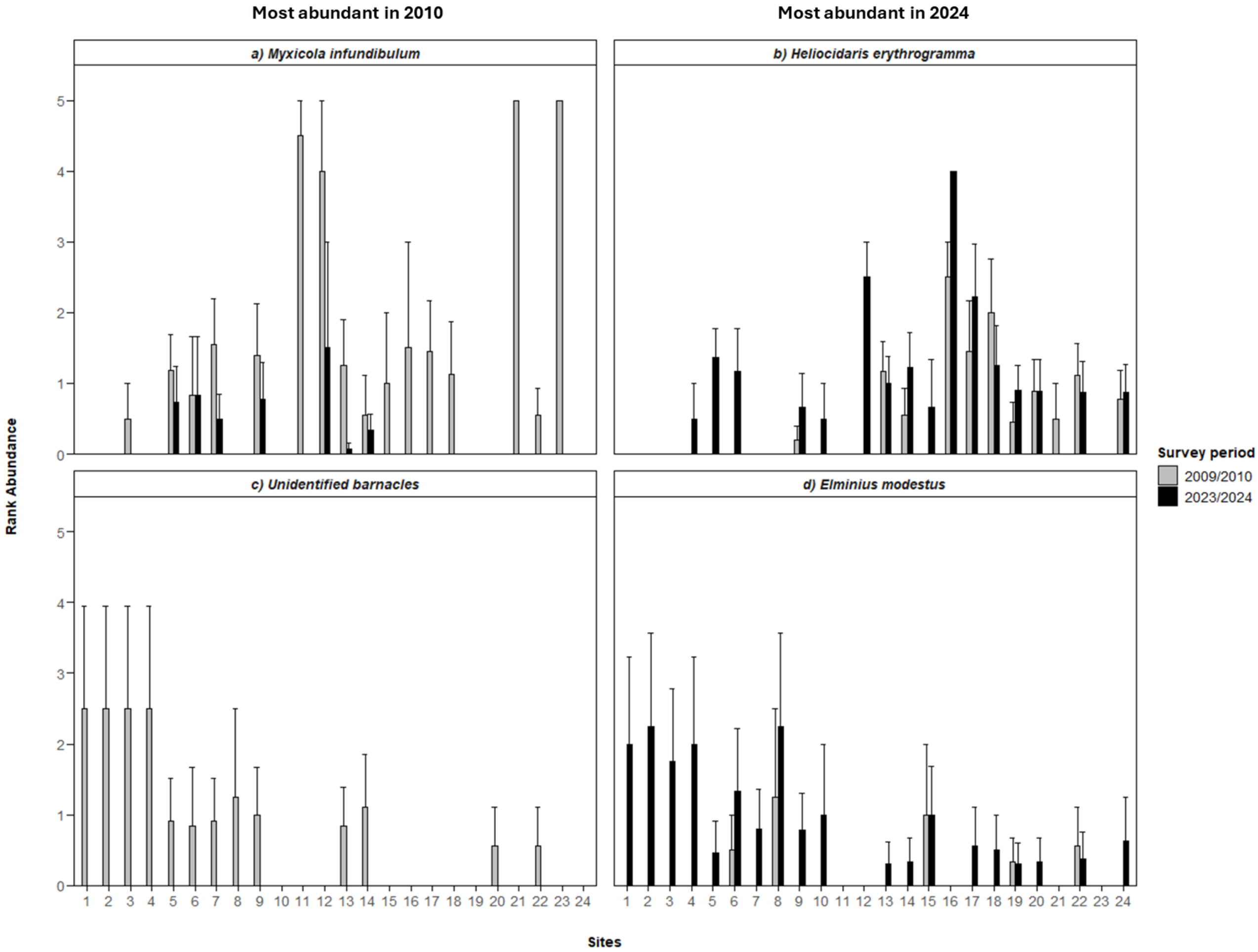

Figure 39: Rank abundance (mean ± SE) of invertebrate species uniquely among the top 8 most abundant in 2010 (a, c) and 2024 (b, d) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 4).

Algae

Forty-one species of algae and plants were counted during the timed survey. Similar to the standard surveys, algal species richness increased from upper to lower estuary – a spatial pattern observed in 2024 across multiple depths for reef habitats; intertidal, 0-1 m, and 1-4.9 m (**Error! Reference source not found.**). Interestingly, species richness in the upper estuary declined in 2024, however this was primarily within the intertidal habitats, and does not represent the same habitat sampled during the standard surveys. Algal observations at 5-8.9 m depths were spread across all three habitat types, with the highest richness recorded in ecotone habitats located in the lower estuary.

Analysis of algal assemblages across the estuary revealed that, among the eight most abundant species, six were consistently among the most abundant in both 2010 and 2024 (Figure 41). In 2024, *Cystophora moniliformis, Ecklonia radiata, Lessonia corrugata* and

Undaria pinnatifida were dominant in reef habitats of the mid and lower estuary (Figure 41b, 41c, 41d, and 41f). *C. moniliformis* declined in relative abundance on reef habitats at some sites but expanded its spatial distribution further north. In contrast, *E. radiata* increased in abundance at all sites. Both species also exhibited increased occurrence and relative abundance within ecotone habitats, particularly in the lower estuary, where *E. radiata* exceeded 1,000 individuals (rank = 5) at several sites. *U. pinnatifida,* an introduced brown seaweed, expanded into additional sites in the lower estuary.

Comparatively, in 2024 *Codium* spp. and *Ulva* spp. (Figure 41a and 41e) remained relatively evenly distributed across the estuary, though overall abundance declined compared to 2010. Abundance peaked slightly in the mid-estuary for *Ulva* spp., in both reef and ecotone habitats, but notable site-level variability was evident. For example, sites 11 and 12 in the mid-estuary recorded no observations of *Ulva* spp. in either survey, while nearby sites 16, 20 and 24 all peaked with rank abundances of 3-4 in 2024. *Codium* spp. was recorded in 2024 further upstream, at sites 4-7, with increased rank abundance, but declined at several other sites in the mid-estuary.

The algal community shifted somewhat in 2024, with species once abundant in 2010 no longer among the top abundant species in 2024. *Dictyopteris muelleri* declined significantly in both abundance and distribution, with its range shifting further north (Figure 42a), while unidentified filamentous brown algae were not recorded at all in 2024 (Figure 42c). Comparatively, the introduced species *Grataloupia turuturu* showed a substantial increase in abundance in 2024, expanding its range into the mid-estuary for reef habitats, and into the lower estuary for ecotone habitats (Figure 42b). A similar spatial distribution was observed for the native *Sargassum fallax,* predominantly present in the mid and lower estuary (Figure 42d). Both species were recorded at several new sites in 2024, indicating range expansions and overall increases in abundance. Site-specific variation was evident, with certain sites showing much reduced abundance for *S. fallax* (e.g., sites 16, 18 and 19) and others increasing substantially in 2024 (e.g., sites 14, 17, 20).

We assessed the relative abundance of *Ecklonia radiata* as an indicator of water clarity across different depth zones and observed both increased abundance and an expanded depth range in 2024, particularly within 0-1 m, 1-4.9 m and 5-8.9 m subtidal zones (Figure 43). Notably, sites 13 and 14 (Bellerive Bluff and Bellerive/Howrah Bluff) exhibited substantial increases, rising from sparse coverage (rank 1-2; ≤10 individuals), to near-complete coverage (rank 4-5; 101-1000+ individuals). Similarly, site 9 (Rosny Point North) showed a marked increase in the 1-4.9 m depth, where *E. radiata* was previously absent but reached a rank abundance of 4-5 in 2024. Sites 17 and 18 (Tranmere Point and The Grange, Taroona) showed comparable trends. At site 17, abundance in the 1-4.9 m zone increased dramatically, from a single individual (rank 1) to an estimated 101-1000+ individuals (rank 4-5). Both sites also recorded new occurrences at 5-8.9 m depth, with moderate rank abundances (ranks 2-3), indicating a deepening distribution.

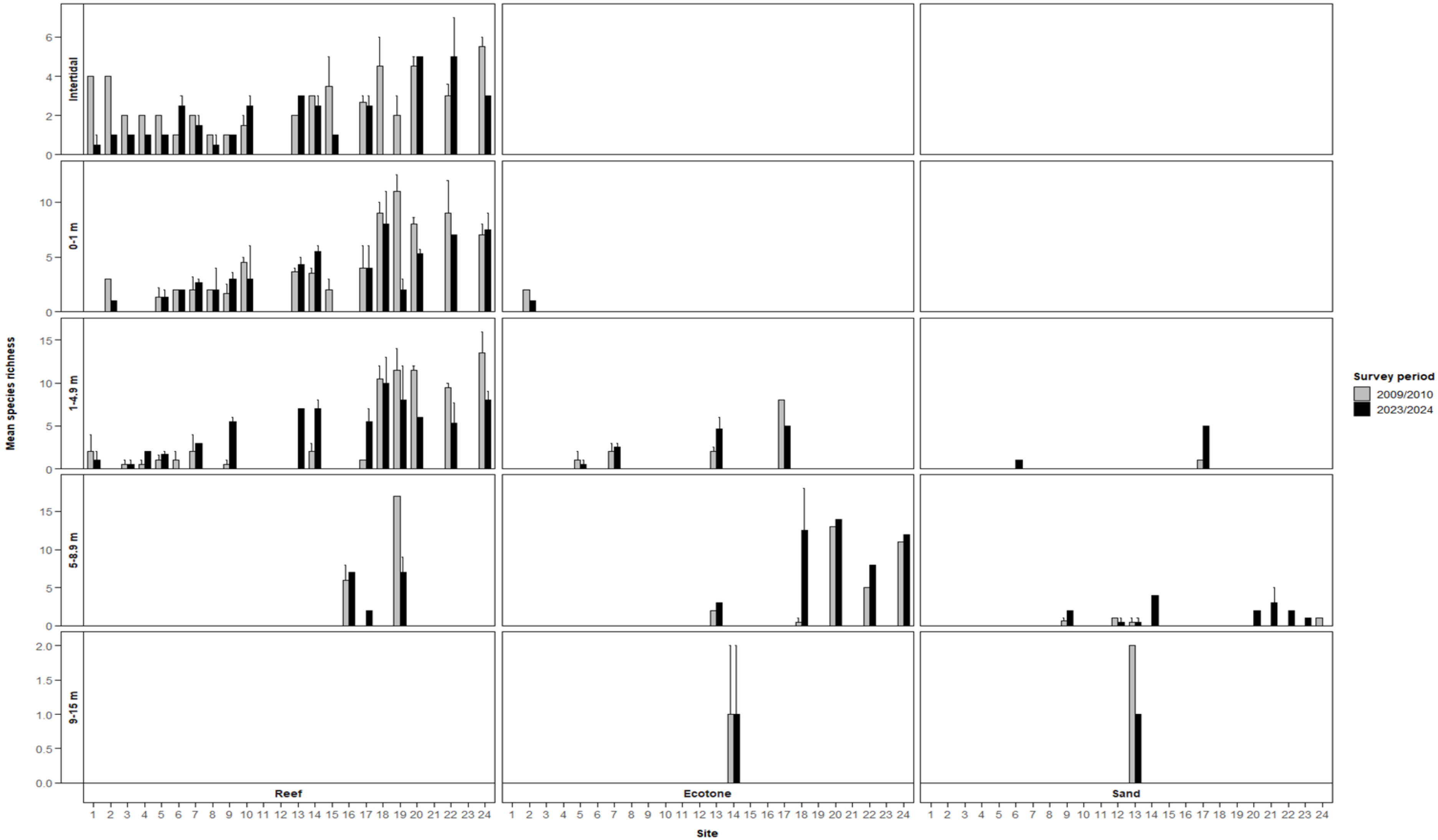

Figure 40: Species richness (mean ± SE) of algal species recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black), in different habitats (Reef, Ecotone, Sand) and different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m).

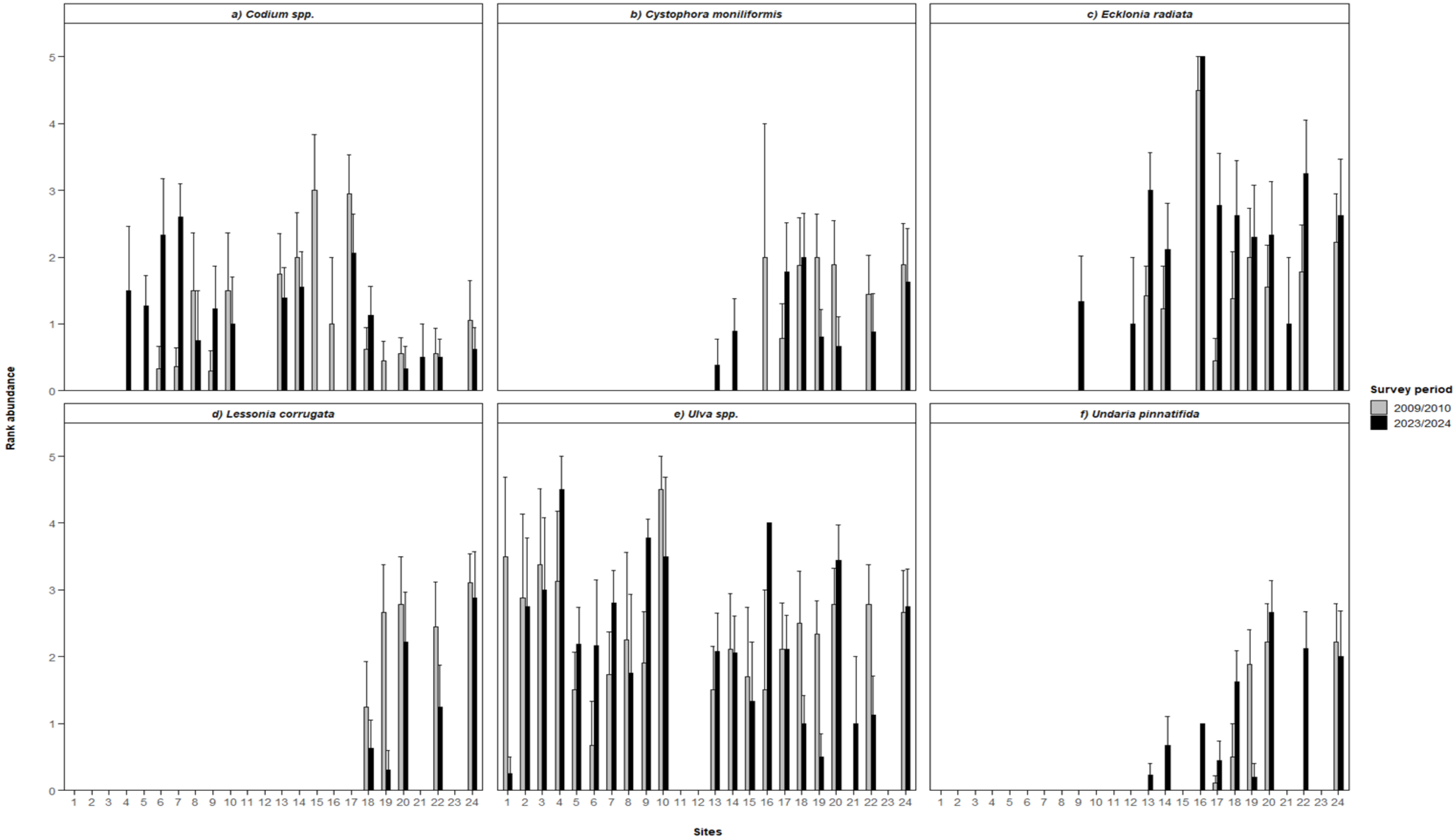

Figure 41: Rank abundance (mean ± SE) of the most abundant algal species in Derwent in 2010 (grey) and 2024 (black). The six species shown were among the top 8 most abundant in both survey periods, and are presented alphabetically. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 5)

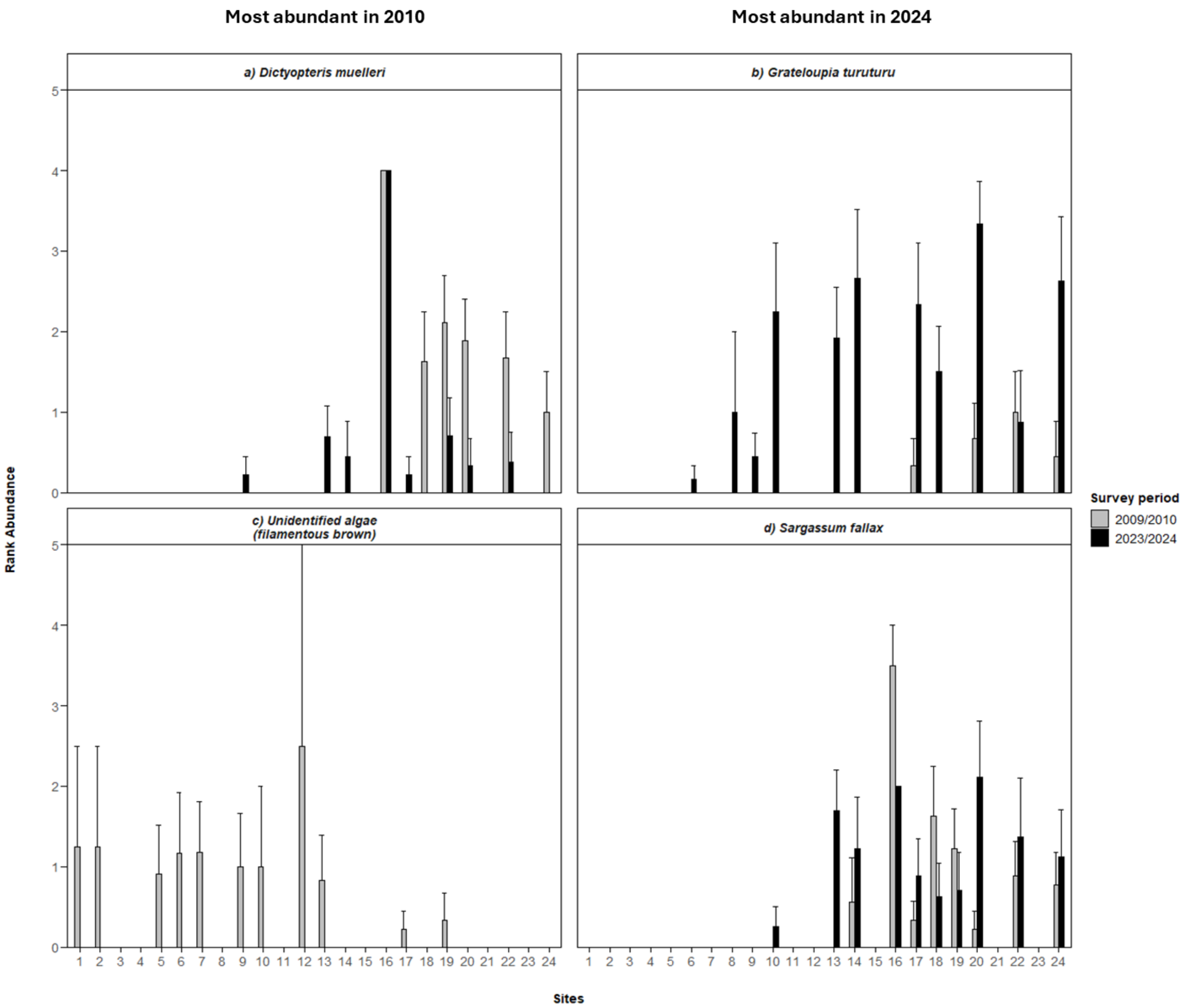

Figure 42: Rank abundance (mean ± SE) of algal species uniquely among the top 8 most abundant in 2010 (a, c) and 2024 (b, d) in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill. Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Habitat-specific patterns are provided in the Appendix (Appendix 6).

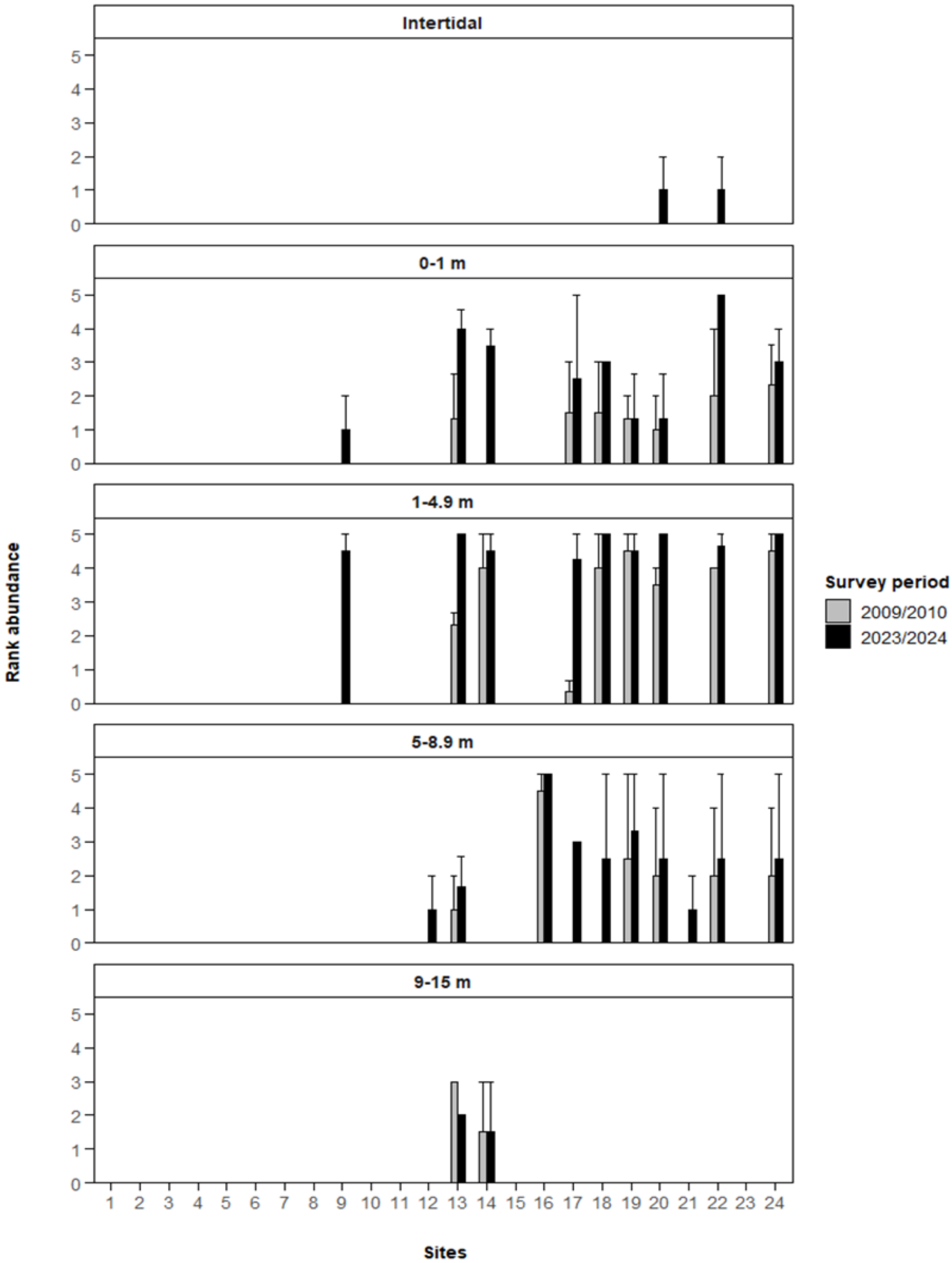

Figure 43: Rank abundance (mean ± SE) of *Ecklonia radiata* recorded during timed swims in the Derwent in 2010 (grey) and 2024 (black) at different depths (Intertidal, 0-1 m, 1-4.9 m, 5-8.9 m, 9-15 m). Abundance score; 1 = only 1 individual, 2 = 2-10, 3 = 11-100, 4 = 101-1000, 5 = 1000+. Note site 17 (Tranmere reef) is offshore, with no reef shallower than 5 m.

3.3 Targeted *Ostrea angasi* survey

The results are shown in Appendix 20 where most collected oysters were able to be positively identified to species by internal features. The sub-sample of these specimens were then further validated using a taqman qPCR assay developed by Coutts et al. (2022) for positive identification of *O. angasi*, results of this molecular analysis is found in Appendix 22.

Overall, these results show a strong correlation with the species site and depth distributions recorded in the earlier surveys, validating the general patterns observed. This shows *C. gigas* dominating the intertidal zone where *O. angasi* was rarely present. This continued through the 0-1 m depth zone before a transition through the 1-5 m depth zone, with *O. angasi* then becoming the dominant species in the 5-10 m zone, although *C. gigas* were still occasionally present in this zone. At times, some collected specimens were not able to be identified to species based on external features alone. Likewise, some intermediate specimens were not even able to be identified using the key internal morphologies (inner marginal teeth and hinge striations, Appendix 21) as these were missing.

For the genetic testing with the qPCR assay, eight of the twelve specimens initially identified as *O. angasi* tested positive, one tested negative suggesting an incorrect morphological ID, while the remaining three were intermediate as they had only 1 of 3 replicates return a positive result. Of the sixteen specimens of *C. gigas* tested, fourteen were negative, while one returned positive results as *O. angasi* and another came back as an intermediate result. The intermediate results were likely caused by the presence of non-DNA contamination preventing successful PCR and cannot be confidently assigned positive or negative. These positive/intermediate results in the *C. gigas* group had previously been flagged as somewhat intermediate in form and lacking clear internal features. These were initially classified as likely C. gigas based on external shell morphology but were prioritised for genetic testing based on the lack of clear differentiating features.

Of note, is that no specific *O. angasi* reefs were found during the study, although the rocky reef at Tranmere reef did have extensive cover between 5-10 m. An extensive oyster reef was found at Cadbury Point in 2-3 m depth, however, all samples collected there were found to be *C. gigas*.

4. DISCUSSION

This study replicates a series of baseline surveys on rocky reefs and adjacent sediments in the Derwent Estuary completed in 2010, with the aims of identifying biodiversity changes through time. This survey revealed several distinct trends in the fish, invertebrate and algal communities in both space and time, building upon the 2010 baseline and establishing a second time point from which to continue decadal monitoring of key ecological components of the system.

4.1 Standard fixed-depth transect-based subtidal reef surveys

Fishes:

Overall, the spatial distribution of fish communities remained broadly consistent through time, with fish species richness increasing from upper to lower estuary, with the greatest richness in the open, marine-influenced sites – as expected for an estuarine system and evidenced in the baseline survey (Barrett et al. 2012). However, overall richness declined for fish communities through time. Of particular note is the decreased richness from Tranmere Point to Blackmans Bay Blowhole (site 17 to 24). Previously a species-rich area of the estuary, this region has declined considerably since 2010 and now matches much of the mid and upper estuary. Generally, the riverine extreme of an estuary produces a more depauperate environment, with reduced species richness and abundance, due to a lower saline environment (Edgar et al. 1999; Neves et al. 2011). This was evident in the historic baseline surveys of 2010 within the Derwent Estuary. However, the current survey suggests a community restructuring, with compositional changes and a general trend of community simplification; with several sites supporting simpler, less-diverse assemblages. Tranmere Point, Alum Cliffs and White Rock, South Arm (sites 17, 20, and 22) – all lower estuary sites – now more closely resemble the richness of the mid-estuary site, Rosny Point North, despite their marine-influenced locations. Localised changes within the estuary are evident though, with species richness increasing from 2010 for several upper and mid-estuary sites, from Bedlam Walls to Rosny Point. This could be a result of localised resilience to the habitat, or habitat improvement, which correlates with the increased algal cover seen at these sites. However, the likely overall cause of the observed decline in richness at the marine end of the system will require further time-series surveys to be undertaken to determine if this is an ongoing real trend, or an artefact of the generally poor visibility encountered during the 2024 survey following a major storm in late February.

Estuary-wide changes in salinity can also result in community restructuring, with increasing salinity during periods of low river flow or frequency of flooding events driving an increase in the richness and abundance of marine and estuarine species as they extend their range upstream (Baptista et al. 2015; Lauchlan & Nagelkerken 2020). An extended period of increased salinity leading up to the 2024 survey may explain the observer increase in marine and estuarine species observed at locations such as Cadbury Point and Bedlam Walls North during the 2024 surveys.

The riverine extremes of estuaries are typically vulnerable to flood events, which are often exacerbated by the urban environments that commonly surround estuaries (Harrison et al. 2022). Flooding can significantly alter an estuary by increasing water flow, sedimentation and nutrient concentrations, and changing the habitats and species within the estuary (Cooper 2002; Rogers & Woodroffe 2016; Henderson et al. 2024). In severe cases floods can result in the complete loss of ecosystems (Davis et al. 2022). No major flooding events have occurred in the Derwent Estuary from June 2016 to June 2024; in 2016 the river exceeded the major flood level (7.3 m), causing widespread damage and loss of life (Bureau of Meteorology 2016). With almost eight years separating the last event from these biodiversity surveys, this reprieve may have allowed the upper estuary to stabilise, with high salinity levels resulting in the increased richness observed at these sites since 2010. Notably, the mid to upper estuary is regularly influenced by rainfall events and periods of lower salinity in surface waters that particularly influence intertidal to immediate subtidal species. However, at moderate depths (5 m) more significant flood events are required to displace many marine species and provide species restructuring over multiple year scales.

At an individual species level, we observed marked declines in several formerly common species since the 2010 baseline, including *Trachinops caudimaculatus* and *Latridopsis forsteri*. *Trachinops caudimaculatus* is a resident reef schooling planktivorous species, and is particularly vulnerable to changes in the plankton communities, with this driving changes in abundance on the open coast communities (Barrett et al. 2007; Bates et al. 2014). Both flooding and eutrophication can disrupt the physical and chemical environment, negatively affecting zooplankton, and by extension, the species that depend on them (Rose et al. 2019; Wang et al. 2021). Ongoing variation in eutrophication in the Derwent (Derwent Estuary Program 2024) resulting from storm events and human actions could be influencing zooplankton availability, resulting in the overall decline observed between 2010 and 2024.

For *Latridopsis forsteri,* a recreationally and commercially targeted species, the potential drivers of the observed decline are possibly more complex, but important to try to understand. This is a resident reef schooling species, typically with variable year to year abundance due in part to its episodic recruitment, which happens in large bursts at infrequent intervals (Edgar 2008). Despite the variability, populations readily build up in no-take marine reserves such as those found at Tinderbox and Maria Island where they remain until reaching sexual maturity at 6-7 years of age (Barrett et al. 2007). Elsewhere, they have declined markedly relative to historical levels, most likely due to their high susceptibility to both recreational and commercial fishing via use of mesh nets (Harries & Croome 1989).

During the 1990s and early 2000s, extensive netting restrictions implemented by the Tasmanian government effectively created a de facto reserve for this species within the Derwent Estuary. These restrictions, along with the species' low susceptibility to capture by handlines, likely contributed to the high numbers of trumpeter observed during the 2010 surveys. However, by the 2024 survey, numbers had declined dramatically. To examine whether this decline reflects natural variation in recruitment or human influence, we contrasted these results with unpublished monitoring data from nearby protected sites within the Tinderbox Marine Reserve. There, numbers declined from a total of 52 to 38 individuals sighted on transects between 2010 and 2024, a much smaller decline than observed in the Derwent Estuary sites. This suggests that poor visibility encountered during the 2024 surveys may have inhibited divers ability to observe *L. forsteri*.

However, recreational fishing remains a major pressure in the Derwent, and increased fishing activity cannot be ruled out as a driver of the decline observed in 2024. Minimum size limits for both commercial and recreational fishing remain well below the estimated size at maturity (Murphy & Lyle 1999), likely hindering successful recruitment. Anecdotally, recreational spearfishing in the Derwent has markedly increased over this period, potentially prompted by the high numbers of trumpeter observed in 2010. This combination of increased spearfishing pressure and impaired recruitment may be contributing to the sharp decline in Trumpeter numbers observed in 2024, although similar declines have also been observed in the marine reserve at Maria Island over this period (Barrett, unpublished data). Increased protection of Trumpeter in the Derwent Estuary through spatial restrictions on spearfishing activities could be one way of assisting in the recovery of Trumpeter stocks, improve conservation and biodiversity values, as well as enhancing snorkelling activities and improving public safety in areas of high recreational use.

In addition to abundance changes, minor range shifts also occurred for several species. Two key species of interest are *F. varium* and *F. gymnotum*, both introduced triplefins and primarily considered cryptic species. While the standard fish surveys showed little change in their abundance or distribution, cryptic fish surveys revealed a substantial increase in both metrics in 2024 for these species. These results also highlighted clear range expansions for both species. Range shifts in marine species are often driven by changing environmental conditions, including warming waters and salinity changes (Hastings et al. 2020; Pinsky et al. 2020), as well as competition and resource allocation (Sorte et al. 2010; Lord & Whitlatch 2015). Range expansions within an estuary, particularly into the upper estuary as we've observed, can occur when increased temperatures and salinity result in more available, favourable habitats throughout the estuary (Baptista et al. 2015). As discussed earlier, a period of relative stability in the estuary in recent years, driven by low flood frequency, may explain much of the range and abundance increase seen at present. Whilst neither *F. varium* nor *F. gymnotum* are considered invasive, these introduced species are a conspicuous component of the reef fish fauna in the mid to upper estuary. Changes in the environment may be favouring these cryptic introduced species, which prefer sheltering in complex rocky reefs (Willis & Anderson 2003), with some sites in 2024 increasing significantly in algal coverage.

In contrast to the fish communities sighted on the broad fish transects, the overall richness and abundance of cryptic fish species (sighted on the narrower detained seabed searches) increased substantially since the 2010 baseline. Our results indicate a clear shift northward for species richness, and coupled with an increase in overall abundance, these findings suggest potential environmental changes that support cryptic species, and their preference for increased habitat complexity. This observation includes the native Tasmanian blenny, *Parablennius tasmanianus,* which increased in abundance within the upper estuary. However, this was matched by a reduction in abundance of gobies in the same region.

Mobile Invertebrates:

These same environmental changes may also be supporting the increase in abundance seen for several cryptic macro-invertebrates, including the two introduced asteroids: the northern Pacific seastar (*Asterias amurensis*) and the New Zealand common cushion star (*Patiriella regularis*). The northern Pacific seastar is a highly invasive echinoderm that has been established in the Derwent Estuary since the 1980's, with significant impacts on aquaculture and commercial shellfish industries (Ross et al. 2004; Hutson et al. 2005). Its establishment also coincides with the decline of the Spotted handfish (*Brachionichthys hirsutus*) in the Derwent, likely due to ecological impacts such as predation on preferred spawning substrates (Bruce et al. 1997; Stuart-Smith et al. 2020). With no recent population assessments in Tasmania, the significant increase observed in the 2024 survey within the estuary should be taken into careful consideration for ongoing management of this pest species. Likewise, *P. regularis* is a dominant species within the upper estuary, and is considered a major competitor to the native, endangered Derwent seastar, *Marginaster littoralis* (Beeton 2009; Barrett et al. 2012), a species now thought to be extinct (O'hara et al. 2018). The population of *P. regularis* appears to be thriving in the current estuarine conditions, with significantly increased abundance from Cadbury Point to Battery Point compared to the baseline data. Again, estuaries are naturally dynamic ecosystems, particularly towards the riverine extreme, where species must be adaptable to withstand acute environmental changes. Much of the variation observed in the middle to upper estuary sites where these species increased the most is likely a reflection of this naturally shifting environment, captured during a period of relative stability. In the absence of any major flooding events in recent years, opportunistic species like *A. amurensis* and *P. regularis* can flourish. Given their invasive nature, continued targeted monitoring of both introduced seastars is recommended. Monitoring at similar spatial coverage and decadal intervals to this repeat study would give sufficient information to understand the trajectory of introduced problem species and their interaction with native species and habitats. While no effective mechanisms have been identified to remediate such invasives at large scales, the information is effective in highlighting the nature of the invasion, possibilities for local area control (e.g. volunteer removals in threatened species hotspots), and the need for ongoing exploration of solutions to the invasive species problem.

This recent lack of major disturbance may also explain increases in the abundance of several common native invertebrate species, including the short-spined sea urchin (*Heliocidaris erythrogramma*). The invasive long-spined sea urchin (*Centrostephanus rodgersii*) is the dominant species responsible for forming urchin barrens, through extensive overgrazing of kelp ecosystems (Ling et al. 2009; Ling & Keane 2024). However the native short-spined sea urchin can also have considerable ecological implications in the environment, particularly in sheltered waters such as the Derwent Estuary. At high densities, *H. erythrogramma* can overgraze algal communities, leading to reduced habitat complexity and biodiversity (Ling et al. 2010). In extreme cases, urchin barrens can form long-term as an alternative stable state for collapsed kelp ecosystems (Scheibling & Filbee-Dexter 2014; Ling et al. 2015). Our results, however, show that while this species increased in abundance, increasing its range into the upper and mid-estuary, it was not found at levels likely to cause urchin barren formation at any sites. Increased urchin abundance has been linked to fishing pressure and the reduction of urchin predators such as the *L. forsterii*. Other positive signs of recovery in the Derwent include the increase in abundance of *Haliotis rubra*, a commercially harvested native abalone, in the lower estuary.

Macroalgae:

The lower estuary continued to provide diverse algal habitats in 2024, with little significant change since 2010. Overall, the wider system maintained the expected trend of species richness declining with distance from the ocean, with algal diversity highest at the marine end of the estuary (Hardwick-Witman & Mathieson 1983; Edgar et al. 1999). One notable change, was an increase in algal cover in the mid to upper estuary sites, particularly for brown and red algae, despite the overall lack of species richness in these regions. In the upper estuarine site at Cadbury Point this was primarily due to a significant cover of unidentified filamentous red algae, while slightly further downstream there was a notable increase in the cover of the red algae *Rhodymenia* spp. Species within this genus (most notably *R. leptophylla*) became the dominant cover at a number of sites that previously lacked algal cover. As with other marine species, a range extension of macroalgae further into the estuary may be from numerous factors, including a more saline environment due to fewer floods, but also more specifically for algae, potentially increased light penetration due to improving water clarity.

In another, and likely related sign of recovery within the estuary, the cover of golden kelp *Ecklonia radiata* has significantly increased across the mid-estuary. The recovery of canopy-forming species like *E. radiata* is a critical first step in the recovery of macroalgal forests (Galobart et al. 2023), and the increased abundance observed in these surveys suggests more favourable environmental conditions within the estuary, including increased light availability at depth. The marked increase in algal cover in the mid-estuary (at sites such as Rosny Point) also appears to be a response to a marked reduction in the cover of a polychaete (tube worm)

– likely a spionid polychaete species – which formed an extensive matting on rocky reefs at many of the mid to upper estuary sites in 2010. During that survey the matting comprised almost 100% cover at transect depths (2-4/5 m) at most sites between Bedlam Walls to Battery Point, effectively trapping silty sediments and inhibiting the settlement of algal gametophytes and development of large sporophytes (Barrett et al. 2012). It was speculated at the time that this may represent an altered state that would be difficult to recover from. However, encouragingly, sites such as Rosny Point and Bellerive Bluff now show strong signs of recovery, with increased coverage of *E. radiata* and *Sargassum fallax* (to a lesser extent) and red algae including *Rhodymenia leptophylla*, *Peyssonnelia* spp., and *Rhodophyta* spp. The apparent reversal of what was once described an alternative stable state dominated by tubeworm matting suggests a shift towards a more biodiverse, healthy ecosystem, potentially driven by a reduction in sediment loading that is thought to facilitate the maintenance of the polychaete mats.

Although no major floods have occurred in recent years, boat traffic throughout the estuary remains consistent, with commercial and recreational vessels operating daily. Eriksson et al. (2004) found that boating activities – and the resulting boat-generated waves – can influence both the vegetation and macrobenthic infauna, although responses are often taxa-specific. Similarly, Bishop & Chapman (2004) observed significant changes in infauna assemblages within Sydney Harbour's wash zone during a temporary cessation of ferry traffic. During this period, assemblages began to resemble those in no-wash zones, suggesting that the wash disturbance directly affects benthic community structure. Eriksson et al. (2004) also reported a sharper decline in vegetation cover and species richness with depth in marinas or inlets exposed to ferry routes compared to those not subject to boating disturbances. In the Derwent, frequent vessel activity – including regular MONA ferry transits and other commercial traffic – may be contributing to ecological changes observed in the upper estuary, via a marked increase in shoreline wave action. Although boat-generated disturbance is often associated with negative effects like sediment resuspension (regularly observed in the 2024 surveys), in this context, it may have also facilitated the removal of sediments trapped by the tubeworm matting at various sites along the ferry route – potentially aiding habitat recovery within the estuary and contributing to increased algal cover. More detailed studies are required to better characterise the overall consequences of significant vessel wake heights in this region.

4.2 Timed intertidal and subtidal surveys

This component of the study aimed to assess temporal changes in biodiversity within the Derwent Estuary in a broader context to the fixed depth transect approach discussed above. This allowed a wider range of habitats to be searched, from intertidal shores to the full depth-range of reefs present and over adjacent sediments. While the primary focus was on describing shifts in species richness and composition over time, the timed surveys – consistent with the 2010 methodology – were also designed to maximise the detection of rare or cryptic species, and those not typically encountered on fixed depth transect surveys, such as intertidal species.

As expected, despite extensive searches conducted in both intertidal and subtidal habitats, *Marginaster littoralis,* the native endangered Derwent River seastar, was not recorded during the 2024 surveys, confirming the tentative extinction of this species as evaluated by O'hara et al. (2018). Similarly, two other endangered seastar species, *Parvulastra vivipara* (the live-bearing seastar) and *Smilasterias tasmaniae* (the Bruny Island seastar), were also absent from all surveyed sites (including the intertidal habitats). This is in line with the surveys conducted in 2010, where no individuals were recorded for any of these rare species (Barrett et al. 2012). Both *P. regularis* and *P. elongatus*, suggested to be a source of competition for *M. littoralis* in 2010, remain dominant in the estuary, with timed surveys confirming similar patterns of abundance and distribution to the standard surveys.

Five independent sightings of the endangered spotted handfish (*Brachionichthys hirsutus*) were recorded in 2024, marking an increase from the single individual observed at Bellerive Bluff in 2010. Most sightings occurred on sand and ecotone habitats at 5-8.9 m, consistent with known habitat preferences, although one individual was unexpectedly recorded on reef habitat at Battery Point in the 0-1 m depth zone. This species was detected at four additional sites compared to 2010, a promising indication of potential recovery and a reflection of the ongoing conservation efforts targeting this highly range-restricted species.

Overall, the patterns observed by the timed-swim approach were generally consistent with those observed on the fixed transect surveys, with a general increase in many species further up the estuary in response to relatively stable conditions in the years prior to the 2024 survey. These included introduced species, such as the fishes *F. varium* and *F. gymnotum* and the seastars *A. amurensis* and *P. regularis*, as well as a range of native species including fishes such as *N. balteatus*, mobile invertebrates such as urchin *H. erythrogramma* and the lobster *J. edwardsii*, and sessile invertebrates such as the native oyster *Ostrea angasi*. Some of these may be responding to the observed increases in algal cover as species, such as the urchins and the rock whiting *N. baleatus* that are herbivorous. Algal cover increased significantly in the mid to upper estuary, particularly due to a major rise in the red algae *Rhodymenia leptophylla* (described from the transect studies) which dominated sites from Bedlam Walls to Rosny Point in 2024. Previously, the extensive polychaete matting present at these sites had precluded algal cover forming.

Timed surveys conducted across multiple depth zones enabled us to assess depth-specific patterns and changes in the distribution of many species through time. While these are detailed in the tables presented as Appendices 14-19, we have simplified reporting here by only focussing on the most significant depth-related change observed (on the set of species examined by the timed-swim method). The most notable change was in the abundance of *Ecklonia radiata,* a canopy-forming kelp species, as this serves as an effective indicator of water clarity due to its dependence on light availability for growth and distribution (Miller et al. 2011; Blain et al. 2020; Janssen et al. 2024). Improved water quality allows greater light penetration at depth, which can support increased abundance and deeper distribution of kelp, like *E. radiata* (Deregibus et al. 2016; Chen et al. 2024). In 2024, the rank abundance of this species increased across multiple sites, with new observations also recorded at several locations and depth zones. At all sites where *E. radiata* was previously recorded in the 0-1 m, 1-4.9 m and 5-8.9 m depth ranges, its abundance increased in 2024. Some sites – particularly Rosny Point North, Bellerive Bluff and Tranmere Point – showed dramatic increases in coverage, potentially reflecting improved water quality in the mid and lower estuary. This expansion in kelp coverage at deeper depths, coupled with the disappearance of widespread tubeworm matting previously recorded between Bedlam Walls and Battery Point, suggests an overall positive ecological shift and signs of recovery in the estuary.

More general patterns observed from the timed swim surveys include an increasing spread of the introduced red algae *Grateoloupia turuturu* upstream from Bellerive/Howrah Bluff to Cornelian Bay, as expected for this recently introduced invasive species. The species first appeared in the vicinity of Bicheno in the mid 2000's (Prof. Gary Saunders, pers.obs.) and has since spread throughout eastern and southeastern Tasmania, as well as in the Tamar estuary. However, despite it being highly abundant in the immediate intertidal, there was no evidence of this annual species displacing native species. Likewise, the large introduced brown seaweed *Undaria pinnatifida* remained at low levels and in the outer estuary sites, although as this is an annual species that is most prevalent from mid-winter to early summer, surveys undertaken in late spring are more suited to understanding its current influence. While the European shore crab *Carcinus maenus* was a recent arrival to the Derwent Estuary at the time of the 2010 study and was anticipated to both spread more widely and increase its abundance in following years, there has been no evidence of this during the recent survey. The New Zealand porcelain crab, *Petrolisthes elongatus* remains the most abundant introduced crab in the system and was extremely abundant under almost any rocks overturned in the mid to upper estuary, as per the 2010 study. However, this is primarily an intertidal species, so the threat is mostly constrained to that habitat.

Some of the more marine species displayed significant changes through time, including a marked increase in the eleven-armed seastar *Coscinasterias muricata,* although such variability in recruitment and subsequent population growth is well documented for this species (Glockner-Fagetti & Phillips 2020). Notable new inclusions included mado sweep, *Atypichthys strigatus*, sighted at a number of locations, as well as several pink snapper, *Chrysophyrus auratus*, seen at Battery Point. Both of these are range-extending species and initial indicators of the increasing influence of coastal warming in this region, particularly over summer. While another range-extending species, the yellowtail kingfish, *Seriola lalandi,* was not sighted on surveys, it was present in large numbers at times, resulting in shore and boat fishing activities limiting access at a number of our sites during the survey. At one site, Howrah Bluff, the seabed was covered in hundreds of snagged lures, with associated fishing line attached, representing a significant marine pollution hazard and safety issue.

In response to increasing interest in re-establishing native oyster (*Ostrea angasi*) reefs throughout the historical range of this species (https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/australia/stories-in-australia/restoring-australias-lost-shellfish-reefs/), we paid particular attention to validating our field observations of this species in the Derwent and the extent that they overlap the distribution of the invasive introduced Pacific oyster (*Crassostrea gigas*, now recently re-named as *Magallana gigas*), and may be confused with on field surveys. This included sub-sampling at a range of depths and locations throughout the estuary and undertaking lab-based identification by a taxonomic expert using key diagnostic features, then further validation of these results with a molecular qPCR assay for full confidence. Typically, these identifications confirmed field-based observations of the distribution of these species. These showed both species to be distributed throughout most of the sites surveyed, with *C. gigas* dominating the intertidal, gradually transitioning to depths around 5 m or more where *O. angasi* became dominant. *O. angasi* was notably abundant on the fixed transect surveys at 5 m depth at Tranmere reef, as well as at sites such as Crayfish

Point on the timed swim surveys. However, the lab-based identification and subsequent DNA testing confirmed that these species can have significant overlap in shell morphology that can cause mis-identification in field surveys and it is recommended that future surveys do include a component of additional expert validation to validate field observations. Notably also, is that *C. gigas* can also form distinct and extensive oyster reefs, based on observation of these reefs at Cadbury Point.

5. Conclusions

This study provides a comprehensive temporal comparison of biodiversity on rocky reefs and adjacent sediments in the Derwent Estuary, highlighting both persistent threats and encouraging signs of ecological recovery.

Notably, invasive species such as *Asterias amurensis*, *Patiriella regularis* and *Petrolisthes elongatus* remain widespread, particularly in the mid-estuary, underscoring the importance of ongoing management strategies that mitigate the extent of disturbed and nutrient enriched habitats that facilitate such species. While many introduced species are found in the Derwent Estuary, there were no major changes since the previous survey in 2010, aside from than the expected increase in the recently introduced red algae *Grateoloupia turuturu,* now highly conspicuous in the immediate subtidal zone at many sites.

Despite this, some notable positive trends were observed. The key observation was a marked increase in algal species on rocky reefs in the mid to upper estuary, with the red algae *Rhodymenia leptophylla* dominating reefs seaward of Dowsings Point to Rosny Point, and increasing cover of the golden kelp, *Ecklonia radiata* from Rosny Point seaward. This included increasing depth distribution of *E. radiata* on mid-estuary reefs and a massive decline in a tough polychaete matting that had previously covered these same sites, likely excluding algal settlement and growth. It is likely that the loss of this matting and increased light penetration (allowing algae to grow deeper) is the result of declining silt and organic enrichment in the estuary over this time, as the polychaete matting is a common indicator of highly organically enriched estuaries (Quiroga et al. 1999).

These changes in algal cover are likely to have ongoing influences on fish and mobile invertebrate species that are supported by the algal production, allowing species such as sea urchins to increase at these sites.

A range of species appear to have increased their abundance and upstream distribution, including the introduced fish species *F. gymnotum* and *F. varium,* and seastars *A. amurensis* and *P. regularis*, however, it is anticipated that this is likely due to a prolonged period of low major flood activity prior to the 2024 surveys. During major floods, much of the upper and mid estuary is inundated with freshwater that is toxic to most marine species, sharply limiting their upstream distribution in subsequent months to years.

While many other species changed in abundance and distribution as may be expected in a dynamic estuarine environment, the most significant change was in the abundance of the fish, the bastard trumpeter, *Latridopsis forsteri*. This species, found in resident schools on a number of reefs in 2010 underwent a major (more than tenfold) decline by 2024, one not observed in other surveys at Tinderbox marine reserve where they are protected. It is likely that much of this decline is in response to a major increase in recreational spearfishing in the Derwent Estuary over this period as fishing practices evolve.

Together, these findings reinforce the importance of long-term ecological monitoring in dynamic systems like the Derwent and provide essential data for continued conservation and management of this ecologically and economically important estuary. They document natural and anthropogenic changes, and responses to human pressures and associated management responses, hopefully underpinning similar future surveys in the future.

6. Acknowledgements

We would like to acknowledge Graham Edgar and Elizabeth Oh, Carolina Zagal, Dane Jones and Amelia Fowles for contribution to the initial baseline survey in 2010, with support funding from an ARC-Linkage grant and a Caring for our Country Grant to the Derwent Estuary Program. For the 2024 survey and reporting, we would like to thank the Derwent Estuary Program for inception and funding (Ursula Taylor and Akira Weller-Wong). WE would also like to thank Hunter Forbes, German Soeler, Jillian Fitzpatrick, Olivia Stowell, Lotus Blossom-Dumpleton, Lara Denis-Roy, Dan Haley and Marianne Pelletier for their assistance with fieldwork and data collection. Finally, Adam Davey and Alex Coutts for expert taxonomic identification of oysters followed by DNA-based validation.

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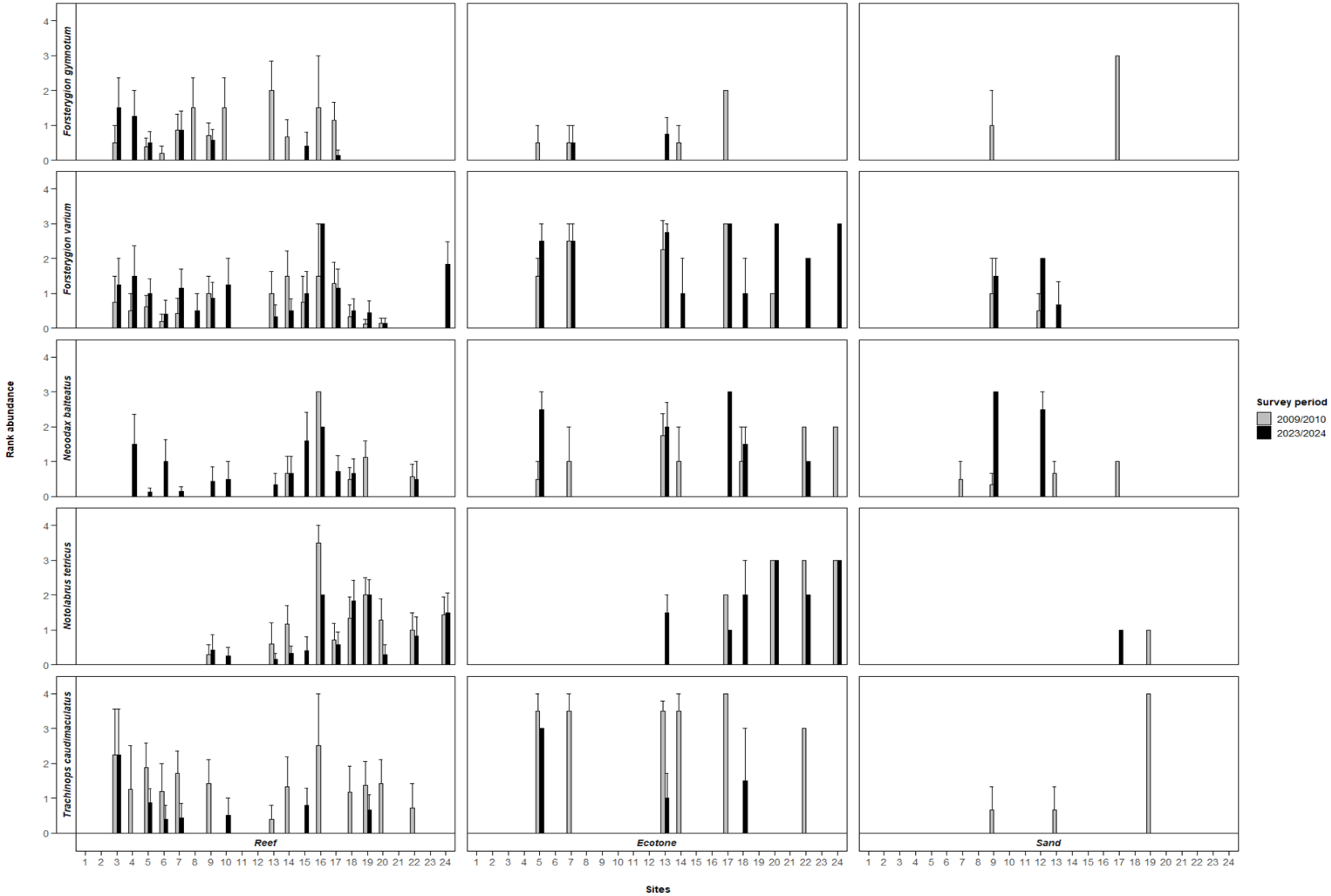
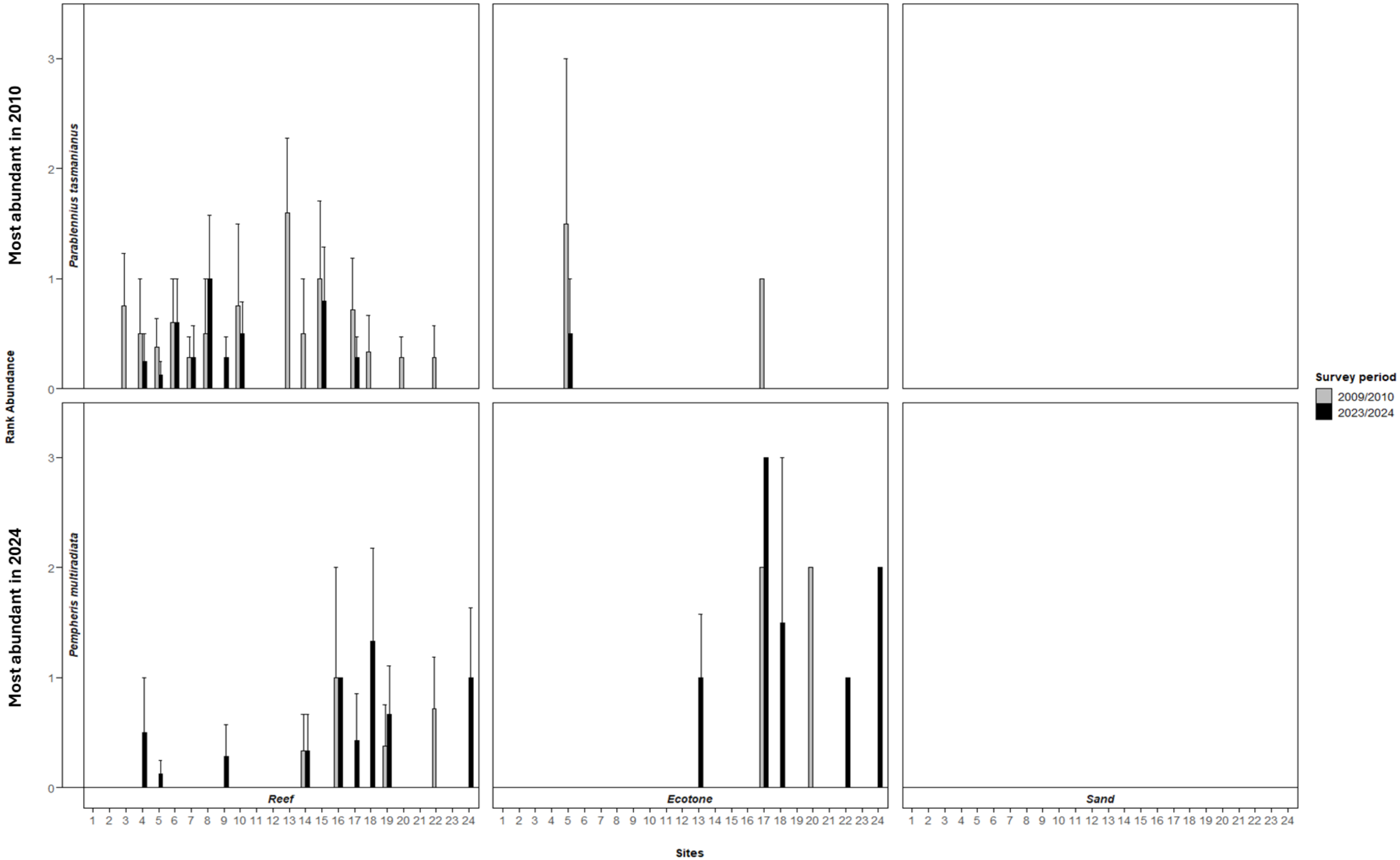
8. Appendix

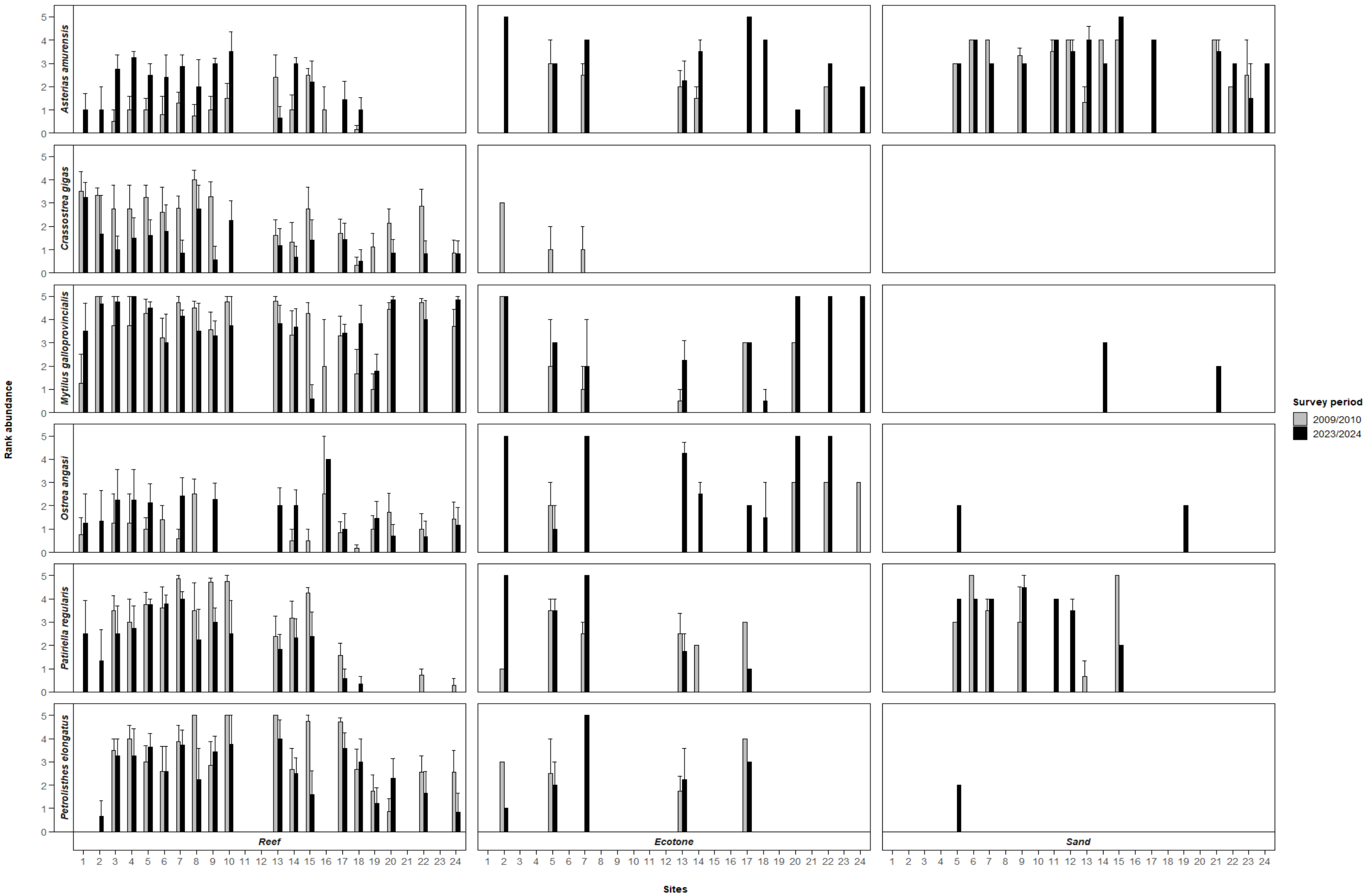
Appendix 1: Habitat-specific rank abundance (mean ± SE) of the most abundant fish species in Derwent in 2010 (grey) and 2024 (black). The five species shown were among the top 6 most abundant in both survey periods, and are presented alphabetically.



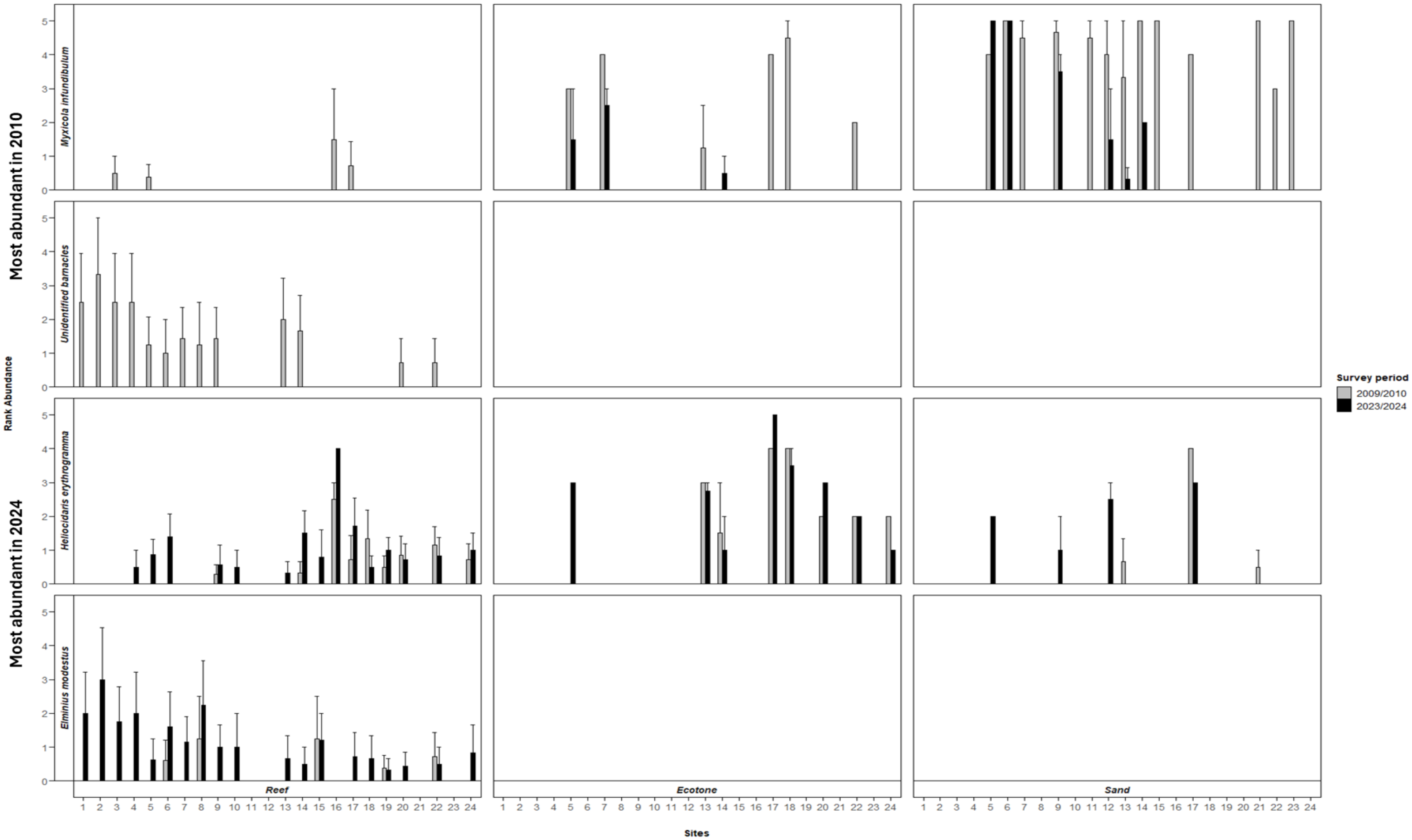
Appendix 2: Habitat-specific rank abundance (mean ± SE) of fish species uniquely among the top 6 most abundant in 2010 and 2024 in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill.



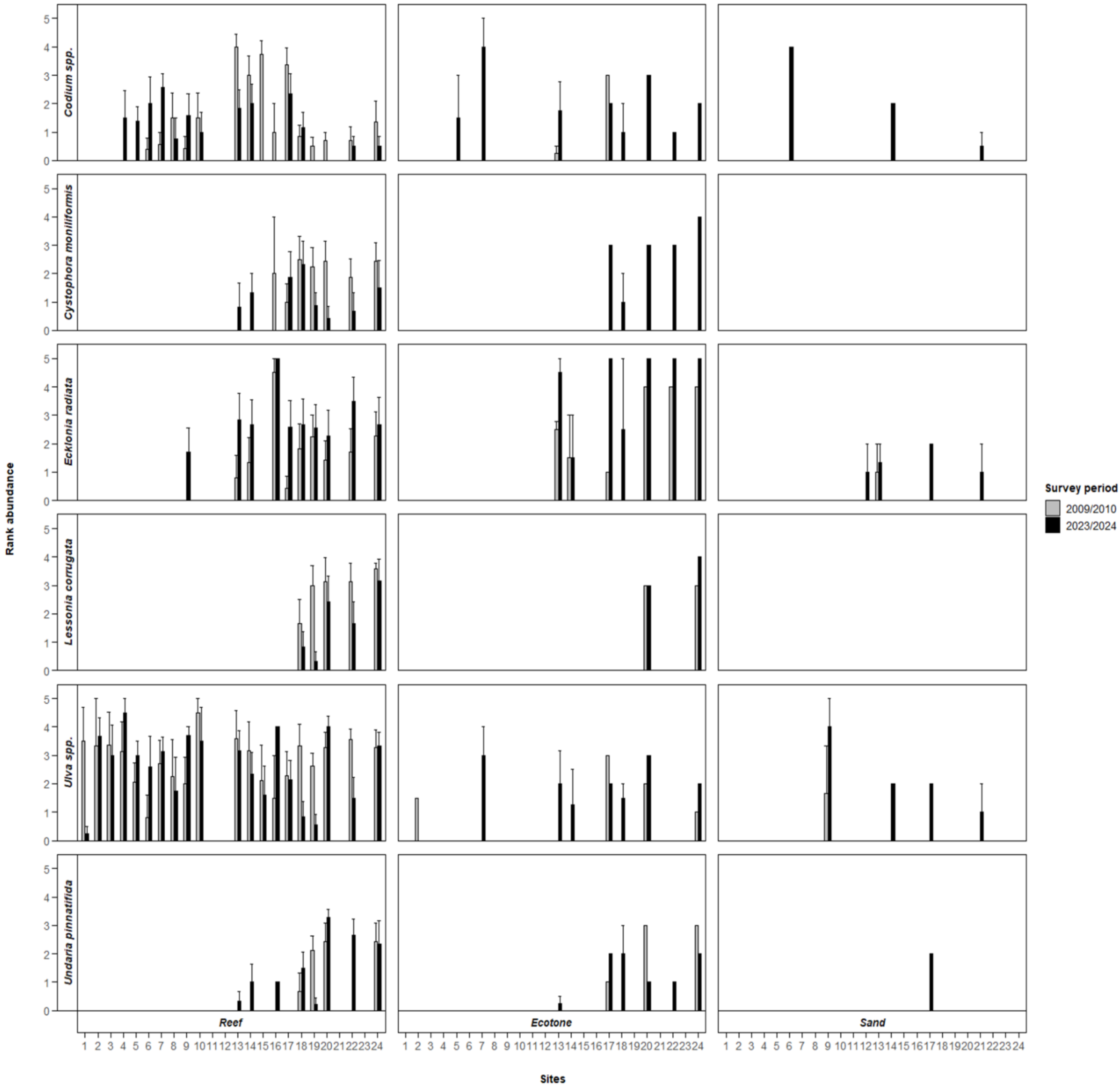
Appendix 3: Habitat-specific rank abundance (mean ± SE) of the most abundant invertebrate species in Derwent in 2010 (grey) and 2024 (black). The six species shown were among the top 8 most abundant in both survey periods, and are presented alphabetically.



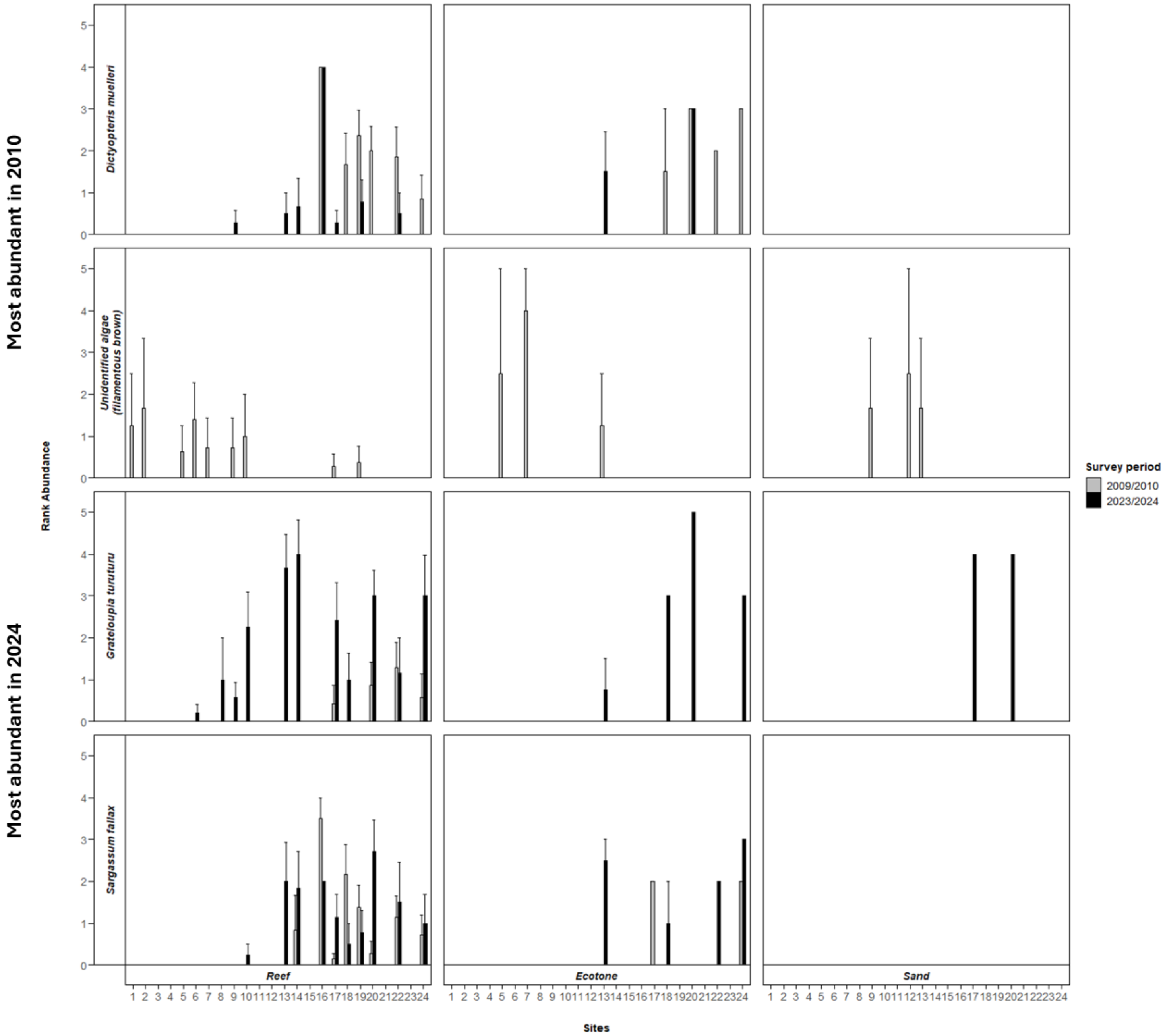
Appendix 4: Habitat-specific rank abundance (mean ± SE) of invertebrate species uniquely among the top 8 most abundant in 2010 and 2024 in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill.



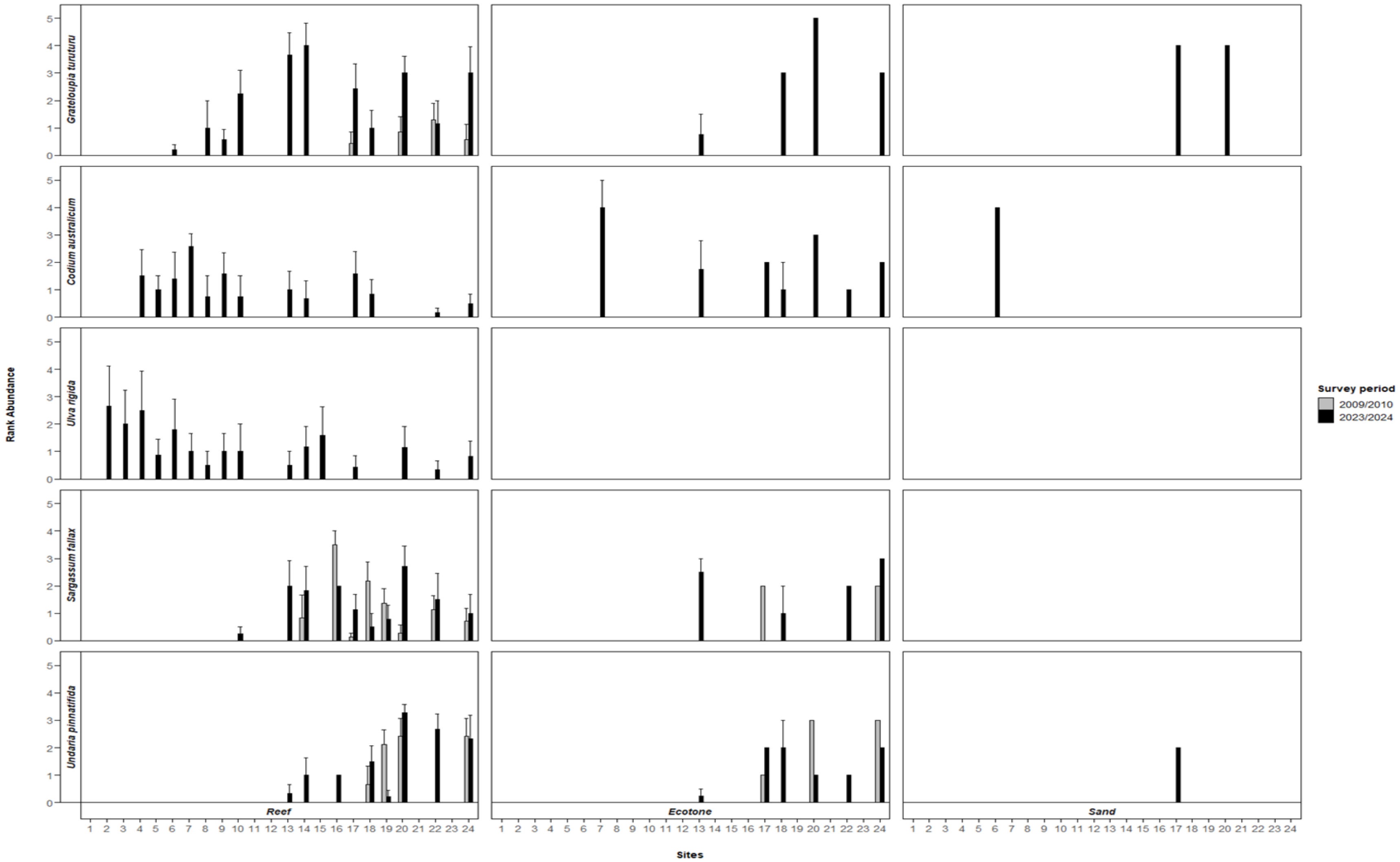
Appendix 5: Habitat-specific rank abundance (mean ± SE) of the most abundant algal species in Derwent in 2010 (grey) and 2024 (black). The three species shown were among the top 8 most abundant in both survey periods, and are presented alphabetically.



Appendix 6: Habitat-specific rank abundance (mean ± SE) of algal species uniquely among the top 8 most abundant in 2010 and 2024 in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill.



Appendix 7: Habitat-specific rank abundance (mean ± SE) of algal species uniquely among the top 8 most abundant in 2024 in the Derwent. While each species peaked in abundance during one period, changes across both survey periods are indicated by grey (2010) and black (2024) fill.



Appendix 8: Total fish abundances recorded during standard surveys in February-April 2010, * = introduced species.

METHOD 1, 2009/2010	**Sites**	1	3	4	5	6	7	9	13	14	15	17	18	19	20	22	24	25	26	27	Total
	Number of transects	2	2	2	2	2	2	2	2	2	2	4	2	4	4	4	4	4	4	4	
Species	**Common name/Depth**	1	4	4	3	2	2	4	4	5	2	3	4	4	5	4	5	5	5	5	
Acanthaluteres spilomelanurus	Bridled leatherjacket	5										2				18					25
Acanthaluteres vittiger	Toothbrush leatherjacket								9	26				2	3	138		2	1	9	190
Aplodactylus arctidens	Marblefish											1			1		3	1		3	9
Aracana aurita	Shaws cowfish												1		2	1	3	1	3	1	12
Arenigobius bifrenatus	Bridled goby	5																			5
Arripis spp.	Australian salmon												15								15
Blenniid spp.	Blenny											1									1
Cephaloscyllium laticeps	Draughtboard shark													2	2			5		1	10
Chirodactylus spectabilis	Banded morwong																			6	6
Cristiceps australis	Crested weedfish											6									6
Dinolestes lewini	Long-fin pike													502		61	171		7	1	742
Diodon nicthemerus	Globe fish											3	3		1	1	1	1			10
Dotalabrus aurantiacus	Castelnaus wrasse												2	12	1	1		2	8	12	38
Eubalichthys gunnii	Gunn's leatherjacket																		1		1
Favonigobius lateralis	Long-finned goby	40	29	13																	82
Forsterygion gymnotum	Estuarine threefin*		35		2		3	2	1												43
Forsterygion varium	Many-rayed threefin*		18	12	55		10	12	52	18	21	172					2				372
Girella zebra	Zebra fish											1									1
Gobiid spp.	Unidentified goby			1			5														6
Hippocampus abdominalis	Bigbelly seahorse	5	1								1										7
Hippocampus spp.	Seahorse					1															1
Latridopsis forsteri	Bastard trumpeter									1			386		13	130	232	5	3	114	884
Meuschenia australis	Brown-striped leatherjacket												2		6	1		2		2	13
Meuschenia freycineti	Six-spine leatherjacket												2		1						3
Myliobatis australis	Eagle ray												1								1
Neoodax balteatus	Little rock whiting			1			2		2	10	3	17	4	11		24	2	1	3	2	82
Neosebastes scorpaenoides	Common gurnard perch				1												1				2
Nesogobius hinsbyi	Hinsbys goby						2														2
Notolabrus fucicola	Purple wrasse											2	11	1	7	13	2	4	8	19	67
Notolabrus tetricus	Blue-throat wrasse			1					3	6		23	43	126	109	40	77	107	76	57	668
Olisthops cyanomelas	Herring cale													1	15						16
Parablennius tasmanianus	Tasmanian blenny		6	8	2						3										19
Pempheris multiradiata	Common bullseye											9					76		35	1	121
Pentaceropsis recurvirostris	Long-snouted boarfish													1						3	4
Phyllopteryx taeniolatus	Weedy seadragon															1	4				5
Pictilabrus laticlavius	Senator wrasse												5	39	18		7	10	28	8	115
Platycephalid spp.	Flathead					1															1
Pseudocaranx dentex	White trevally																20				20
Pseudocaranx georgianus	Silver trevally												85								85
Pseudogoniistius nigripes	Magpie perch																		1		1
Pseudolabrus rubicundus	Rosy wrasse													1							1
Pseudophycis bachus	Red cod														1		1			2	4
Pseudophycis barbata	Bearded cod										1		1	1	1						4
Siphonognathus beddomei	Pencil weed whiting																	1			1
Spiniraja whitleyi	Melbourne skate																			1	1
Syngnathid spp.	Unidentified pipefish										1										1
Trachinops caudimaculatus	Hulafish		2638	3345	1490	106	145	228	107	98	233	1720	73	602	700	35	62	25	10	798	12415
Trachurus declivis	Jack mackerel									20							20				40
Urolophus cruciatus	Banded stingaree					1		2	2		1										6
Vincentia conspersa	Southern cardinalfish														1						1
Species richness (total species per site)		**4**	**6**	**7**	**5**	**4**	**6**	**4**	**7**	**7**	**8**	**12**	**15**	**13**	**17**	**13**	**17**	**14**	**13**	**18**	
Total species richnes											**50**										

Appendix 9: Total fish abundances recorded during standard surveys in 2023-2024, * = introduced species.

METHOD 1, 2023/2024	**Sites**	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**22**	**24**	**25**	**26**	**27**	**Total**
	Number of transects	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	
Species	**Common name / Depth**	**1**	**4**	**4**	**3**	**2**	**2**	**2**	**4**	**4**	**2**	**3**	**4**	**3**	**5**	**4**	**4**	**5**	**5**	**5**	
Acanthaluteres spilomelanurus	Bridled leatherjacket								8	40						10					**58**
Acanthaluteres vittiger	Toothbrush leatherjacket			1		3				1								1		2	**8**
Aplodactylus arctidens	Marblefish																3	1	5	1	**10**
Aracana aurita	Shaws cowfish																1		1		**2**
Atypichthys strigatus	Bridled goby											20		3			12	26			**61**
Cephaloscyllium laticeps	Draughtboard shark													1	1				1	1	**4**
Chirodactylus spectabilis	Banded morwong														1	1	6				**8**
Cristiceps australis	Crested weedfish													1							**1**
Dinolestes lewini	Long-fin pike															2			39	70	**111**
Diodon nicthemerus	Globe fish				2				2				1				2	1		1	**9**
Dotalabrus aurantiacus	Castelnaus wrasse												3	2	2	1		2	1	1	**12**
Enoplosus armatus	Old wife																			2	**2**
Eocallionymus papilio	Painted stinkfish											1									**1**
Forsterygion gymnotum	Estuarine threefin*		3	9	7		14	6													**39**
Forsterygion varium	Many-rayed threefin*		6	39	11	2	30	4	11	7	42	9		6	6		31	2	1		**207**
Haletta semifasciata	Blue weed whiting													1							**1**
Heteroclinus johnstoni	Johnston's weedfish										1										**1**
Heteroclinus tristis	Sharp-nose weedfish																		1		**1**
Latridopsis forsteri	Bastard trumpeter												3				22	2	17	19	**63**
Lotella rhacina	Rock cod																		2		**2**
Nemadactylus macropterus	Jackass morwong																		1		**1**
Neoodax balteatus	Little rock whiting	1		55		14	1	5	30	15	30	15	3	4	1	9	3	2		4	**192**
Nesogobius hinsbyi	Hinsbys goby	10																			**10**
Nesogobius maccullochi	Girdled goby	1				3															**4**
Notolabrus fucicola	Purple wrasse										2				1	3	5	3	27	5	**46**
Notolabrus tetricus	Blue-throat wrasse			2				45	1	1	3	14	19	16	26	27	28	79	120	19	**400**
Olisthops cyanomelas	Herring cale																	2		2	**4**
Parablennius tasmanianus	Tasmanian blenny				1	2	2				2										**7**
Pempheris multiradiata	Common bullseye			2				20	6	7		6			100			15	67	4	**227**
Pentaceropsis recurvirostris	Long-snouted boarfish																			1	**1**
Pictilabrus laticlavius	Senator wrasse								3	1		1	7	17	8		1	17	22	4	**81**
Pseudogoniistius nigripes	Magpie perch																		1	1	**2**
Pseudolabrus rubicundus	Rosy wrasse																	1			**1**
Pseudophycis bachus	Red cod			1																	**1**
Scorpis aequipinnis	Sea sweep															1					**1**
Scorpis lineolata	Silver sweep												2				5	1	38	4	**50**
Siphonognathus beddomei	Pencil weed whiting					2			2				1			9	1	13		4	**32**
Trachinops caudimaculatus	Hulafish		830	709	28	6	6	1			9			54	3	6	10	155	1	684	**2502**
Trinorfolkia clarkei	Clark's threefin						1				3										**4**
Urolophus cruciatus	Banded stingaree									2											**2**
Species richness (total species per site)		**3**	**3**	**8**	**5**	**7**	**6**	**6**	**8**	**8**	**8**	**7**	**8**	**10**	**10**	**10**	**14**	**17**	**17**	**19**	
Total species richness										**40**											

Appendix 10: Invertebrate and cryptic fish abundances recorded during standard surveys in February-April 2010, * = introduced species.

METHOD 2, Inverts/Cryptic Fish	**2009/2010**	**Site**	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**22**	**24**	**25**	**26**	**27**	**Total**
		Number of transects	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	
Groupings	**Species**	**Common name / Depth**	**1**	**4**	**4**	**3**	**2**	**2**	**4**	**4**	**5**	**2**	**3**	**4**	**4**	**5**	**4**	**5**	**5**	**5**	**5**	
Crypitc fish	*Blenniid spp.*	Blenny											2									**2**
	Bovichtus angustifrons	Dragonet															1					**1**
	Cephaloscyllium laticeps	Draughtboard shark									1										2	**3**
	Forsterygion gymnotum	Estuarine threefin*							9	1												**10**
	Forsterygion varium	Many-rayed threefin*				46		27	8	34	14	12	71	1				8				**221**
	Gobiid spp.	Unidentified goby	9	11	5				4	22	5											**56**
	Heteroclinus johnstoni	Johnstons weedfish		1										1	1							**3**
	Hippocampus abdominalis	Bigbelly seahorse	1	1			1			1	1											**5**
	Nesogobius hinsbyi	Hinsbys goby						20					1									**21**
	Nesogobius maccullochi	Girdled goby				1		3					2									**6**
	Parablennius tasmanianus	Tasmanian blenny						2	3	1		1										**7**
	Pempheris multiradiata	Common bullseye								2	1							32			17	**52**
	Phyllopteryx taeniolatus	Weedy seadragon																1				**1**
	Scorpaena papillosa	Southern rock cod							1	3	2		1	2	2	6	2	16	4		2	**41**
	Trinorfolkia clarkei	Clark's threefin						2	5	6				2	4	2	1	1	4			**27**
	Urolophus cruciatus	Banded stingaree																			1	**1**
Crustaceans	*Carcinus maenas*	Green crab*				3						3	8									**14**
	Decapoda spp.	Unidentified hermit crab									3			1		1	3	1	2			**11**
	Halicarcinus ovatus	Three-pronged flat spider crab											1									**1**
	Jasus edwardsii	Southern rock lobster													20	1		3	6	8	28	**66**
	Malacostraca spp.	Unidentified shrimp	5																			**5**
	Metacarcinus novaezelandiae	Piecrust crab*		3	2	2				1												**8**
	Nectocarcinus tuberculosus	Velvet crab															1					**1**
	Pagurid spp.	Hermit crab																	1			**1**
	Paragrapsus laevis	Shore crab				1																**1**
	Petrolisthes elongatus	New Zealand porcelain crab*			13		1	17			1											**32**
	Plagusia chabrus	Red bait crab														2	1	10	1	10	4	**28**
	Strigopagurus strigimanus	Stridulating hermit crab																		1		**1**
Cnidaria	*Phlyctenactis tuberculosa*	Swimming anemone																		31		**31**
Echinoderms	*Amblypneustes ovum*	Short-spined urchin												48			43					**91**
	Asterias amurensis	Northern Pacific seastar*		16	10	9	2	5	9	5	2	26										**84**
	Australostichopus mollis	Sea cucumber										1				1	1	1	2			**6**
	Cenolia trichoptera	Feather star													25	8		24	27	90	450	**624**
	Comanthus tasmaniae	Tasmanian feather star													2				7	5		**14**
	Coscinasterias muricata	Eleven-armed seastar								1			3	1			1	5	2			**13**
	Goniocidaris impressa	Pencil urchin																	2			**2**
	Goniocidaris spp.	Unidentified urchin																	4			**4**
	Goniocidaris tubaria	Thorny sea urchin									1											**1**
	Heliocidaris erythrogramma	Purple urchin								105	20	42	163	100	11	49	17	23	191	153	95	**969**
	Meridiastra calcar	Eight-armed seastar										1		1		253		220	14			**489**
	Nectria ocellata	Ocellate seastar																		1		**1**
	Patiriella regularis	New Zealand common cushion star*		232	80	19	173	244	507	124	97	372	3					2				**1853**
	Petricia vernicina	Velvet seastar															1		1	1	5	**8**
	Tosia australis	Southern biscuit star												8			1		1	1		**11**
	Tosia magnifica	Magnificent biscuit star								1	1		3					1	2			**8**
	Uniophora granifera	Granular seastar																2	1			**3**
Molluscs	*Agnewia tritoniformis*	Murex snail														3	2	1				**6**
	Argobuccinum pustulosum	Pustular triton															2	1				**3**
	Austrocochlea spp.	Top snail														3		3				**6**
	Cabestana spengleri	Spengler's trumpet									1		2			22		14	28			**67**
	Cabestana spp.	Predatory whelks														14	2					**16**
	Cabestana tabulata	Shouldered triton																3				**3**
	Cominella lineolata	Lined whelk														7		2				**9**
	Dicathais orbita	White rock shell															2		7	2	1	**12**
	Haliotis rubra	Blacklip abalone												1		3		1	7	17	5	**34**
	Lunella undulata	Common warrener													1	40	7	7	17			**72**
	Maoricolpus roseus	New Zealand screwshell									60											**60**
	Pleuroploca australasia	Tulip shell									1					1						**2**
	Scutus antipodes	Elephant snail															2			1		**3**
	Species richness (total species per site)		**3**	**6**	**5**	**7**	**4**	**8**	**8**	**14**	**16**	**8**	**12**	**11**	**8**	**17**	**18**	**24**	**22**	**13**	**11**	
	Total species richness											59										

Appendix 11: Invertebrate and cryptic fish abundances recorded during standard surveys in 2023-2024, * = introduced species.

METHOD 2, Inverts/Cryptic Fish	2023/2024	Site	1	3	4	5	6	7	9	13	14	15	17	18	19	20	22	24	25	26	27	Total
		Number of transects	2	2	2	2	2	2	2	2	2	2	4	2	4	4	4	4	4	4	4	
Groupings	Species	Common name / Depth	1	4	4	3	2	2	2	4	4	2	3	4	3	5	4	4	5	5	5	
Cryptic fish	*Bovichtus angustifrons*	Dragonet														1		1		1		3
	Cephaloscyllium laticeps	Draughtboard shark																		1	2	3
	Conger verreauxi	Southern conger																			1	1
	Cristiceps australis	Crested weedfish								1												1
	Diodon nicthemerus	Globefish						1		1									1			3
	Eocallionymus papilio	Painted stinkfish				1	1															2
	Forsterygion gymnotum	Estuarine threefin*		9	15	20		39	9	1		6	12	7								118
	Forsterygion varium	Many-rayed threefin*		23	130	34	2	72	26	70	74	20	40		6	38		233	18	3	8	797
	Heteroclinus johnstoni	Johnstons weedfish												2								2
	Heteroclinus tristis	Longnose weedfish					1					1										2
	Hippocampus abdominalis	Bigbelly seahorse										1										1
	Neosebastes scorpaenoides	Common gurnard perch																	1			1
	Nesogobius hinsbyi	Hinsbys goby	7	1	1	8	5	1		1												24
	Nesogobius maccullochi	Girdled goby		4																		4
	Parablennius tasmanianus	Tasmanian blenny		2	1	5		2	1													11
	Pempheris multiradiata	Common bullseye			1	1			20	14	35			55				1		39	74	240
	Pseudaphritis urvillii	Freshwater flathead			1																	1
	Pseudophycis bachus	Rod cod									1											1
	Scorpaena papillosa	Southern rock cod									1		1			2				1	7	12
	Trachichthys australis	Southern roughy									13											13
	Trinorfolkia clarkei	Clark's threefin		3	1			5	1		1	6	3	3	1	1		1		1	5	32
	Vincentia conspersa	Southern cardinalfish		1	12	3					1										2	19
Crustaceans	*Carcinus maenas*	Green crab*					1															1
	Halicarcinus rostratus	Beaked flat spider crab		2			1															3
	Jasus edwardsii	Southern rock lobster								16	24				11	2	5	14		54	42	168
	Metacarcinus novaezelandiae	Piecrust crab*					6															6
	Nectocarcinus integrifrons	Rough rock crab					1															1
	Pagurixus handrecki	Handrecks hermit crab										3	8									11
	Petrolisthes elongatus	New Zealand porcelain crab*			5	2																7
	Plagusia chabrus	Red bait crab															1	7		1	2	11
	Strigopagurus strigimanus	Stridulating hermit crab																1				1
Cnidarians	*Phlyctenactis tuberculosa*	Swimming anemone																		1		1
Echinoderms	*Asterias amurensis*	Northern Pacific seastar*		97	117	130	267	200	429	5	95	116	464	19				3				1942
	Astrostole scabra	Seven-armed starfish																2		1		3
	Australostichopus mollis	Sea cucumber										1	1	5				1				8
	Cenolia trichoptera	Feather star								3	1				30	17	1	35	35		735	857
	Comanthus tasmaniae	Tasmanian feather star													1				1	2	6	10
	Coscinasterias muricata	Eleven-armed seastar								1	1			19		32		39	5			97
	Goniocidaris tubaria	Thorny sea urchin																	3			3
	Heliocidaris erythrogramma	Purple urchin			2	2	101		49	81	128	275	386	93	21	46	8	10	51	2	6	1261
	Holopneustes inflatus	Seagrass sea urchin							2													2
	Meridiastra calcar	Eight-armed seastar														208		220	53			481
	Neothyonidium spp.	Unidentified sea cucumber																	89			89
	Patiriella regularis	New Zealand common cushion star*	667	859	408	495	629	1084	797		429	471	30					1				5870
	Tosia magnifica	Magnificent biscuit star								2		1	1	1				1				6
	Uniophora granifera	Granular seastar																	1			1
Molluscs	*Argobuccinum pustulosum*	Pustular triton											1					1				2
	Cabestana spengleri	Spengler's trumpet														8	1	2	1			12
	Charonia lampas	Pink lady																		1		1
	Dicathais orbita	White rock shell														3						3
	Fusinus novaehollandiae	New holland spindle											4									4
	Haliotis rubra	Blacklip abalone												1	15	18	1	11	16	5		67
	Lunella undulata	Common warrener												124	151							275
	Maoricolpus roseus	New Zealand screwshell									1											1
	Penion mandarinus	Mandarin penion									1		3						1			5
	Pleuroploca australasia	Tulip shell									1		1									2
	Polycera capensis	Crowned nudibranch		2	8				1		1		7		2	1		2	2			26
	Ranella australasia	Australian rock whelk												2		26		11		1		40
	Scutus antipodes	Elephant snail									3					3						6
	Species richness (total species per site)		2	11	13	11	11	8	10	12	18	11	15	12	9	15	6	21	15	15	12	
	Total species richness											59										

Appendix 12: Average algal percentage covers per site, recorded during standard surveys in February-April 2010, * = introduced species.

METHOD 3, 2009/2010	Site	1	3	4	5	6	7	9	13	14	15	17	18	19	20	22	24	25	26	27	Total
	Number of transects	2	2	2	2	2	2	2	2	2	2	4	2	4	4	4	4	4	4	4	
Groupings	**Species / Depth**	1	4	4	3	2	2	4	4	5	2	3	4	4	5	4	5	5	5	5	
Brown algae	*Acrocarpia paniculata*	0	0	0	0	0	0	0	0	0	0	0	25.4	22.7	2.8	4.1	2.3	0.5	6.9	7.5	**72.2**
	Carpoglossum confluens	0	0	0	0	0	0	0	0	0	0	0	0	11.9	7.3	48.5	13.4	21	7.7	20.2	**130**
	Caulocystis cephalornithos	0	0	0	0	0	0	0	0	0	0	1.5	2	0	0	0	0	0	0	0	**3.5**
	Caulocystis uvifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	**0.3**
	Cladostephus spongiosus	0	0	0	0	0	0	0	0	0	0	0.5	2.8	4.5	0.9	0.3	2.7	0	0	0	**11.7**
	Cystophora moniliformis	0	0	0	0	0	0	0	0	0	0	0	0.6	2.2	0	0.6	3.5	0	0	0	**6.9**
	Dictyopteris muelleri	0	0	0	0	0	0	0	0	0	0	0	2	3.6	11.3	0	6.4	0	0	0	**23.3**
	Dictyota dichotoma	0	0	0	0	0	0	0	0	1.2	0	0.4	0	0	0	4.3	0	0	0	0	**5.9**
	Ecklonia radiata	0	0	0	0	0	0	0	9.2	5.4	0	0	28.2	18.8	2	32	24.6	40.6	23.5	73.6	**257.9**
	Halopteris paniculata	0	0	0	0	0	0	0	1.2	0	0	0	0	0	0.1	0	0	0	0	0	**1.3**
	Lessonia corrugata	0	0	0	0	0	0	0	0	0	0	0	0	17.3	43.7	0	21	0.9	14.1	0.4	**97.4**
	Macrocystis pyrifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10.9	0.8	1.4	**15.1**
	Perithalia caudata	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0	0	0	0	0	0	**1.2**
	Phaeophyceae spp.	0	0	0	0	0	0	0	1	0	0	0	0	0	2.5	0	0	0	0	0	**3.5**
	Sargassum fallax	0	0	0	0	0	0	0	0	10.2	0	0	10	3.7	6.4	0.9	1.6	5.3	1.9	1.2	**41.2**
	Sargassum spp.	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	**0.2**
	Sargassum verruculosum	0	0	0	0	0	0	0	0	0	0	0	0	1.6	3.2	0	0	0.5	0.2	0	**5.5**
	Sporochnus comosus	0	0	0	0	0	0	0	0	3.2	0	7.9	0	0	1	0	0	0	0	0	**12.1**
	Undaria pinnatifida	0	0	0	0	0	0	0	0	0	0	0	3.6	1.9	1.8	0	0	0.2	0	0	**7.5**
	Xiphophora gladiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	**0.3**
	Zonaria spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0.2	0	0	**1**
Red algae	*Aeodes nitidissima*	0	0	0	0	0	10.6	1.2	2.8	0.2	0	0	0	0	0	0	0	0	0	0	**14.8**
	Areschougia spp.	0	0	0	0	0	0	0	0	0	0	0	0	1.8	0	0	0	0	0	0	**1.8**
	Ballia callitricha	0	0	0	0	0	0	0	0	1	0	0	0	2	0.9	0	1.8	0.8	0	2.6	**9.1**
	Callophyllis rangiferina	0	0	0	0	0	0	0	0	0	0	0	0	7.7	3.1	2.4	5.3	1.9	6.7	0.8	**27.9**
	Ceramium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1.6	0	**2.6**
	Champia viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0.4	**1.1**
	Corallinales spp.	0	0	0	0	0	0	0	0	0	0	0	0.6	11.3	12.7	10.1	6.7	26.9	6.3	13.8	**88.4**
	Delisea pulchra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0	**1.4**
	Echinothamnion hystrix	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0.8	0	0	0	**1.5**
	Euptilota articulata	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0.1	3.1	0.4	0	**8.9**
	Gelidium pusillum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.5	1	0	0	**4.5**
	Gigartina muelleriana	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0	**0.6**
	Gracilaria ramulosa	14.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**14.6**
	Grateloupia turuturu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	**0.2**
	Halymenia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	**0.3**
	Hemineura frondosa	0	0	0	0	0	0	0	0	0	0	0	0.4	2.3	1.4	1	6.8	1.2	9.1	0	**22.2**
	Hypnea spp.	0	0	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0	0	0	0	**3.6**
	Laurencia spp.	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0.7	0	**1.1**
	Lenormandia marginata	0	0	0	0	0	0	0	0	0	0	0	0	2.9	0.6	3.4	0	3.4	10.3	9.6	**30.2**
	Mastophoropsis canaliculata	0	0	0	0	0	0	0	0	0	0	0	0	0	2.6	0	0	0	0	0	**2.6**
	Peyssonnelia novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.5	**0.9**
	Peyssonnelia spp.	0	0	0	0	0	0	0	13	13	0	63.8	44.4	21.1	16.3	49.6	13.9	23.7	8.2	9.1	**276.1**
	Phacelocarpus alatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.9	1.6	**3.5**
	Phacelocarpus peperocarpos	0	0	0	0	0	0	0	0	0	0	0	0	4.6	0.2	0	0	5.1	15.6	0.9	**26.4**
	Plocamium angustum	0	0	0	0	0	0	0	0	0	0	0	1.8	25.8	4.8	0	3.6	2.5	5.2	2.6	**46.3**
	Plocamium cartilagineum	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	**0.2**
	Plocamium dilatatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	2.6	6.5	**10.7**
	Pollexfenia lobata	0	0	0	0	0	0	0	0	0	0	0	5.4	9.9	14.8	7.7	7.3	1.5	0.7	0	**47.3**
	Polyopes constrictus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	**2**
	Pterocladiella capillacea	0	0	0	0	0	0	0	0	0	0	0	0.6	0.5	3.9	0	0	0	0	0	**5**
	Ptilonia australasica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.9	**1.2**
	Rhodophyta spp.	24.6	1.6	17.6	2.4	0	0.6	8.6	3.2	0	6.8	0.4	0.4	0	2.7	0.6	14.1	16.3	3.6	2.4	**105.9**
	Rhodymenia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	3.5	0	0	0	0.4	6	**9.9**
	Sonderophycus coriaceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	**0.9**
	Stenogramma interruptum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	2.4	**2.9**
	Thamnoclonium dichotomum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	**0.5**
	Tsengia feredayae	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0.3	0.3	0	0	0	**1**

Appendix 12 cont: Average algal percentage covers per site, recorded during standard surveys in February-April 2010, * = introduced species.

METHOD 3, 2009/2010	**Site**	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**22**	**24**	**25**	**26**	**27**	**Total**
	Number of transects	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	
Groupings	**Species / Depth**	**1**	**4**	**4**	**3**	**2**	**2**	**4**	**4**	**5**	**2**	**3**	**4**	**4**	**5**	**4**	**5**	**5**	**5**	**5**	
Green algae	*Bryopsis spp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	**0.2**
	Caulerpa geminata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.5	**1.5**
	Caulerpa longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0	**0.6**
	Caulerpa simpliciuscula	0	0	0	0	0	0	0	0	0	0	0	0	5.6	0.8	0	0.3	0	1	0.2	**7.9**
	Caulerpa trifaria	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0	0	0.7	0	2.6	4.3	**8.8**
	Chlorophyta spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	**0.4**
	Codium spp.	0	0	0	0	0	0	0.6	1.6	0.2	7.4	1.3	0	0	0	0	0	0	0	0	**11.1**
	Ulva spp.	0.6	0	0	0	0	0	0	0	1.6	0	0	3.2	0	1.8	0.5	0	0.4	0	0	**8.1**
Algae	*Algae spp.*	37.8	0	0	0	0	0	0	0	4.4	0	6.9	33	9.6	12.7	15.4	6.8	9.5	0	1	**137.1**
Sessile Invertebrates	*Animalia spp.*	0	85.8	84.2	83.6	92.6	66	71.8	58.2	0	72.6	0	0	0	0	0	1.6	0	1	3	**620.4**
	Anthozoa spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0.5	0.4	0	0	**1.8**
	Ascidiacea spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	**0.9**
	Bryozoa spp.	0	0	0	0	0	0	0	0.8	0	0	0	0	0.4	0	0	0	0	1.1	5	**7.3**
	Corynactis australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	**0.4**
	Crassostrea gigas	2.4	1.4	0.8	0	0	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**
	Culicia tenella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.5	**1**
	Erythropodium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	**4**
	Galeolaria spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	**0.2**
	Herdmania grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	**0.6**
	Hydroida spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	**0.2**
	Mytilus galloprovincialis	0.6	0	0	0	0	0	0	0	0	0	0	0	0	2.2	4	0	0	0	0	**6.8**
	Ostrea angasi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	12.6	1.5	0	0	0	**14.5**
	Oulactis mucosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	**0.2**
	Phlyctenanthus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	**0.8**
	Porifera spp.	0	0	0	0	0	0	0	0	0.2	0	0.2	0.6	24.6	17.4	6.2	26.2	14	53	51.1	**193.5**
	Pyura australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	**0.1**
	Pyura gibbosa	0	0	0	0	0	0	0	0	0	0	0	0.2	0	3.6	0	3.7	0	0	0	**7.5**
Other	Bare rock	0	0	0	0	0	0	0	0	0	0	1.5	0	0	0	0	0	0	1.8	0	**3.3**
	Cobble	34.6	88.2	10	6.4	51	39.8	21.8	0	0	2	10.8	0	0	0	0	0	11.5	0	0	**276.1**
	Gravel	31	11.2	0	0	0	34	26	0	0	0	9	0	18.7	0	0	10.8	0	8.2	0	**148.9**
	Sand	0	0	0	0	0	0	0	25	0	0	7.2	19.4	0	10	9.7	6.9	4.4	0	2.1	**84.7**
	Shell	0	0	0	0	0	0	0	0	0	23.8	0	0	0	0	1.8	0	0	0	0	**25.6**
	Silt on reef	32	0.6	11.6	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**52.2**
	Turf/sand/sediment matrix	0	0	0	0	0	0	0	0	69.8	0	0	0	0	16.7	0	0	0	1	0	**87.5**
	Heterozostera tasmanica	21.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**21.6**
Species richness (total species per site)		**10**	**6**	**5**	**3**	**3**	**6**	**6**	**10**	**12**	**5**	**15**	**22**	**32**	**38**	**22**	**41**	**30**	**39**	**34**	
Total species richness										**93**											

Appendix 13: Average algal percentage covers per site, recorded during standard surveys in 2023-2024, * = introduced species.

METHOD 3, 2023/2024	**Site**	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**13**	**14**	**15**	**17**	**18**	**19**	**20**	**22**	**24**	**25**	**26**	**27**	**Total**
	Number of transects	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	
	Species / Depth	**1**	**4**	**4**	**3**	**2**	**2**	**2**	**4**	**4**	**2**	**3**	**4**	**3**	**5**	**4**	**4**	**5**	**5**	**5**	
Brown algae	Acrocarpia paniculata	0	0	0	0	0	0	0	0	0	0	0	8.4	9	0	1	0.2	1.1	10.9	3.4	**34**
	Carpoglossum confluens	0	0	0	0	0	0	0	0	0	0	0	2.8	3.2	6.6	18.3	5.9	29.8	31.7	18.6	**116.9**
	Caulocystis uvifera	0	0	0	0	0	0	0	0	0	0	4.3	0	0	0	0	0	0	0	0	**4.3**
	Cladostephus spongiosus	0	0	0	0	0	0	0	0	0	0	0	1.6	1.8	0	0	0	0	0	0	**3.4**
	Colpomenia sinuosa	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	**0.1**
	Cystophora moniliformis	0	0	0	0	0	0	0	0	0	0	2.1	2	5.7	0.5	0.4	2.2	0	0	0	**12.9**
	Dictyopteris muelleri	0	0	0	0	0	0	0	0	2.8	0	7	0	1.4	0	0.2	0.2	0.7	0	0.1	**12.4**
	Dictyota nigricans	0	0	0	0	0	0	0	0	0	0	0	0	0	2.1	0	1.4	0	0	0	**3.5**
	Ecklonia radiata	0	0	0	0	0	0	27.2	72.2	43.2	0	23.3	56.4	48.7	39.3	36.7	30.7	37.8	10	71.4	**496.9**
	Halopteris paniculata	0	0	0	0	0	0	0	0	0	0	7	0	9.2	0	0	0	0.2	0	0	**16.4**
	Lessonia corrugata	0	0	0	0	0	0	0	0	0	0	0	0	0	14.7	0.2	3.2	0	2	0	**20.1**
	Macrocystis pyrifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.1	0.5	6.2	0	**10.8**
	Perithalia caudata	0	0	0	0	0	0	0	0	0	0	0	0	6.1	0	0	0	1.9	1	0	**9**
	Phaeophyceae spp.	0	0	0	0	0	0	0.8	0	0	0.8	0.8	0	0	0	0	0	0	0	0.6	**3**
	Sargassum fallax	0	0	0	0	0	0	0	5.8	2	1.2	0.5	0.8	2.1	5	1.8	3.1	0	0.3	0.5	**23.1**
	Sargassum vestitum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0.8	0.9	**3.1**
	Undaria pinnatifida	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.5	0	0.3	0	0	**1**
	Xiphophora gladiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	**0.8**
	Zonaria spp.	0	0	0	0	0	0	0	0.6	0	0	0.7	0	0.4	2.1	0	0.1	1.1	0	0.4	**5.4**
Red algae	Aeodes nitidissima	0	0	0	0	0	1.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	**1.4**
	Areschougia congesta	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0.2	**0.6**
	Ballia callitricha	0	0	0	0	0	0	0	0	2	0	0	0	1	0.4	1.8	0.6	0	0	0.6	**6.4**
	Ballia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.7	1.9	**6.6**
	Callophyllis rangiferina	0	0	0	0	0	0	0	0	0	0	0	0	0.1	2.1	12.8	0	6.7	10.8	0	**32.5**
	Champia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	**0.8**
	Champia viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	**0.3**
	Corallinales spp.	0	0	0	0	0	0	0	0.2	0.4	0	0.5	2.2	31.2	3.7	13	3	40.9	30.5	11.7	**137.3**
	Craspedocarpus ramentaceus	0	0	0	3.4	0	0.4	3.2	0.2	0	0	0	0	0	0	0	0	0	0	0	**7.2**
	Dasythamniella plumigera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	**0.1**
	Delisea pulchra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	**0.3**
	Echinothamnion hystrix	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	2.2	0	0	**2.5**
	Euptilota articulata	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	1.2	0.2	**2.1**
	Gigartina muelleriana	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	3.8	0	0	0	0	**5.2**
	Gracilaria cliftonii	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0	**0.8**
	Grateloupia turuturu	0	0	0	0	0	0	0	0.4	0.4	0	1.4	0	0	0.5	0.2	0	0.3	0	0	**3.2**
	Haliptilon roseum	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0	0	0	0	1.3	0	**2.7**
	Hemineura frondosa	0	0	0	0	0	0	0	0	0	0	0	2.6	0	0.5	0.6	0.1	0.8	4	0	**8.6**
	Kallymenia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
	Laurencia spp.	0	0	0	0	0	0	0	0.8	1.2	0	11	0	0.7	0	2.6	0	0.2	1.6	0.3	**18.4**
	Lenormandia marginata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.9	0.6	5.7	5.7	7	**20.1**
	Mychodea aciculare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	**0.2**
	Peyssonnelia spp.	0	0	0	0	0	0	3.6	52.2	21	0.6	23	21.8	21.3	5.2	17.9	9	22.8	22.8	14.3	**235.5**
	Phacelocarpus apodus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.5	0	**2.5**
	Phacelocarpus peperocarpos	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	2.8	9.5	0.9	**13.6**
	Phacelocarpus sessilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	**0.1**
	Plocamium angustum	0	0	0	0	0	0	0	0	0	0	0	0	2.3	0.2	0	0.1	8.9	7.4	1.1	**20**
	Plocamium costatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	9.7	5.6	**15.9**
	Plocamium dilatatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.5	0	**1.5**
	Plocamium patagiatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	**0.5**
	Pollexfenia lobata	0	0	0	0	0	0	0	0	0	0	0.6	0	2.8	2.9	6.6	0.9	0.6	3.8	0	**18.2**
	Polyopes constrictus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0.2	**1.4**
	Ptilonia australasica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	**0.7**
	Rhodophyta spp.	30	0	0	10.2	2.2	19.4	6	0	12.4	25	2.2	0.6	0	0	0	0.9	0	3	0.5	**112.4**
	Rhodymenia spp.	0	35	85.8	14	0	0.8	50.2	17	27	2.6	0.9	1.4	0.8	3.5	1	5.5	1	3.2	6.3	**256**
	Sonderophycus coriaceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.3	**1.8**
	Thamnoclonium dichotomum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	**1.1**
	Tsengia feredayae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0	0	**1.2**

Appendix 133 cont: Average algal percentage covers per site, recorded during standard surveys in 2023-2024, * = introduced species.

METHOD 3, 2023/2024	Site	1	3	4	5	6	7	9	13	14	15	17	18	19	20	22	24	25	26	27	Total
	Number of transects	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	
	Species / Depth	**1**	**4**	**4**	**3**	**2**	**2**	**2**	**4**	**4**	**2**	**3**	**4**	**3**	**5**	**4**	**4**	**5**	**5**	**5**	
Green algae	Apjohnia laetevirens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	**0.5**
	Caulerpa geminata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	2.3	**3**
	Caulerpa longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	**0.2**
	Caulerpa simpliciuscula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0	**1.6**
	Caulerpa trifaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	**0.8**
	Chaetomorpha coliformis	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0.4	0.6	0.1	**1.4**
	Chlorophyta spp.	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0.6	0	**1**
	Cladophora spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8	0.5	0.1	**2.4**
	Codium spp.	0	0	0	3.4	31.2	5	3.2	0	1.2	64.4	0.8	0	0.6	0	0	0.2	0.1	0	0	**110.1**
	Ulva spp.	0	0	0	0	0	0	3	0	2	0	0.4	1.2	0.2	0	1.9	8.9	1.3	0	0	**18.9**
Algae	Algae spp.	30	0	0	50.2	82.2	0	7.4	0	46.6	0	20.2	25.6	13.5	16	8	46	2.5	12.9	10.2	**371.3**
Sessile Invertebrates	Anthothoe albocincta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	**0.5**
	Anthozoa spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0.2	0	**0.5**
	Ascidiacea spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0.3	1	1	**2.7**
	Bryozoa spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.6	10	**12.1**
	Corynactis spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	**0.2**
	Crassostrea gigas	13.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13.8**
	Culicia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	**0.2**
	Galeolaria caespitosa	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	**0.4**
	Herdmania grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	**0.4**
	Hydroida spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0.5	0.5	**1.8**
	Magallana gigas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.9	0	0	0	**1.9**
	Mytilid spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0	0	**1.6**
	Mytilus galloprovincialis	0.8	0	1.2	25.6	0	8.2	0	0	0	0	0.2	7.4	0	50.4	30.4	18.7	2.2	0	0	**145.1**
	Ostrea angasi	0	6.6	0	8.6	0	14.2	0	3.6	0.4	0	0.2	0	0	0	1.3	0	0	0	0	**34.9**
	Ostrea spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	**0.2**
	Porifera spp.	0	2.4	7.4	0	3.4	3	1	5.8	5	0	0.6	6	6.6	10.2	11.8	5.3	7.8	16.4	38.7	**131.4**
	Pyura australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.9	0	0.6	0.2	**2.7**
	Pyura gibbosa	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.5	0	0	0	0	0	**2**
	Sessilia spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	**0.1**
Other	Bare rock	0	0	0	0	1.6	0	21	1.8	0	9.6	17	1	1	1.1	0	1.2	0.8	0.7	0.4	**57.2**
	Cobble	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	**0.5**
	Gravel	0	0	0	0	2.6	0	0	3.4	0	0	0	0	2.8	1.1	0	2.7	1.2	0	1.8	**15.6**
	Sand	0	0	0	0	0	0	4	1	0	7.8	30.6	27.4	10.2	4.2	7.9	3.6	7.8	0	0.4	**104.9**
	Shell	0	10.4	2.4	0	0	0	0	0	0	14	0	0	0	2	0	0	5.1	0	0	**33.9**
	Silt on reef	32	7.4	22	4.8	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**68.2**
	Turf/sand/sediment matrix	38	54	0	0	0	75.2	6	10.2	0	0	0	0	0	0	0	0	7.9	6.6	7.7	**205.6**
	Heterozostera nigricaulis	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**30**
Species richness (total species per site)		**7**	**6**	**5**	**8**	**6**	**9**	**15**	**17**	**15**	**9**	**26**	**19**	**32**	**27**	**26**	**31**	**44**	**45**	**47**	
Total species richness										**95**											

Appendix 14: Rank abundances of algae and plant species recorded during timed surveys (sites 1–9) in February-March 2010. Depth. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand. * = introduced species.

2009/2010	Site	1				2				3				4				5											6						7											8				9									
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2		-1		0		-1		0			1		2		
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R	S	S	R		R			R		E		S		R		R		R		R			R		S		
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	17	1	2	1	1	1	1	1	2	1	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	1	2	3
Brown algae	*Acrocarpia paniculata*																																																										
	Bellotia eriophorum																																																										
	Carpoglossum confluens																																																										
	Caulocystis cephalornithos																																																										
	Caulocystis uvifera																																																										
	Cladosiphon filum																																																										
	Cladostephus spongiosus																																																		5						
	Colpomenia sinuosa																																																										
	Cystophora monilifera																																																										
	Cystophora moniliformis																																																										
	Cystophora retorta																																																										
	Cystophora retroflexa																																																										
	Dictyopteris muelleri																																																										
	Dictyota dichotoma																																																										
	Dictyota spp.																																																										
	Distromium flabellatum																																																										
	Ecklonia radiata																																																										
	Halopteris paniculata																																																										
	Hormosira banksii																																																										
	Lessonia corrugata																																																										
	Macrocystis pyrifera																																																										
	Phyllospora comosa																																																										
	Sargassum fallax																																																										
	Sargassum spp.																																																										
	Sargassum verruculosum																																																										
	Sargassum vestitum																																																										
	Sporochnus comosus																																																										
	Undaria pinnatifida																																																										
	Unidentified algae (brown turf)																																																										
	Unidentified algae (filamentous brown)			5				5													5						5				4	3									5	5	3									5							5
	Zonaria turneriana/angustata																																																										
Green algae	*Caulerpa brownii*																																																										
	Caulerpa geminata																																																										
	Caulerpa longifolia																																																										
	Caulerpa simpliciuscula																																																										
	Caulerpa trifaria																																																										
	Chaetomorpha coliformis																																																										
	Cladophora spp.																																																										
	Codium duthieae																																																										
	Codium spongiosum																																																										
	Codium spp.																															2							3		1							3	3						3				
	Ulva spp.	5	5	4		5	5		2	5	5	5		5	5	5		5	5	3	3			2					4						5	5	4		3		2					5			4	5	5		5				5		
	Unidentified algae (filamentous green)			5																										4	2								2		2		1				5												
Plants	*Sarcocornia quinqueflora*	5	5			1	2																																																				
Red algae	*Aeodes nitidissima*																																															3				5							
	Dasya spp.																																																										
	Gigartina recurva																																																										
	Gracilaria ramulosa							5																																																			
	Gracilaria spp.																																																										
	Grateloupia turuturu																																																										
	Unidentified algae (filamentous red)			5																	4		5				3										5		4				4																
	Unidentified algae (red)																																																										
Seagrasses	*Heterozostera tasmanica*	5	5			5	5	5	3																																																		
Unclassified algae	Unidentified algae																																																										
	Unidentified algae (turf)	2	2			2	2			2	2			3	3			2	2				5												2	2																5							
Species richness (total species per depth & habitat)		**4**	**4**	**4**	**0**	**4**	**4**	**3**	**2**	**2**	**2**	**1**	**0**	**2**	**2**	**1**	**0**	**2**	**2**	**1**	**3**	**0**	**2**	**1**	**0**	**0**	**2**	**0**	**1**	**1**	**2**	**2**	**0**	**0**	**2**	**2**	**2**	**0**	**4**	**0**	**4**	**1**	**3**	**0**	**0**	**1**	**1**	**2**	**2**	**1**	**1**	**3**	**2**	**0**	**1**	**0**	**1**	**0**	**1**
Total species richness (total species per site)		7				6				2				2				4											4						6											4				6									

Appendix 14 cont.: Rank abundances of algae and plant species recorded during timed surveys (sites 19-24) in February-March 2010. Depth. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand. * = introduced species.

2009/2010	Site	19									20									21		22									23		24								
	Depth category	-1		0			1		2		-1		0			1		2		2		-1			0		1		2		2		-1		0			1		2	
	Habitat	R		R			R		R	S	R		R			R		E	E	S		R			R		R		S	E	S		R		R			R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	2	1	1	1	2	1	2	1	2	3	1	2	1	1
Brown algae	*Acrocarpia paniculata*			3		3	3	3	4		2						3	4								2	3	4										3	3		3
	Bellotia eriophorum																																							2	
	Carpoglossum confluens						4	3	4							5	3	3								3	5	4		4									4		
	Caulocystis cephalornithos			2		2		2																		3		2													
	Caulocystis uvifera								3																																
	Cladosiphon filum												2																												
	Cladostephus spongiosus				3		3		2						3											3		2									4	4			
	Colpomenia sinuosa																																								
	Cystophora monilifera																																								
	Cystophora moniliformis			3	4	4		3	4		2		3		4	5	3								4	3	3	3							4	3	3	4	3		
	Cystophora retorta											2																													
	Cystophora retroflexa																																								
	Dictyopteris muelleri			2	4	2	4	3	4				2	3	2	4	3	3							4	2	4	3		2					3				3		3
	Dictyota dichotoma																																								
	Dictyota spp.																																								
	Distromium flabellatum																																								
	Ecklonia radiata			2		2	5	4	5				3			4	3	4								4	4	4		4					3		4	5	4		4
	Halopteris paniculata								2																																
	Hormosira banksii										3																						3	3							
	Lessonia corrugata			3	5	4	4	3	5				4	5	4	5	4	3				2	3		5	4	4	4					3	3	4	4	4	4	3		3
	Macrocystis pyrifera																																					3	2		2
	Phyllospora comosa																																						2		
	Sargassum fallax				3	2		3	3		2												1	1		3	3											3	2		2
	Sargassum spp.																																2	3							
	Sargassum verruculosum			2			5	3	5								3	3								2				2									2		2
	Sargassum vestitum			2	4								3	3		3	3	2							4										4		2				
	Sporochnus comosus						3																																		
	Undaria pinnatifida			2	3	3	3	2	4				3	3	4	4	3	3																	3	4	3	4	3		3
	Unidentified algae (brown turf)																																								
	Unidentified algae (filamentous brown)					3																																			
	Zonaria turneriana/angustata					1		2				1			1		2	2												3							2		3		
Green algae	*Caulerpa brownii*								4							4																						5			
	Caulerpa geminata																																						2		
	Caulerpa longifolia								4									1																							
	Caulerpa simpliciuscula			2		3		2										2																					1		2
	Caulerpa trifaria			2				2	4									3																				4	3		3
	Chaetomorpha coliformis					2																													3						
	Cladophora spp.		3																																						
	Codium duthieae																																								
	Codium spongiosum													5		5											3														
	Codium spp.		2						2			1	1		2		1					3				2							3	2		5					
	Ulva spp.	4	3	2	4	3		2	3		4	1	4	5	4	3	2	2				5	2	4	4	4	3	3					4	4	3		5	4	3		1
	Unidentified algae (filamentous green)																																2								
Plants	*Sarcocornia quinqueflora*																																								
Red algae	*Aeodes nitidissima*																																								
	Dasya spp.																																								
	Gigartina recurva																																								
	Gracilaria ramulosa																																								
	Gracilaria spp.																																								
	Grateloupia turuturu													3		3						3			3		3											4			
	Unidentified algae (filamentous red)																																								
	Unidentified algae (red)																																								
Seagrasses	*Heterozostera tasmanica*																																								
Unclassified algae	Unidentified algae																																								
	Unidentified algae (turf)																																								
Species richness (total species per depth & habitat)		**1**	**3**	**12**	**8**	**13**	**9**	**14**	**17**	**0**	**5**	**4**	**9**	**7**	**8**	**11**	**12**	**13**	**0**	**0**	**0**	**4**	**3**	**2**	**6**	**12**	**10**	**9**	**0**	**5**	**0**	**0**	**6**	**5**	**8**	**5**	**8**	**11**	**16**	**1**	**11**
Total species richness (total species per site)		**25**									**23**									**0**		**16**									**0**		**26**								

Appendix 15: Rank abundances of algae and plant species recorded during timed surveys (sites 1-9) in 2024. Depth. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand. * = introduced species.

2024	Site	1				2				3				4				5											6						7										8				9								
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2	-1		0		-1		0			1		2	
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S	R		R		R		R			R		S	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	1	2	1	2	1	2	1	2	3	1	2	1	2
Brown algae	*Acrocarpia paniculata*																																																								
	Carpoglossum confluens																																																								
	Caulocystis uvifera																																																								
	Cladostephus spongiosus																																																								
	Colpomenia sinuosa																																																								
	Cystophora cf. monilifera																																																								
	Cystophora grevillei																																																								
	Cystophora moniliformis																																																								
	Cystophora subfarcinata																																																								
	Dictyopteris muelleri																																																				2			
	Ecklonia radiata																																																	3			4	5		
	Glossophora nigricans																																																								
	Halopteris paniculata																																																								
	Halopteris spp.																																																								
	Hormosira banksii																																																								
	Lessonia corrugata																																																								
	Macrocystis pyrifera																																																								
	Myriodesma integrifolium																																																								
	Perithalia caudata																																																								
	Sargassum fallax																																																								
	Sargassum spp.																																																								
	Sargassum verruculosum																																																								
	Sporochnus comosus																																																								
	Undaria pinnatifida																																																								
	Zonaria angustata																																																		3					
	Zonaria turneriana/angustata																																																								
Green algae	*Apjohnia laetevirens*																																																								
	Caulerpa longifolia																																																								
	Caulerpa simpliciuscula																																																								
	Caulerpa spp.																																																								
	Caulerpa trifaria																																																								
	Codium spongiosum																																																								
	Codium spp.															2	4			3	2			3	3		3		3	2	5			4	3		3	2	3	4	3	5	3				3					1	4	1	5		
	Ulva spp.			1		3	5	3		3	5	4		5	5	3	5	3	4	4	3		2	4	4				4	5	4				3	4	1	4	3	5	2	4	2		2		5		3	4	4	3	5	3	4	3	5
Red algae	*Aeodes nitidissima*																																					3	3	3	3	1					3					5	5	4	4	3	3
	Craspedocarpus ramentaceus																																																								
	Grateloupia turuturu																													1																	4							2	2		
	Thamnoclonium dichotomum																																																								
	Unidentified algae (red)																																																								
Seagrasses	*Heterozostera nigricaulis*			5					5																																																
	Heterozostera tasmanica	3																																																							
Species richness (total species per depth & habitat)		**1**	**0**	**2**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**2**	**0**	**1**	**2**	**2**	**0**	**1**	**0**	**2**	**3**	**2**	**0**	**0**	**1**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**0**	**4**	**0**	**1**	**1**	**2**	**4**	**3**	**6**	**5**	**2**	**2**
Total species richness (total species per site)		**3**				**2**				**1**				**2**				**2**											**3**						**3**										**4**				**7**								

Appendix 15 cont.: Rank abundances of algae and plant species recorded during timed surveys (sites 10-18) in 2024. Depth. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand. * = introduced species.

2024	Site	10				11		12		13													14									15						16	17									18							
	Depth category	-1		0		2		2		-1		0			1				2			3	-1		0		1		2	3		-1		0			2	2	-1		0		1				2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			R	E			S		E	S	R		R		R		S	E		R		R			S	R	R		R		R		S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	3	1	1	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2
Brown algae	*Acrocarpia paniculata*																																										4								4	4		2	
	Carpoglossum confluens																																																			5		4	
	Caulocystis uvifera																																																		3			2	
	Cladostephus spongiosus																																																					4	
	Colpomenia sinuosa			5																																																			
	Cystophora cf. monilifera																										2																												
	Cystophora grevillei																																																					2	
	Cystophora moniliformis														5										2	2		4													5		5	3		3				3	5	3	3	2	
	Cystophora subfarcinata													2		3																																					4		
	Dictyopteris muelleri														3			4			2							4										4					2												
	Ecklonia radiata							2				4	5	3	5	5	5	5	2		3	2			3	4	4	5		3								5			5		5	5	2	5	3			3	3	5	5	5	
	Glossophora nigricans																																																			3		3	
	Halopteris paniculata																																																		1				
	Halopteris spp.																																																						
	Hormosira banksii																																																		1				
	Lessonia corrugata																																																		2	3			
	Macrocystis pyrifera																																																						
	Myriodesma integrifolium																																																					1	
	Perithalia caudata																																																						
	Sargassum fallax			1								3	5		4	3	3	3			1				3		3	5										2			2	3		3								3		2	
	Sargassum spp.																																																						
	Sargassum verruculosum																																					2																	
	Sporochnus comosus																																																						
	Undaria pinnatifida													2		1									3	3												1							2	2				3	3	1	2	3	1
	Zonaria angustata																																																						
	Zonaria turneriana/angustata																											4	1																										
Green algae	*Apjohnia laetevirens*																																																						
	Caulerpa longifolia																																																			1		1	2
	Caulerpa simpliciuscula																																																	2			3		3
	Caulerpa spp.																																																						
	Caulerpa trifaria																																																					2	3
	Codium spongiosum																																																			4			
	Codium spp.	1		3						3	4			2	2	3		4						2	3		3	4	2										3	3	4		5	2		2					3	2	2	2	
	Ulva spp.	4	5	5						3	5	4	4		3	4		4					3	4			3	4	2	3		5	3					4		3	5	3	2		2	2	2					2	3	2	1
Red algae	*Aeodes nitidissima*			5																						1																													
	Craspedocarpus ramentaceus												2																																										
	Grateloupia turuturu	3	2	4						3	5		5	5	4			3					5	5	5	5		4											3	5	5		4		4					3	3			3	3
	Thamnoclonium dichotomum																																																			4		4	
	Unidentified algae (red)																																																						
Seagrasses	*Heterozostera nigricaulis*																																																						
	Heterozostera tasmanica																										1		3									1							4						3			4	3
Species richness (total species per depth & habitat)		**3**	**2**	**6**	**0**	**0**	**0**	**1**	**0**	**3**	**3**	**3**	**5**	**5**	**7**	**6**	**2**	**6**	**1**	**0**	**3**	**1**	**2**	**3**	**6**	**5**	**6**	**8**	**4**	**2**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**7**	**2**	**3**	**6**	**2**	**7**	**4**	**5**	**5**	**2**	**0**	**0**	**5**	**11**	**13**	**7**	**18**	**7**
Total species richness (total species per site)		**6**				**0**		**1**		**10**													**12**									**1**						**7**	**10**									**24**							

Appendix 15 cont.: Rank abundances of algae and plant species recorded during timed surveys (sites 19-24) in 2024. Depth. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand. * = introduced species.

2024	**Site**	**19**										**20**									**21**		**22**								**23**		**24**							
	Depth category	**-1**		**0**			**1**		**2**			**-1**		**0**			**1**		**2**		**2**		**-1**		**0**	**1**			**2**		**2**		**-1**		**0**		**1**		**2**	
	Habitat	**R**		**R**			**R**		**R**		**S**	**R**		**R**			**R**		**S**	**E**	**S**		**R**		**R**	**R**			**S**	**E**	**S**		**R**		**R**		**R**		**S**	**E**
	Species / Replicate search	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**
Brown algae	*Acrocarpia paniculata*			3			5		3											3					4		4			4					3		4			3
	Carpoglossum confluens						4		5	4							5			5					4		5	3		5							3	3		3
	Caulocystis uvifera																																							
	Cladostephus spongiosus																																							
	Colpomenia sinuosa																																							
	Cystophora cf. monilifera																																							
	Cystophora grevillei																																							
	Cystophora moniliformis						3		2	3							3			3							4			3					5		4			4
	Cystophora subfarcinata									4							3											1								2		3		
	Dictyopteris muelleri						4		3											3							3													
	Ecklonia radiata			4			5	4	5	5		2		4			5	5		5	2		2		5	4	5	5		5					4	2	5	5		5
	Glossophora nigricans												3							3																				
	Halopteris paniculata						4											3																						
	Halopteris spp.																						2																	
	Hormosira banksii																																							
	Lessonia corrugata			3									4	5	5	3				3					4		3	3					3		5	3	5	3		4
	Macrocystis pyrifera																																				3	3		3
	Myriodesma integrifolium																				2											2								
	Perithalia caudata						5		4																															
	Sargassum fallax			4			3					3		5	4	3		4							5		4			2					4		2			3
	Sargassum spp.																						2																	
	Sargassum verruculosum																																							
	Sporochnus comosus																			2																				
	Undaria pinnatifida						2					3	3	5	3	3	3	3		1			3	3	4		3	3		1					5	3	4	2		2
	Zonaria angustata																																							
	Zonaria turneriana/angustata																			3										2										2
Green algae	*Apjohnia laetevirens*																								3															
	Caulerpa longifolia						3	1	4																															
	Caulerpa simpliciuscula				1	3			5											3																				
	Caulerpa spp.							3		3																														
	Caulerpa trifaria						3		3																															
	Codium spongiosum																																							
	Codium spp.																			3	1		1	2						1				1	2					2
	Ulva spp.						3	2				3	5	5	3	3	4	5		3	2		2				4	3					3	2	5	4	4	2		2
Red algae	*Aeodes nitidissima*																																							
	Craspedocarpus ramentaceus																																							
	Grateloupia turuturu											2	3	3	4	4		5	4	5			2	5									4	4	5	5				3
	Thamnoclonium dichotomum																																							
	Unidentified algae (red)																		3										2											
Seagrasses	*Heterozostera nigricaulis*																																							
	Heterozostera tasmanica																				4	3							3		1									
Species richness (total species per depth & habitat)		**0**	**0**	**4**	**1**	**1**	**12**	**4**	**9**	**5**	**0**	**5**	**5**	**6**	**5**	**5**	**6**	**6**	**2**	**14**	**5**	**1**	**7**	**3**	**7**	**1**	**9**	**6**	**2**	**8**	**1**	**1**	**3**	**3**	**9**	**6**	**9**	**7**	**0**	**12**
Total species richness (total species per site)		**16**										**18**									**5**		**18**								**2**		**13**							

Appendix 16: Rank abundances of invertebrates recorded during timed surveys (sites 1–9) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	1				2				3				4			
	Depth category	-1		1		-1		0		-1		1		-1		1	
	Habitat	R		R		R		R	E	R		R		R		R	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2
Barnacles	*Catomerus polymerus*																
	Chamaesipho tasmanica																
	Elminius modestus																
	Tetraclitella purpurascens																
	Unidentified barnacles	5	5			5	5			5	5			5	5		
Crustaceans	*Bellidilia undecimspinosa*																
	Brachynotus spinosus	2	2														
	Carcinus maenas					2	3	2		2							
	Cyclograpsus granulosus	2	2			3	4			3	3	1		3	3		
	Ebalia intermedia																
	Halicarcinus ovatus	1															
	Halicarcinus rostratus							1									
	Helograpsus haswellianus	4	4				1										
	Jasus edwardsii																
	Lophopagurus nanus																
	Metacarcinus novaezelandiae												2				
	Munida gregaria																
	Naxia aurita																
	Notomithrax ursus																
	Pagurid spp.																
	Paguristes frontalis																
	Pagurixus handrecki																
	Palaemon dolospina				3								4				4
	Palaemon intermedius																
	Palaemon serenus			4				2	3							1	
	Paragrapsus gaimardii	4	4		2	4	4			4	4			4	4		
	Paragrapsus laevis							2									
	Paragrapsus quadridentatus											1		2	2		
	Petrolisthes elongatus								3	3	3	3	5	3	3	5	
	Plagusia chabrus																
	Strigopagurus strigimanus																
	Unidentified crab																
	Unidentified crab (decorator)																
	Unidentified hermit crab																
	Unidentified shrimp																
Echinoderms	*Amblypneustes ovum*																
	Amphiura (Amphiura) constricta																
	Amphiura (Amphiura) elandiformis																
	Asterias amurensis												2			2	2
	Australostichopus mollis																
	Clarkcoma canaliculata																
	Comanthus tasmaniae																
	Comanthus trichoptera																
	Coscinasterias muricata																
	Goniocidaris spp.																
	Goniocidaris tubaria																
	Heliocidaris erythrogramma																
	Meridiastra calcar																
	Patiriella regularis								1	2	3	5	4	4	4	5	4
	Petrolisthes elongatus																5
	Tosia australis																
	Tosia magnifica																
	Uniophora granifera																

2009/2010	Site	5											6					
	Depth category	-1		0			1					2	-1		0	1		
	Habitat	R		R			R			E		S	R		R	R		S
	Species / Replicate search	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1
Barnacles	*Catomerus polymerus*																	
	Chamaesipho tasmanica																	
	Elminius modestus													3				
	Tetraclitella purpurascens																	
	Unidentified barnacles	5	5										5					
Crustaceans	*Bellidilia undecimspinosa*																	
	Brachynotus spinosus																	
	Carcinus maenas	2	2	2	3	2		1			1		4	2		1	1	
	Cyclograpsus granulosus	3	3										3	3				
	Ebalia intermedia											1						
	Halicarcinus ovatus	1	2											1			2	
	Halicarcinus rostratus											2						
	Helograpsus haswellianus		2															
	Jasus edwardsii																	
	Lophopagurus nanus																	
	Metacarcinus novaezelandiae						1		1	1						1		
	Munida gregaria																	
	Naxia aurita																	
	Notomithrax ursus																	
	Pagurid spp.																	
	Paguristes frontalis																	
	Pagurixus handrecki																	
	Palaemon dolospina																	
	Palaemon intermedius					4												
	Palaemon serenus			2	3			2							4		3	
	Paragrapsus gaimardii	4	4		2								4	3				
	Paragrapsus laevis																	
	Paragrapsus quadridentatus	2	2											2				
	Petrolisthes elongatus	4	4			5	3	3	5	1	4		5		4		4	
	Plagusia chabrus																	
	Strigopagurus strigimanus																	
	Unidentified crab																	
	Unidentified crab (decorator)																	
	Unidentified hermit crab																	
	Unidentified shrimp																	
Echinoderms	*Amblypneustes ovum*																	
	Amphiura (Amphiura) constricta																	
	Amphiura (Amphiura) elandiformis																	
	Asterias amurensis					2		3	3	4	2	3				4		4
	Australostichopus mollis																	
	Clarkcoma canaliculata																	
	Comanthus tasmaniae																	
	Comanthus trichoptera																	
	Coscinasterias muricata																	
	Goniocidaris spp.																	
	Goniocidaris tubaria																	
	Heliocidaris erythrogramma																	
	Meridiastra calcar																	
	Patiriella regularis	5	5	4	4	5	2	1	4	3	4	3		4	5	5	4	5
	Petrolisthes elongatus																	
	Tosia australis																	
	Tosia magnifica																	
	Uniophora granifera																	

2009/2010	Site	7											8				9									
	Depth category	-1		0			1				2		-1		0		-1		0			1		2		
	Habitat	R		R			R		E		S		R		R		R		R			R		S		
	Species / Replicate search	1	2	1	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	1	2	3
Barnacles	*Catomerus polymerus*																									
	Chamaesipho tasmanica																									
	Elminius modestus													5												
	Tetraclitella purpurascens																									
	Unidentified barnacles	5	5										5				5	5								
Crustaceans	*Bellidilia undecimspinosa*																									
	Brachynotus spinosus																									
	Carcinus maenas	2	1	3		4	1			3			3	2	2	1										
	Cyclograpsus granulosus	3	3							1			3	3			3	3								
	Ebalia intermedia										1													2	2	2
	Halicarcinus ovatus		2			1								2		3	2	2							2	
	Halicarcinus rostratus																							1		2
	Helograpsus haswellianus																									
	Jasus edwardsii																									
	Lophopagurus nanus																									
	Metacarcinus novaezelandiae																									
	Munida gregaria																									
	Naxia aurita																									
	Notomithrax ursus																									
	Pagurid spp.																									
	Paguristes frontalis																									
	Pagurixus handrecki																									
	Palaemon dolospina																									
	Palaemon intermedius					3				3						3										
	Palaemon serenus			3	4			3							3	3					3					
	Paragrapsus gaimardii	4	4	3	3										3		4	4								
	Paragrapsus laevis																									
	Paragrapsus quadridentatus	2	1													1	2	3			2					
	Petrolisthes elongatus	5	5	5	5		4	3					5	5	5	5	5	5	5		5					
	Plagusia chabrus																									
	Strigopagurus strigimanus																									
	Unidentified crab																									
	Unidentified crab (decorator)																									
	Unidentified hermit crab																									
	Unidentified shrimp																			1		2	3			
Echinoderms	*Amblypneustes ovum*																									
	Amphiura (Amphiura) constricta										3															
	Amphiura (Amphiura) elandiformis											2														
	Asterias amurensis				3	2	2	2	3	2	4	4			2	1				2	4		1	3	4	3
	Australostichopus mollis																									
	Clarkcoma canaliculata																									
	Comanthus tasmaniae																									
	Comanthus trichoptera																									
	Coscinasterias muricata																									
	Goniocidaris spp.																									
	Goniocidaris tubaria																									
	Heliocidaris erythrogramma																						2			
	Meridiastra calcar					1																				
	Patiriella regularis	5	5	5	5	5	5	4	2	3	4	3		4	5	5	5	5	5	5	5	4	4	5	4	
	Petrolisthes elongatus																									
	Tosia australis																									
	Tosia magnifica																				1					
	Uniophora granifera																					1				

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 1–9) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	**Site**	**1**				**2**				**3**				**4**				**5**											**6**						**7**											**8**				**9**									
	Depth category	**-1**		**1**		**-1**		**0**		**-1**		**1**		**-1**		**1**		**-1**		**0**			**1**					**2**	**-1**		**0**	**1**			**-1**		**0**			**1**				**2**		**-1**		**0**		**-1**		**0**			**1**		**2**		
	Habitat	**R**		**R**		**R**		**R**	**E**	**R**		**R**		**R**		**R**		**R**		**R**			**R**			**E**		**S**	**R**		**R**	**R**		**S**	**R**		**R**			**R**		**E**		**S**		**R**		**R**		**R**		**R**			**R**		**S**		
	Species / Replicate search	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**3**
Molluscs	*Afrolittorina praetermissa*																																																										
	Agnewia tritoniformis																																																										
	Aplysia parvula																																																										
	Aplysia spp.																																																										
	Aplysia sydneyensis																																																										
	Argobuccinum pustulosum																																																										
	Austrocochlea constricta																																																										
	Austrocochlea spp.																																																										
	Austrolittorina unifasciata																																															4	4								
	Bembicium auratum																																																										
	Bembicium melanostomum																											1																	1													
	Bembicium nanum																	1	1																2	1														1									
	Brachidontes rostratus																																																										
	Cabestana spengleri																																																										
	Cabestana tabulata																																																										
	Cellana solida																																																1								
	Cellana tramoserica																																																										
	Chiton glaucus																																															1									
	Chlorodiloma odontis																																																										
	Clanculus undatus																																																										
	Clypidina rugosa																																																										
	Cominella lineolata																																																										
	Crassostrea gigas	2	2	5	5	3	3	4	3	3	3	5		3	3	5		3	3	4	4	4	5	3			2		5	4	4				3	3	4	3	4		4	2				5	4	4	3	4	4	5	4	4	2				
	Dicathais orbita																																																										
	Diloma concamerata																																																										
	Haliotis rubra																																																										
	Ischnochiton australis																																						1													1							
	Ischnochiton elongatus																												1																														
	Ischnochiton variegatus																																																										
	Lepsiella vinosa																																																										
	Maoricolpus roseus																																																										
	Mytilus galloprovincialis			5	2	5	5	5	5	5	5	5	2	5	5	5	5	5	5	5	5	5		5	4		4		5	4	4		3		5	5	5	5	5	3	5		2			5	5	4	4	5	5	5	3	5	2				
	Notoacmea flammea																																																										
	Notoacmea petterdi																																																										
	Octopus tetricus																																																										
	Ostrea angasi		3										5				5				2	3			3	1	3		2		2		3							3	1					1	2	3	4										
	Patella (Scutellastra) chapmani																																																										
	Patella (Scutellastra) peronii																																																										
	Patelloida latistrigata																																																										
	Patelloida victoriana																																																										
	Pecten fumatus																																																								1	
	Phallomedusa solida		3																																																								
	Plaxiphora albida																																																										
	Pleurobranchaea maculata																																	1											2														
	Pleuroploca australasia																																																										
	Ranella australasia																																																										
	Sassia verrucosa																																																										
	Siphonaria diemenensis																											1																															
	Siphonaria funiculata																	2																																3	3								
	Siphonaria spp.																												2																														
	Siphonaria tasmanica																																																										
	Sypharochiton pelliserpentis																																																1		1								
	Tatea huonensis	5	5																																																								
	Turbo undulatus																																																										
	Unidentified chiton																																																										
	Xenostrobus pulex	5	5			3	3			3	3			3																																													
	Xenostrobus securis				5																																																						

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 1–9) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	1				2				3				4			
	Depth category	-1		1		-1		0		-1		1		-1		1	
	Habitat	R		R		R		R	E	R		R		R		R	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2
Other	*Dorvillea australiensis*																
	Galeolaria caespitosa																
	Ikeda spp.																
	Myxicola infundibulum												2				
	Notoplana australis															1	
	Paraplanocera spp.																
	Polynoid polychaete																
	Sabellastarte australiensis																
	Sabellastarte spp.																
	Sabellid spp.																
	Unidentified flatworm																
	Unidentified invertebrates (tube matting)																
	Unidentified polychaete																
	Unidentified serpulids																
Sessile invertebrates	*Actinia tenebrosa*																
	Anthothoe albocincta																
	Ascidia sydneiensis																
	Ascidiella aspersa																
	Aulactinia veratra																
	Botrylloides spp.																
	Ciona intestinalis																
	Cnemidocarpa radicosa																
	Corynactis australis																
	Culicia spp.																
	Cyanea rosella																
	Epiactis spp.																
	Eudistoma constrictum																
	Herdmania grandis																
	Herdmania momus																
	Oulactis mucosa																
	Phlyctenanthus australis																
	Pyura australis																
	Pyura gibbosa																
	Pyura stolonifera																
	Sycozoa spp.																
	Unidentified anemone																
	Unidentified ascidians																
	Unidentified sponges																
Species richness (total species per depth & habitat)		9	10	3	5	7	8	6	5	9	8	6	8	9	8	7	6
Total species richness (total species per site)		15				13				15				16			

2009/2010	Site	5											6					
	Depth category	-1		0			1					2	-1		0	1		
	Habitat	R		R			R			E		S	R		R	R		S
	Species / Replicate search	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1
Other	*Dorvillea australiensis*																	
	Galeolaria caespitosa																	
	Ikeda spp.																	
	Myxicola infundibulum						3			3	3	4						5
	Notoplana australis																	
	Paraplanocera spp.																	
	Polynoid polychaete																	
	Sabellastarte australiensis																	
	Sabellastarte spp.																	
	Sabellid spp.																	
	Unidentified flatworm																	
	Unidentified invertebrates (tube matting)				5		5		5									
	Unidentified polychaete																	
	Unidentified serpulids										3							
Sessile invertebrates	*Actinia tenebrosa*																	
	Anthothoe albocincta																	
	Ascidia sydneiensis																	
	Ascidiella aspersa										2	3						
	Aulactinia veratra																	
	Botrylloides spp.																	
	Ciona intestinalis																	
	Cnemidocarpa radicosa																	
	Corynactis australis																	
	Culicia spp.																	
	Cyanea rosella																	
	Epiactis spp.																	
	Eudistoma constrictum																	
	Herdmania grandis																	
	Herdmania momus																	
	Oulactis mucosa																	
	Phlyctenanthus australis																	
	Pyura australis																	
	Pyura gibbosa																	
	Pyura stolonifera																	
	Sycozoa spp.																	
	Unidentified anemone																	
	Unidentified ascidians																	
	Unidentified sponges																	
Species richness (total species per depth & habitat)		12	12	5	8	8	6	7	7	6	10	6	10	11	6	4	7	4
Total species richness (total species per site)		24											21					

2009/2010	Site	7											8			
	Depth category	-1		0			1				2		-1		0	
	Habitat	R		R			R		E		S		R		R	
	Species / Replicate search	1	2	1	2	3	1	2	1	2	1	2	1	2	1	2
Other	*Dorvillea australiensis*															
	Galeolaria caespitosa															
	Ikeda spp.															
	Myxicola infundibulum								4	4	4	5				
	Notoplana australis				1											
	Paraplanocera spp.															
	Polynoid polychaete					1										
	Sabellastarte australiensis															
	Sabellastarte spp.															
	Sabellid spp.											2				
	Unidentified flatworm															
	Unidentified invertebrates (tube matting)				5		5									
	Unidentified polychaete															
	Unidentified serpulids								1	3						
Sessile invertebrates	*Actinia tenebrosa*															
	Anthothoe albocincta															
	Ascidia sydneiensis															
	Ascidiella aspersa									2	3	3				
	Aulactinia veratra															
	Botrylloides spp.															
	Ciona intestinalis															
	Cnemidocarpa radicosa															
	Corynactis australis															
	Culicia spp.															
	Cyanea rosella															
	Epiactis spp.															
	Eudistoma constrictum										2					
	Herdmania grandis															
	Herdmania momus															
	Oulactis mucosa															
	Phlyctenanthus australis															
	Pyura australis															
	Pyura gibbosa															
	Pyura stolonifera															
	Sycozoa spp.															
	Unidentified anemone															
	Unidentified ascidians															
	Unidentified sponges															
Species richness (total species per depth & habitat)		10	11	7	9	10	7	7	5	9	7	7	8	9	9	12
Total species richness (total species per site)		29											17			

2009/2010	Site	9									
	Depth category	-1		0			1		2		
	Habitat	R		R			R		S		
	Species / Replicate search	1	2	1	2	3	1	2	1	2	3
Other	*Dorvillea australiensis*										
	Galeolaria caespitosa										
	Ikeda spp.										
	Myxicola infundibulum								4	5	5
	Notoplana australis										
	Paraplanocera spp.										
	Polynoid polychaete										
	Sabellastarte australiensis										
	Sabellastarte spp.										
	Sabellid spp.									2	
	Unidentified flatworm										
	Unidentified invertebrates (tube matting)								5		
	Unidentified polychaete										
	Unidentified serpulids										3
Sessile invertebrates	*Actinia tenebrosa*										
	Anthothoe albocincta										
	Ascidia sydneiensis										
	Ascidiella aspersa								2	4	3
	Aulactinia veratra										
	Botrylloides spp.										
	Ciona intestinalis										
	Cnemidocarpa radicosa										
	Corynactis australis										
	Culicia spp.										
	Cyanea rosella										
	Epiactis spp.										
	Eudistoma constrictum								1		
	Herdmania grandis										
	Herdmania momus										
	Oulactis mucosa										
	Phlyctenanthus australis										
	Pyura australis										
	Pyura gibbosa										
	Pyura stolonifera										
	Sycozoa spp.										
	Unidentified anemone										
	Unidentified ascidians										
	Unidentified sponges										
Species richness (total species per depth & habitat)		13	13	5	5	8	5	4	8	8	6
Total species richness (total species per site)		31									

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	**Site**	**10**				**11**		**12**		**13**												**14**									**15**					**16**		**17**									**18**							
	Depth category	**-1**		**0**		**2**		**2**		**-1**		**0**			**1**			**2**			**3**	**-1**		**0**		**1**		**2**	**3**		**-1**		**0**		**2**	**2**		**-1**			**0**		**1**			**2**	**-1**		**0**		**1**		**2**	
	Habitat	**R**		**R**		**S**		**S**		**R**		**R**			**E**			**S**		**E**	**S**	**R**		**R**		**R**		**S**	**E**		**R**		**R**		**S**	**R**		**R**			**R**		**R**	**S**	**E**	**R**	**R**		**R**		**R**		**E**	
	Species / Replicate search	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Barnacles	*Catomerus polymerus*																																						3								4	4						
	Chamaesipho tasmanica	5	3																												5								5	3							5	5						
	Elminius modestus																															5																						
	Tetraclitella purpurascens																																																					
	Unidentified barnacles									5	5											5	5																															
Crustaceans	*Bellidilia undecimspinosa*																	3																																				
	Brachynotus spinosus																																																					
	Carcinus maenas	2							1													4	4								1																							
	Cyclograpsus granulosus									4	4											3	2															3	3	2														
	Ebalia intermedia																		2	1																																		
	Halicarcinus ovatus				2														1													1																						
	Halicarcinus rostratus					3												2		2																																		
	Helograpsus haswellianus																																																					
	Jasus edwardsii																																			2	1																	
	Lophopagurus nanus																																													1								
	Metacarcinus novaezelandiae																																																					
	Munida gregaria						2																																															
	Naxia aurita					2																																																
	Notomithrax ursus																			1																													1		1			
	Pagurid spp.								1																																													
	Paguristes frontalis																																																				2	
	Pagurixus handrecki																																																					
	Palaemon dolospina																																																					
	Palaemon intermedius				3																																																	
	Palaemon serenus			3	3																				3	2											2					3			3	1						2		2
	Paragrapsus gaimardii	2		2	2						1											2	1								2	3								3														
	Paragrapsus laevis																																																					
	Paragrapsus quadridentatus	1			2																	3	2								2	1							1	2							2							
	Petrolisthes elongatus	5	5	5	5					5	5	5	5	5		2	2			3		5	5		3	3					5	5	5	4				5	5	4	5	5	4		4	5	4	5	4		3			
	Plagusia chabrus																																																					
	Strigopagurus strigimanus					2																						1							1																			
	Unidentified crab														1																																							
	Unidentified crab (decorator)						2		2																																													
	Unidentified hermit crab																												1																									
	Unidentified shrimp														2																																							
Echinoderms	*Amblypneustes ovum*																																																		1		1	
	Amphiura (Amphiura) constricta																																																					
	Amphiura (Amphiura) elandiformis																																																					
	Asterias amurensis		1	3	2	3	4	4	4			4	4	4		3	2	2	2	3				3	3			4	1	2	2	2	3	3	4		2															1		
	Australostichopus mollis																			1						2																				1					1			1
	Clarkcoma canaliculata																																													1								
	Comanthus tasmaniae																																																					
	Comanthus trichoptera																																																					
	Coscinasterias muricata														1									2			1										2				2		2		1	2	1	1	1		1			
	Goniocidaris spp.																													1																								
	Goniocidaris tubaria																									1																												
	Heliocidaris erythrogramma														3	3	3			3	2					2			3							2	3							4	4	5					4	4	4	4
	Meridiastra calcar																																														2	2	2	3	1			
	Patiriella regularis	5	4	5	5					3	3	5	1		3	4	3				2	3	3	5	5	3			2	2	4	4	5	4	5			1	2	2		4	2		3									
	Petrolisthes elongatus																																																					
	Tosia australis																																			1															1	1		2
	Tosia magnifica																																			1	1								1									
	Uniophora granifera																				1																							1								1		

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	10				11		12		13												14									15					16		17									18							
	Depth category	-1		0		2		2		-1		0			1			2			3	-1		0		1		2	3		-1		0		2	2		-1			0		1			2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			E			S		E	S	R		R		R		S	E		R		R		S	R		R			R		R	S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	1	1	2	1	2	1	2	1	2
Molluscs	*Afrolittorina praetermissa*																																																					
	Agnewia tritoniformis																																																					
	Aplysia parvula																																																2				
	Aplysia spp.						1																																															
	Aplysia sydneyensis			1																											1																							
	Argobuccinum pustulosum																																																					
	Austrocochlea constricta		2																				2															1									2	3						
	Austrocochlea spp.																																																1				
	Austrolittorina unifasciata									4	4											4	4															5	3	3								5						
	Bembicium auratum	1																																																				
	Bembicium melanostomum																																																					
	Bembicium nanum																						2																															
	Brachidontes rostratus																																														5							
	Cabestana spengleri																																												1	1			1		2	1		
	Cabestana tabulata																																																					
	Cellana solida																																					3	2	2							4							
	Cellana tramoserica																														2																							
	Chiton glaucus	1								2			2									3	3								1	2						2			3	3	2		1		2	1	2					
	Chlorodiloma odontis																																														2							
	Clanculus undatus																																																					
	Clypidina rugosa																																														2							
	Cominella lineolata																														3	3						3	4	4							3	4						
	Crassostrea gigas									3	3			2								4	4								4	4		3				3	3	3		3						2						
	Dicathais orbita																																						2	1							4	3		1				
	Diloma concamerata																																															2						
	Haliotis rubra																																																			1		
	Ischnochiton australis											1																					1						2	3														
	Ischnochiton elongatus																																																					
	Ischnochiton variegatus																																									1												
	Lepsiella vinosa																															3																						
	Maoricolpus roseus															4	2																																				5	4
	Mytilus galloprovincialis	5	5	5	4					5	5	5	5	4			2					5	5	5	5						5	5	4	3			4	5	5	4	5	4			3		5	5						
	Notoacmea flammea																																														2							
	Notoacmea petterdi																																					3																
	Octopus tetricus																																																					
	Ostrea angasi																							3										2		5			1		3	2					1							
	Patella (Scutellastra) chapmani																																						2															
	Patella (Scutellastra) peronii																															3										3												
	Patelloida latistrigata										2																																					3						
	Patelloida victoriana																																																					
	Pecten fumatus																1											1																										
	Phallomedusa solida																																																					
	Plaxiphora albida																								1																													
	Pleurobranchaea maculata																																																1					
	Pleuroploca australasia																																																					
	Ranella australasia																																																					
	Sassia verrucosa																																																					
	Siphonaria diemenensis									4	4											5	5								5							5		4	5						5							
	Siphonaria funiculata									3	2																				2	4							5									4						
	Siphonaria spp.																																																					
	Siphonaria tasmanica																																																					
	Sypharochiton pelliserpentis				1					3	3		3									3	4		3						3	3						4	3	3	4	3					3	3						
	Tatea huonensis																																																					
	Turbo undulatus																																															3		3				
	Unidentified chiton																																	1																2				
	Xenostrobus pulex																																															5						
	Xenostrobus securis																																																					

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	10				11		12		13												14									15					16		17									18							
	Depth category	-1		0		2		2		-1		0			1			2			3	-1		0		1		2	3		-1		0		2	2		-1			0		1			2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			E			S		E	S	R		R		R		S	E		R		R		S	R		R			R		R	S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	1	1	2	1	2	1	2	1	2
Other	*Dorvillea australiensis*																																													2								
	Galeolaria caespitosa																																															4						
	Ikeda spp.																											2																										3
	Myxicola infundibulum					5	4	5	3									5	5	5								5							5		3							4	4	5							5	4
	Notoplana australis																																2																					
	Paraplanocera spp.																						1																															
	Polynoid polychaete																																																					
	Sabellastarte australiensis																																																					
	Sabellastarte spp.					3																																																
	Sabellid spp.																		3		3							4	3						3									1		3							2	
	Unidentified flatworm																															1		1								2												
	Unidentified invertebrates (tube matting)							3																									4																					
	Unidentified polychaete														2																																							
	Unidentified serpulids						4		4											3																									1									3
Sessile invertebrates	*Actinia tenebrosa*																								3													3	4	3							3	3						
	Anthothoe albocincta																																																					
	Ascidia sydneiensis						2	1	2									3	3									5							2																			1
	Ascidiella aspersa					5	4		4									2	2																																			
	Aulactinia veratra																																																					
	Botrylloides spp.														1						2																																	
	Ciona intestinalis																																		1																			
	Cnemidocarpa radicosa																																																					
	Corynactis australis																																																					
	Culicia spp.																																																					
	Cyanea rosella																																												1									
	Epiactis spp.																																																					
	Eudistoma constrictum																																																					
	Herdmania grandis																																		2																			
	Herdmania momus																																																					
	Oulactis mucosa																								2					2									2								4	4						
	Phlyctenanthus australis																																				2																	
	Pyura australis																																																					1
	Pyura gibbosa																																																4					
	Pyura stolonifera																											3			2	3												2				3	5					
	Sycozoa spp.																																																			3		3
	Unidentified anemone																												2																									
	Unidentified ascidians															1					1								1																									
	Unidentified sponges																				2								2																									
Species richness (total species per depth & habitat)		**9**	**6**	**7**	**10**	**7**	**8**	**4**	**8**	**11**	**12**	**5**	**6**	**4**	**7**	**6**	**7**	**6**	**7**	**9**	**7**	**13**	**16**	**5**	**9**	**6**	**1**	**8**	**8**	**4**	**17**	**17**	**7**	**8**	**8**	**5**	**9**	**14**	**19**	**16**	**7**	**11**	**4**	**5**	**12**	**11**	**21**	**22**	**9**	**6**	**9**	**8**	**6**	**11**
Total species richness (total species per site)		**16**				**12**		**9**		**37**												**38**									**32**					**11**		**42**									**55**							

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 19-24) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	19									20									21		22									23		24								
	Depth category	-1		0			1		2		-1		0			1		2		2		-1			0		1		2		2		-1		0			1		2	
	Habitat	R		R			R		R	S	R		R			R		S	E	S		R			R		R		S	E	S		R		R			R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	2	1	1	1	2	1	2	1	2	3	1	2	1	1
Barnacles	*Catomerus polymerus*	5	4								4	4											4										5	5							
	Chamaesipho tasmanica	5	5								5	5											5	3									5	5							
	Elminius modestus		3																			5																			
	Tetraclitella purpurascens	4	3																																						
	Unidentified barnacles													5											5																
Crustaceans	*Bellidilia undecimspinosa*																																								
	Brachynotus spinosus																																								
	Carcinus maenas																																								
	Cyclograpsus granulosus	2									3	3										3	3	3									3	3							
	Ebalia intermedia																																								
	Halicarcinus ovatus																																								
	Halicarcinus rostratus																																								
	Helograpsus haswellianus																																								
	Jasus edwardsii			3	3	3	3	2	3				1			3	2																								
	Lophopagurus nanus																																								
	Metacarcinus novaezelandiae																																								
	Munida gregaria																																								
	Naxia aurita																																								
	Notomithrax ursus											2																											1		
	Pagurid spp.																				1											1									
	Paguristes frontalis																																								
	Pagurixus handrecki																			3																					
	Palaemon dolospina																																								
	Palaemon intermedius																																								
	Palaemon serenus																																								
	Paragrapsus gaimardii																																								
	Paragrapsus laevis																																								
	Paragrapsus quadridentatus																							2																	
	Petrolisthes elongatus	4	4		4	2						3				3						4	4	3		4		3					4	5			4		5		
	Plagusia chabrus				1			1																														1			
	Strigopagurus strigimanus																			2																					
	Unidentified crab																																								
	Unidentified crab (decorator)																				2																				
	Unidentified hermit crab																																								
	Unidentified shrimp																																								
Echinoderms	*Amblypneustes ovum*																										1	4													
	Amphiura (Amphiura) constricta																																								
	Amphiura (Amphiura) elandiformis																																								
	Asterias amurensis																			4	4								2	2	4	1									
	Australostichopus mollis																																					1	1		
	Clarkcoma canaliculata																																								
	Comanthus tasmaniae																1																								
	Comanthus trichoptera						3	2	3								2																								
	Coscinasterias muricata															1		2													1							1	1	2	3
	Goniocidaris spp.																																								
	Goniocidaris tubaria																																								
	Heliocidaris erythrogramma							2	2							3	3		2		1					3	3	2		2								2	3		2
	Meridiastra calcar	3	3									2	4		3	3	4		2							1							4	4	4	4	3	4	4		3
	Patiriella regularis																					1		1		2	1								2						
	Petrolisthes elongatus																																								
	Tosia australis																																								
	Tosia magnifica																												1	2											1
	Uniophora granifera																																								1

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 19-24) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	19									20									21		22									23		24								
	Depth category	-1		0			1		2		-1		0			1		2		2		-1			0		1		2		2		-1		0			1		2	
	Habitat	R		R			R		R	S	R		R			R		S	E	S		R			R		R		S	E	S		R		R			R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	2	1	1	1	2	1	2	1	2	3	1	2	1	1
Molluscs	*Afrolittorina praetermissa*																					3																			
	Agnewia tritoniformis																																	1							
	Aplysia parvula																																								
	Aplysia spp.																				1											1									
	Aplysia sydneyensis																																								
	Argobuccinum pustulosum					2																																1			
	Austrocochlea constricta	2	3								3	4										2											4	4							
	Austrocochlea spp.			2													2																								
	Austrolittorina unifasciata		5								5	5										5	5	3									5	5							
	Bembicium auratum																																								
	Bembicium melanostomum																																1	2							
	Bembicium nanum																																3	2							
	Brachidontes rostratus	5																																							
	Cabestana spengleri				1			1					3	3	2	4	3		3	2					2		2				2		1		2		3	3			1
	Cabestana tabulata																1																								
	Cellana solida	4	3									3		4									3	3	2								2	3				1			
	Cellana tramoserica																																								
	Chiton glaucus																					3				1								1							
	Chlorodiloma odontis	3			2																																				
	Clanculus undatus																										1									4					
	Clypidina rugosa																																								
	Cominella lineolata	2	3			2						3																					4	4				1	2		
	Crassostrea gigas				4	2		3			3	2	3		4		3					4	4	4		4		4					3	3							
	Dicathais orbita	2	3		1	2						2	2	1	3										1	2								2	2	3	3				
	Diloma concamerata		3																															2							
	Haliotis rubra				1											1	2																		2				3		2
	Ischnochiton australis																											1													
	Ischnochiton elongatus											2																													
	Ischnochiton variegatus																																								
	Lepsiella vinosa																																								
	Maoricolpus roseus																																								
	Mytilus galloprovincialis	4	4								5	4	4	5	5	5	3		3			5	5	4	5	5	4	5					5	5	5	5	3		3		
	Notoacmea flammea										1	1				2									5																
	Notoacmea petterdi																					2			4																
	Octopus tetricus																				1																				
	Ostrea angasi						4	1	3						4	5	3		3								4	3		3						4	2		4		3
	Patella (Scutellastra) chapmani																																								
	Patella (Scutellastra) peronii		3																							3								3		4		2			
	Patelloida latistrigata		3																																						
	Patelloida victoriana																								2																
	Pecten fumatus																																								
	Phallomedusa solida																																								
	Plaxiphora albida											2														1							2	3							
	Pleurobranchaea maculata																																					1			
	Pleuroploca australasia																													1		1									
	Ranella australasia																									2													2		
	Sassia verrucosa																		1																						
	Siphonaria diemenensis	4																				5		4																	
	Siphonaria funiculata		3								4	4										3											5	5							
	Siphonaria spp.																																								
	Siphonaria tasmanica	1																																							
	Sypharochiton pelliserpentis	2	2		2						3	3										4	3	3									4	4							
	Tatea huonensis																																								
	Turbo undulatus			2	4	4		2	2					3	2	4	2																		3	4		3	3		1
	Unidentified chiton																																						2		
	Xenostrobus pulex		5								5	5																					5	5							
	Xenostrobus securis																																								

Appendix 16 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 19-24) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	**Site**	**19**									**20**									**21**		**22**									**23**		**24**								
	Depth category	**-1**		**0**			**1**		**2**		**-1**		**0**			**1**		**2**		**2**		**-1**			**0**		**1**		**2**		**2**		**-1**		**0**			**1**		**2**	
	Habitat	**R**		**R**			**R**		**R**	**S**	**R**		**R**			**R**		**S**	**E**	**S**		**R**			**R**		**R**		**S**	**E**	**S**		**R**		**R**			**R**		**S**	**E**
	Species / Replicate search	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**
Other	*Dorvillea australiensis*																																								
	Galeolaria caespitosa		3																				4											4							
	Ikeda spp.																			2	1								1												
	Myxicola infundibulum																			5	5								3	2	5	5									
	Notoplana australis																																								
	Paraplanocera spp.																																								
	Polynoid polychaete																																								
	Sabellastarte australiensis																										2														
	Sabellastarte spp.																			2																					
	Sabellid spp.																																								
	Unidentified flatworm																											2													
	Unidentified invertebrates (tube matting)																																								
	Unidentified polychaete																																								
	Unidentified serpulids																				3																				
Sessile invertebrates	*Actinia tenebrosa*	2	2																			3	3	3									4	4				3			
	Anthothoe albocincta				4							3													4								2	3		4					
	Ascidia sydneiensis																	3		5	3								3	1	4	3								4	
	Ascidiella aspersa																													1											
	Aulactinia veratra										2	3																													
	Botrylloides spp.																																								
	Ciona intestinalis																																								
	Cnemidocarpa radicosa																												2												
	Corynactis australis																		2											3					2	5					
	Culicia spp.																5													3											
	Cyanea rosella																																								1
	Epiactis spp.							3									3		3																1						
	Eudistoma constrictum																																								
	Herdmania grandis														3		2		3																						
	Herdmania momus																				2											3									
	Oulactis mucosa	3	3												1																		2	2	4			3			
	Phlyctenanthus australis							1							4	3	3		3								2			2			2	2			4		3		2
	Pyura australis															5		4	2						5		4			3								4			
	Pyura gibbosa			4	5	4		3					4			5	4		3							4		3					3	2	5	5	5	5	4		4
	Pyura stolonifera	3	3										4	5	3	5				5		4	4	2	5								3	3	2	5					
	Sycozoa spp.																				1							1		1											1
	Unidentified anemone							1																																	
	Unidentified ascidians																																								
	Unidentified sponges	0																																							
Species richness (total species per depth & habitat)		**20**	**22**	**4**	**12**	**8**	**3**	**12**	**5**	**0**	**12**	**21**	**8**	**7**	**12**	**14**	**18**	**3**	**12**	**9**	**12**	**16**	**12**	**13**	**11**	**12**	**10**	**10**	**6**	**13**	**5**	**7**	**24**	**29**	**12**	**11**	**8**	**16**	**15**	**2**	**13**
Total species richness (total species per site)						**43**									**44**					**17**						**52**					**9**						**52**				

Appendix 17: Rank abundances of invertebrates recorded during timed surveys (sites 1-9) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	1				2				3				4				5											6						7										8				9								
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2	-1		0		-1		0			1		2	
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S	R		R		R		R			R		S	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	1	2	1	2	1	2	1	2	3	1	2	1	2
Barnacles	*Catomerus polymerus*																																																								
	Chamaesipho tasmanica																																																								
	Cthamalus antennatus																																																								
	Elminius modestus	3	5			4	5			3	4			3	5				5										3	5					3	5									5	4			3	4							
	Tetraclitella purpurascens																																																								
Crustaceans	*Bellidilia undecimspinosa*																																																								2
	Carcinus maenas			2		2		1				2												2	1					3									1	2																	
	Cyclograpsus granulosus		2			3	4				4				4				3											3					3	4									3	3			3	4							
	Ebalia intermedia																																																								
	Halicarcinus ovatus																											3																													
	Halicarcinus rostratus			3				2				2																				2																						2			
	Helograpsus haswellianus	3	4							1																																															
	Jasus edwardsii																																																								
	Metacarcinus novaezelandiae															1												1					2								3			2			4								1		
	Naxia aurita																											1																5												1	
	Nectocarcinus integrifrons																															1										2															
	Notomithrax ursus																																																								
	Paguristes brevirostris																																																								
	Pagurixus handrecki																																																								
	Pagurus sinuatus																																																								
	Palaemon dolospina				1																																																				
	Palaemon intermedius																3																																								
	Palaemon serenus											3				2								2								4	3								2						3							1	2		
	Palaemon spp.			4								2									3		3			3											4		3			3	2													2	
	Paracilicaea spp.					2																																																			
	Paragrapsus gaimardii	1			1		4			2				1				2						1					1	2					2					1									3								
	Paragrapsus quadridentatus					2				3												1																																			
	Petrocheles australiensis															2																																									
	Petrolisthes elongatus					2			1	2	2	4	5	3	5		5		5	3	4	4	3	5	5	3	1	2	4	5	4				4	5	4	4	4		5	5	5				4	5	4	5	4	2		4	5		
	Petrolisthes spp.															4																																									
	Pilumnus tomentosus				1																																																				
	Plagusia chabrus																																																								
	Strigopagurus strigimanus																																																								
Echinoderms	*Allostichaster polyplax*																																																								
	Asterias amurensis			1	3			3	5	3	1	3	4	3	3	3	4	4		3	3	2	3	4	1	3	3	3			4	4	4	4	3	3	4	3	4		3	4	4	3			4	4	3	3	3	3	2	4	3	3	3
	Astrostole scaber																																																								
	Australostichopus mollis																																																								
	Comanthus tasmaniae																																																								
	Comanthus trichoptera																																																								
	Coscinasterias muricata																																																			1			1		
	Goniocidaris spp.																																																								
	Heliocidaris erythrogramma															2				3			2	2		3	3	2			1	3	3																						4	2	
	Holopneustes inflatus																																																								
	Meridiastra calcar																																																								
	Nectria ocellata																																																								
	Ophiomyxa australis																																																								
	Patiriella regularis			5	5			4	5	1		4	5		3	4	4	3	3	4	4	3	4	5	4	3	4	4	3	3	5	4	4	4	3	3	4	4	4	5	5	5	5	4			4	5	3	3	4	2		4	5	4	5
	Petricia vernicina																																																								
	Tosia australis																																																								
	Tosia magnifica																																																								
	Uniophora granifera																																																								

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 1-9) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	1				2				3				4				5											6						7										8				9								
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2	-1		0		-1		0			1		2	
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S	R		R		R		R			R		S	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	1	2	1	2	1	2	1	2	3	1	2	1	2
Molluscs	*Afrolittorina praetermissa*																																																								
	Agnewia tritoniformis																																																								
	Aphelodoris spp.																																																								
	Aplysia sydneyensis																															1		1																							
	Austrocochlea constricta																																																1							
	Austrocochlea porcata																																																								
	Austrolittorina unifasciata									1																																															
	Austromytilus rostratus																																																								
	Bembicium auratum					2																													3														2								
	Bembicium melanostomum						3												1											3						3																					
	Bembicium nanum	1																																															1								
	Cabestana spengleri																																																								
	Cabestana tabulata																																																								
	Cellana solida																												1																												
	Charonia lampas rubicunda																																																								
	Chiton glaucus																																																2							
	Chthamalus antennatus																																																								
	Cominella lineolata																																																	2			1			
	Crassostrea gigas	3	2	3	5		5			2	2			3	3			3	4		2		4						4	5					3	3									3	3		5		4							
	Dicathais orbita																																																								
	Diloma concamerata																																																								
	Electroma georgiana																																																								
	Equichlamys bifrons																																											1													
	Fusinus noveahollandiae																																																								
	Gibbomodiola albicostus				4																																																				
	Haliotis rubra																																																								
	Hastula brazieri																																																								
	Ischnochiton (Heterozona) cariosus																																																								
	Ischnochiton australis																				1	1			1				2		1									1		1						1	2	2	2	1	2	2			
	Ischnochiton elongatus																																																								
	Ischnochiton variegatus																																																								
	Lasaea australisÂ																												2						3										3												
	Limatula strangei															1																																									
	Maoricolpus roseus																																																								
	Mitra carbonaria																																																								
	Mitra glabra																																																								
	Mytilus galloprovincialis	4	5		5	4	5	5	5	5	5	4	5	5	5	5	5	5	5	3	4	5	4	5	5	3	3		5	5	5				4	5	4	4	4	5	3		4		5	4		5	4	5		3	5	3	3		
	Nassarius nigellus																																																								
	Notoacmea alta																																																								
	Notoacmea petterdi																																																								
	Octopus pallidus																																																								
	Octopus tetricus																																																								
	Ostrea angasi			5				4	5			4	5			5	4			4		5		5	3		2	2									4	1	4	5	3	5	5								4	2	4	2	4		
	Oxynoe viridis																																																								
	Patella (Scutellastra) peronii																																			2																					
	Plaxiphora albida																																																								
	Pleurobranchaea maculata											1																																				1									2
	Polycera capensis											1				1	2										2																											1			
	Rhyssoplax calliozona																																																								
	Saccostrea glomerata																														3																										
	Sassia verrucosa																																																								
	Scutus antipodes																																																					2		
	Siphonaria diemenensis																		2																															3							
	Siphonaria funiculata													3				2	3										2						2	2										1			2	3							
	Siphonaria tasmanica																																		1																						
	Sypharochiton pelliserpentis																																																								
	Trichomya hirsuta																																																								
	Turbo undulatus																																																								
	Xenostrobus pulex			3		3																																																			

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 1-9) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	1				2				3				4				5											6						7										8				9								
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2	-1		0		-1		0			1		2	
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S	R		R		R		R			R		S	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	1	2	1	2	1	2	1	2	3	1	2	1	2
Other	*Eunice laticeps*	2				1																																																			
	Galeolaria spp.																	2																																							
	Ikeda spp.																																																								
	Lepidonotus melanogrammus																																		1																						
	Myxicola infundibulum																									3		5						5								3	2													3	4
	Notoplana australis																	2	2										2																												
	Polynoid polychate																												1																												
	Sabellastarte australiensis																																																								
	Terebellidae spp.																												1																												
	Unidentified flatworm																															2																									
	Unidentified nemertean 1																												1																												
	Unidentified nemertean 2																							1																																	
	Unidentified nemertean 3					1																													1																						
	Unidentified polychaete																																		1																						
Sessile invertebrates	*Actinia tenebrosa*																																																								
	Anthothoe albocincta	2																																																							
	Ascidia sydneiensis																																											1													
	Carajoa sp.															4																																									
	Herdmania grandis																																																								
	Oulactis mucosa																																																								
	Phlyctenanthus australis																																																								
	Polycarpa viridis																																																								
	Pyura australis																																																								
	Pyura gibbosa																																																								
	Pyura stolonifera																																																								
	Sycozoa pulchra																																																								
	Unidentified anemone																																																								
	Unidentified ascidians																																																								
	Unidentified Pyrura sp.																											3						3										2													2
Species richness (total species per depth & habitat)		8	5	8	8	11	6	6	5	10	6	11	5	7	7	11	8	8	10	6	7	7	7	10	7	7	7	10	14	9	7	8	5	5	15	10	6	5	7	6	7	8	7	7	5	5	5	7	11	12	6	7	4	10	10	6	6
Total species richness (total species per site)		18				18				18				19				27											28						29										13				30								

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	10				11		12		13														14									15						16	17											18						
	Depth category	-1		0		2		2		-1		0			1				2			3	-1		0		1		2	3		-1		0			2	2	-1		0		1				2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			R	E			S		E	S	R		R		R		S	E		R		R			S	R	R		R		R		S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	3	1	1	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2
Barnacles	*Catomerus polymerus*		3							2	3																													3																
	Chamaesipho tasmanica		4							5	5													5	5																4	5												4						
	Cthamalus antennatus										4																																																
	Elminius modestus	4								4													3									2	4						5										4							
	Tetraclitella purpurascens																							4																									3	4						
Crustaceans	*Bellidilia undecimspinosa*						2																																																		
	Carcinus maenas																							2																														
	Cyclograpsus granulosus	3	4							2	2													2										4						2	3										2	3						
	Ebalia intermedia																																																						1
	Halicarcinus ovatus																																																						
	Halicarcinus rostratus					3		2														4					1		1		3																										3
	Helograpsus haswellianus																																																						
	Jasus edwardsii														2	2	3	2			2						2										3						1											3		
	Metacarcinus novaezelandiae														1											1																				1											
	Naxia aurita																		1			2																																
	Nectocarcinus integrifrons																																			1																		
	Notomithrax ursus																																								1													
	Paguristes brevirostris																														2																							
	Pagurixus handrecki																														2			3	3																			
	Pagurus sinuatus													1																																								
	Palaemon dolospina																																																						
	Palaemon intermedius																																																						
	Palaemon serenus			3												2	3																		3		1						3										1		
	Palaemon spp.							3																																														
	Paracilicaea spp.																																																						
	Paragrapsus gaimardii												1																																										
	Paragrapsus quadridentatus									2													2								3							3	2								2								
	Petrocheles australiensis																								2																													
	Petrolisthes elongatus	5	5		5					5	5	4		5	5	4		5					3	2	3	5	2					5	3						3	3	5	5	5	4		3			5	3	5	5			
	Petrolisthes spp.																																																						
	Pilumnus tomentosus																																																						
	Plagusia chabrus																																																						
	Strigopagurus strigimanus																														1																							
Echinoderms	*Allostichaster polyplax*														1																																							
	Asterias amurensis	2	2	5	5	4	4	3	4			3		1		3	2		3	4	4	5	3	3	3	4	3	2	3	4	3			4	4	3	5			1				4	4	5	5			2		1	3	4	4
	Astrostole scaber																																																						
	Australostichopus mollis							1	2																									1		2																				
	Comanthus tasmaniae																																																						
	Comanthus trichoptera																				2						1				1							1																		
	Coscinasterias muricata			1				2																		1																	3										3		
	Goniocidaris spp.																																																						1
	Heliocidaris erythrogramma			2				2	3						2	3	3	3			2				3		3	3		2				4				4						5	4	3	5	3			2	1			3	4
	Holopneustes inflatus							2																																														
	Meridiastra calcar																																																	4	4	2	2		
	Nectria ocellata																																																						
	Ophiomyxa australis																																																						
	Patiriella regularis			5	5	4	4	3	4			4	2	3	2	3	1	3					2		4		4	4							5	3	4	2						3	1		1				2					
	Petricia vernicina			1																																																		
	Tosia australis																																																						2
	Tosia magnifica							1																											1								2			2									2
	Uniophora granifera																																																				1		

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	10				11		12		13													14									15						16	17									18							
	Depth category	-1		0		2		2		-1		0			1				2			3	-1		0		1		2	3		-1		0			2	2	-1		0		1				2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			R	E			S		E	S	R		R		R		S	E		R		R			S	R	R		R		R		S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	3	1	1	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2
Molluscs	*Afrolittorina praetermissa*																																																						
	Agnewia tritoniformis									2																																													
	Aphelodoris spp.																		1																																				
	Aplysia sydneyensis																												4	5	3						5								5		2								
	Austrocochlea constricta									2														1															3	3															
	Austrocochlea porcata																																																						
	Austrolittorina unifasciata	3																					4	4									4						4	4								4	4						
	Austromytilus rostratus																								4																														
	Bembicium auratum																															1																							
	Bembicium melanostomum	2																															4																						
	Bembicium nanum									3														1								3							3	4															
	Cabestana spengleri																										3			2																							3		3
	Cabestana tabulata																																																				2		1
	Cellana solida										1																						1							2									3						
	Charonia lampas rubicunda																																														2					2		2	
	Chiton glaucus									3	1																															1													
	Chthamalus antennatus																							4																4									3						
	Cominella lineolata									3	3		3	3	2	2		2					3	1	3	1						3	3						2		2	4		3		1				2					
	Crassostrea gigas	3	4		2					3	4												3	1								4	3						4	4		2							3						
	Dicathais orbita																									1																3								3	3				
	Diloma concamerata																																																3						
	Electroma georgiana																																																						
	Equichlamys bifrons																																																						
	Fusinus noveahollandiae					1	3	1	3																																					3	1								1
	Gibbomodiola albicostus																																																						
	Haliotis rubra																																			4																2	2		
	Hastula brazieri																																																						
	Ischnochiton (Heterozona) cariosus																																																						
	Ischnochiton australis									2			3	3	2	2		3														2							1		3	3	2	2		2				1					
	Ischnochiton elongatus																	2																																					
	Ischnochiton variegatus																																																						
	Lasaea australisÂ	2								3																																													
	Limatula strangei																																													1									1
	Maoricolpus roseus							3												1	2						2		2															3		3	2								3
	Mitra carbonaria																																																						
	Mitra glabra																														1																							1	
	Mytilus galloprovincialis	5	5		5					5	5	4	5	4		2	3	4					5	5	4		3	5	3				3						4	5	3	4	2	3		3	3	4	5		5	5	4		1
	Nassarius nigellus																																																						
	Notoacmea alta										1																																												
	Notoacmea petterdi	2								3																																													
	Octopus pallidus								1																																						1								
	Octopus tetricus				1			1																																															
	Ostrea angasi											2	2	3	5	5	4	5			3				3	4	3	2		2	3							4			4					2	3								3
	Oxynoe viridis																																																						
	Patella (Scutellastra) peronii																																							4															
	Plaxiphora albida																																																						
	Pleurobranchaea maculata				1		1	2		3														2																			1												3
	Polycera capensis							1									2										2																	1		3									
	Rhyssoplax calliozona																																									2				2									
	Saccostrea glomerata																																																						
	Sassia verrucosa																																																						
	Scutus antipodes														2			1									1																												
	Siphonaria diemenensis	2	5							5	5												5	5									3						4	4															
	Siphonaria funiculata	3								5	3												5									4	3						4	3								3	3						
	Siphonaria tasmanica																																																						
	Sypharochiton pelliserpentis									5	3												4	2								3							2	3		3							2	3	1				
	Trichomya hirsuta																										3																												
	Turbo undulatus											4																																						4	5	4	3		
	Xenostrobus pulex									5	5																															3						4		4					

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	10				11		12		13													14									15						16	17									18							
	Depth category	-1		0		2		2		-1		0			1				2			3	-1		0		1		2	3		-1		0			2	2	-1		0		1				2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			R	E			S		E	S	R		R		R		S	E		R		R			S	R	R		R		R		S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	3	1	1	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2
Other	*Eunice laticeps*																																																						
	Galeolaria spp.																																							5								3							
	Ikeda spp.																												1		2																							1	2
	Lepidonotus melanogrammus																																																						
	Myxicola infundibulum								3											1									2	1																									
	Notoplana australis																																														1								
	Polynoid polychate																																																						
	Sabellastarte australiensis																																														1								
	Terebellidae spp.																																																						
	Unidentified flatworm																																																						
	Unidentified nemertean 1																																																						
	Unidentified nemertean 2																																																						
	Unidentified nemertean 3																																																						
	Unidentified polychaete	1																																																					
Sessile invertebrates	*Actinia tenebrosa*									2	3							3					2																2									2							
	Anthothoe albocincta																										2																												
	Ascidia sydneiensis					3	3		2										3			3																																5	3
	Carajoa sp.																																																						
	Herdmania grandis																																				2																		
	Oulactis mucosa									4													2									2																							
	Phlyctenanthus australis																								3		2																												
	Polycarpa viridis																																																					1	
	Pyura australis																																																					2	
	Pyura gibbosa																								3	3		3		1																						3		2	
	Pyura stolonifera																				4																																	5	
	Sycozoa pulchra																																																						
	Unidentified anemone																																																						
	Unidentified ascidians					3																															1										2								
	Unidentified Pyrura sp.																			2	2						3										4								3										
Species richness (total species per depth & habitat)		**13**	**8**	**6**	**7**	**6**	**6**	**14**	**8**	**23**	**16**	**6**	**6**	**8**	**10**	**10**	**8**	**11**	**4**	**4**	**8**	**4**	**15**	**16**	**12**	**6**	**18**	**6**	**7**	**7**	**10**	**11**	**11**	**5**	**4**	**6**	**6**	**5**	**16**	**18**	**6**	**10**	**10**	**10**	**4**	**14**	**12**	**10**	**12**	**11**	**7**	**8**	**11**	**10**	**17**
Total species richness (total species per site)		**22**				**8**		**17**		**49**													**48**									**30**						**5**	**47**									**50**							

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 10-18) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	**Site**	**19**										**20**									**21**		**22**								**23**		**24**							
	Depth category	**-1**		**0**			**1**		**2**			**-1**		**0**			**1**		**2**		**2**		**-1**		**0**	**1**			**2**		**2**		**-1**		**0**		**1**		**2**	
	Habitat	**R**		**R**			**R**		**R**		**S**	**R**		**R**			**R**		**S**	**E**	**S**		**R**		**R**	**R**			**S**	**E**	**S**		**R**		**R**		**R**		**S**	**E**
	Species / Replicate search	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**
Barnacles	*Catomerus polymerus*				3	3						4	5			1							5	5									4	4						
	Chamaesipho tasmanica	4	5									4	5										5	5									5	5						
	Cthamalus antennatus																																							
	Elminius modestus	3										3											3										5							
	Tetraclitella purpurascens	3	4									3	3																				3							
Crustaceans	*Bellidilia undecimspinosa*																																							
	Carcinus maenas																																							
	Cyclograpsus granulosus		3										3											3																
	Ebalia intermedia																												1											
	Halicarcinus ovatus																																							
	Halicarcinus rostratus																												1		3									
	Helograpsus haswellianus																																							
	Jasus edwardsii						4	3	2	3								2								2	2										2			
	Metacarcinus novaezelandiae																																							
	Naxia aurita																	1																						
	Nectocarcinus integrifrons																																							
	Notomithrax ursus																																							
	Paguristes brevirostris																					3									2									
	Pagurixus handrecki																																							
	Pagurus sinuatus																														1									
	Palaemon dolospina																																							
	Palaemon intermedius																																							
	Palaemon serenus						2																																	
	Palaemon spp.																																							
	Paracilicaea spp.																																							
	Paragrapsus gaimardii																																							
	Paragrapsus quadridentatus	3																																						
	Petrocheles australiensis																																							
	Petrolisthes elongatus	2	4	5								3	5				3	5						4	5		1										5			
	Petrolisthes spp.																																							
	Pilumnus tomentosus																																							
	Plagusia chabrus				1				1					1																							1	1		1
	Strigopagurus strigimanus																					1																		
Echinoderms	*Allostichaster polyplax*																																							
	Asterias amurensis																			1	4	3							3	3	3								3	2
	Astrostole scaber																																				1	2		
	Australostichopus mollis								1																															
	Comanthus tasmaniae																																							1
	Comanthus trichoptera						3	1	3	3							2										1													
	Coscinasterias muricata							1										3		4										2					2					3
	Goniocidaris spp.																																							
	Heliocidaris erythrogramma				1		3	2	2	1							2	3		3						2	3			2					1		2	3		1
	Holopneustes inflatus																																							
	Meridiastra calcar				1									4			4	3	2	5													2	3	3	4	5	5		5
	Nectria ocellata								1											2																				
	Ophiomyxa australis						2																																	
	Patiriella regularis																																							
	Petricia vernicina								1																															
	Tosia australis																																							
	Tosia magnifica																				1											2								1
	Uniophora granifera																	1									1										1	1		2

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 19-24) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	19										20									21		22								23		24							
	Depth category	-1		0			1		2			-1		0			1		2		2		-1		0	1			2		2		-1		0		1		2	
	Habitat	R		R			R		R		S	R		R			R		S	E	S		R		R	R			S	E	S		R		R		R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	2	1	2	1	1	2	3	1	1	1	2	1	2	1	2	1	2	1	1
Molluscs	*Afrolittorina praetermissa*												1																											
	Agnewia tritoniformis																																							
	Aphelodoris spp.																																							
	Aplysia sydneyensis																				1						3		1											
	Austrocochlea constricta												3											2										2						
	Austrocochlea porcata												1																					3						
	Austrolittorina unifasciata	4										5	5										4	3									5	5						
	Austromytilus rostratus																																							
	Bembicium auratum	1																																						
	Bembicium melanostomum																																							
	Bembicium nanum																							2																
	Cabestana spengleri																3	4		1		2			2				2	3							3	3		1
	Cabestana tabulata																1																					2		
	Cellana solida	3	4										3										1	3									3	3						
	Charonia lampas rubicunda																													1		2					2			
	Chiton glaucus											2																												
	Chthamalus antennatus		3		4	5																		5										3						
	Cominella lineolata												2											2											1	2	1			
	Crassostrea gigas											2	4										3	2									3	2						
	Dicathais orbita			3	2	3	2								3		2	3							3	2	2								2	3	4	3		
	Diloma concamerata	3	4										3											1																
	Electroma georgiana																					3																		
	Equichlamys bifrons																																							
	Fusinus noveahollandiae																				1	3							3		2	2								
	Gibbomodiola albicostus																																							
	Haliotis rubra							3									3								1	1									4		2	3		1
	Hastula brazieri																		2																					
	Ischnochiton (Heterozona) cariosus																1																							
	Ischnochiton australis			2									3												2		1													
	Ischnochiton elongatus																																							
	Ischnochiton variegatus		2																															2						
	Lasaea australisÂ																																							
	Limatula strangei																																							
	Maoricolpus roseus																																							
	Mitra carbonaria																																					3		
	Mitra glabra			1															2																					
	Mytilus galloprovincialis	4		5		3	4					5	5	5	5	4	5	5		5	2	2	5	5	5	4	5			5			5	5	5	4	5	5		5
	Nassarius nigellus																					5																		
	Notoacmea alta																																							
	Notoacmea petterdi		3										3																											
	Octopus pallidus																																							
	Octopus tetricus																																						1	
	Ostrea angasi						5		5	3	2						3	2		5							4			5						3		4		
	Oxynoe viridis																														1									
	Patella (Scutellastra) peronii																																							
	Plaxiphora albida											1																												
	Pleurobranchaea maculata																																							
	Polycera capensis																																							
	Rhyssoplax calliozona																																							
	Saccostrea glomerata																																							
	Sassia verrucosa						2		3																															
	Scutus antipodes																																		1					
	Siphonaria diemenensis	4	4										3											4									3	3						
	Siphonaria funiculata	4										5											3	4										2						
	Siphonaria tasmanica												3											1																
	Sypharochiton pelliserpentis				4	2							3										3	2									2					1		
	Trichomya hirsuta																																							
	Turbo undulatus			3	3	3	3	4		3							1	3																	2	4		4		
	Xenostrobus pulex	4			5	5																											2							

Appendix 17 cont.: Rank abundances of invertebrates recorded during timed surveys (sites 19-24) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	**Site**	**19**										**20**									**21**		**22**								**23**		**24**							
	Depth category	**-1**		**0**			**1**		**2**			**-1**		**0**			**1**		**2**		**2**		**-1**		**0**	**1**			**2**		**2**		**-1**		**0**		**1**		**2**	
	Habitat	**R**		**R**			**R**		**R**		**S**	**R**		**R**			**R**		**S**	**E**	**S**		**R**		**R**	**R**			**S**	**E**	**S**		**R**		**R**		**R**		**S**	**E**
	Species / Replicate search	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**
Other	*Eunice laticeps*																																							
	Galeolaria spp.	3																						5									3							
	Ikeda spp.										3								2		2	3									2	1								
	Lepidonotus melanogrammus																																							
	Myxicola infundibulum																																							
	Notoplana australis																																							
	Polynoid polychate																																							
	Sabellastarte australiensis																	3								2											2			
	Terebellidae spp.																																							
	Unidentified flatworm																																							
	Unidentified nemertean 1																																							
	Unidentified nemertean 2																																							
	Unidentified nemertean 3																																							
	Unidentified polychaete																																							
Sessile invertebrates	*Actinia tenebrosa*	3				2						3	4			2								3									3							
	Anthothoe albocincta											2														4														
	Ascidia sydneiensis																				4	4							3		4	5							3	1
	Carajoa sp.																																							
	Herdmania grandis																																							
	Oulactis mucosa	2																						3									3	3						
	Phlyctenanthus australis																																							
	Polycarpa viridis																				3											3								
	Pyura australis																																							
	Pyura gibbosa													5	4			5							3	3									5		5			3
	Pyura stolonifera											1											3										4							
	Sycozoa pulchra																				1																			
	Unidentified anemone																										2		2											
	Unidentified ascidians																																							
	Unidentified Pyrura sp.																												3		2									
Species richness (total species per depth & habitat)		**16**	**10**	**6**	**9**	**8**	**10**	**6**	**9**	**5**	**2**	**14**	**20**	**4**	**3**	**3**	**12**	**14**	**4**	**8**	**9**	**10**	**10**	**20**	**7**	**8**	**11**	**0**	**9**	**7**	**9**	**6**	**16**	**14**	**10**	**6**	**15**	**14**	**3**	**13**
Total species richness (total species per site)		**41**										**48**									**14**		**44**								**12**		**45**							

Appendix 18: Rank abundances of fish recorded during timed surveys (sites 1-9) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	1				2				3				4			
	Depth category	-1		1		-1		0		-1		1		-1		1	
	Habitat	R		R		R		R	E	R		R		R		R	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2
Fish	*Acanthaluteres spilomelanurus*				1												
	Acanthaluteres vittiger																
	Afurcagobius tamarensis							2									
	Alabes dorsalis																
	Ammotretis rostratus																
	Aplodactylus arctidens																
	Aracana aurita																
	Arenigobius bifrenatus				1												
	Arripis trutta																
	Atherinid spp.																
	Blennid spp.																
	Brachaluteres jacksonianus							1									
	Brachionichthys hirsutus																
	Callorhinchus milii																
	Cyttus australis																
	Dinolestes lewini																
	Diodon nicthemerus												1				2
	Dotalabrus aurantiacus																
	Eocallionymus papilio																
	Favonigobius lateralis				1								2			3	3
	Forsterygion gymnotum												2				
	Forsterygion varium												3				2
	Galaxiid spp.							5									
	Girella zebra																
	Gobiid spp.			1													
	Heteroclinus johnstoni																
	Heteroclinus perspicillatus																
	Hippocampus abdominalis																
	Hippocampus bleekeri				2								1				
	Lactoria cornuta																
	Latridopsis forsteri																
	Lepidotrigla mulhalli																
	Lepidotrigla papilio																
	Leptatherina presbyteroides																
	Meuschenia australis																
	Meuschenia freycineti																
	Monacanthid spp.																
	Neoodax balteatus																
	Neosebastes scorpaenoides																
	Nesogobius hinsbyi																
	Nesogobius maccullochi								3								
	Nesogobius sp. 6																
	Notolabrus fucicola																
	Notolabrus tetricus																
	Omegophora armilla																
	Parablennius tasmanianus											1	2				2
	Parapriacanthus elongatus																
	Pegasus lancifer																
	Pelates sexlineatus																
	Pempheris multiradiata																
	Phyllopteryx taeniolatus																
	Pictilabrus laticlavius																
	Platycephalid spp.																
	Platycephalus bassensis																
	Pseudaphritis urvillii																
	Pseudolabrus psittaculus																
	Pseudophycis bachus																
	Pseudophycis barbata																
	Sarda australis																
	Scorpaena papillosa																
	Scorpis aequipinnis																
	Trachinops caudimaculatus											5	4				5
	Trachurus novaezelandiae																
	Trinorfolkia clarkei								1								
	Tripterygiid spp.																
	Unidentified seahorse																
	Vincentia conspersa																1

Site	5											6					
Depth category	-1		0			1					2	-1		0	1		
Habitat	R		R			R			E		S	R		R	R		S
Species / Replicate search	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1
Acanthaluteres spilomelanurus																	
Acanthaluteres vittiger																	
Afurcagobius tamarensis			3					2							2		
Alabes dorsalis	1	1															
Ammotretis rostratus																	
Aplodactylus arctidens																	
Aracana aurita								1									
Arenigobius bifrenatus																	
Arripis trutta																	
Atherinid spp.																	
Blennid spp.																	
Brachaluteres jacksonianus																	
Brachionichthys hirsutus																	
Callorhinchus milii																	
Cyttus australis																	
Dinolestes lewini																	
Diodon nicthemerus									1								
Dotalabrus aurantiacus																	
Eocallionymus papilio																	
Favonigobius lateralis						2											
Forsterygion gymnotum			2					1		1						1	
Forsterygion varium						2	1	2	2	1						1	
Galaxiid spp.																	
Girella zebra																	
Gobiid spp.																	
Heteroclinus johnstoni																	
Heteroclinus perspicillatus																	
Hippocampus abdominalis																1	
Hippocampus bleekeri															2		
Lactoria cornuta																	
Latridopsis forsteri																	
Lepidotrigla mulhalli																	
Lepidotrigla papilio																	
Leptatherina presbyteroides																	
Meuschenia australis																	
Meuschenia freycineti								1									
Monacanthid spp.									1								
Neoodax balteatus										1							
Neosebastes scorpaenoides																	
Nesogobius hinsbyi										2							
Nesogobius maccullochi				4									3			3	
Nesogobius sp. 6																	
Notolabrus fucicola																	
Notolabrus tetricus																	
Omegophora armilla										1							
Parablennius tasmanianus							2	1		3					1	2	
Parapriacanthus elongatus																	
Pegasus lancifer																	
Pelates sexlineatus																	
Pempheris multiradiata																	
Phyllopteryx taeniolatus																	
Pictilabrus laticlavius																	
Platycephalid spp.																	
Platycephalus bassensis															2		
Pseudaphritis urvillii																	1
Pseudolabrus psittaculus																	
Pseudophycis bachus																	
Pseudophycis barbata																	
Sarda australis																	
Scorpaena papillosa																	
Scorpis aequipinnis																	
Trachinops caudimaculatus				3		4	4	4	4	3					4	2	
Trachurus novaezelandiae																	
Trinorfolkia clarkei																	
Tripterygiid spp.																	
Unidentified seahorse																	
Vincentia conspersa								1									

Site	7											8				9									
Depth category	-1		0			1				2		-1		0		-1		0			1		2		
Habitat	R		R			R		E		S		R		R		R		R			R		S		
Species / Replicate search	1	2	1	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	1	2	3
Acanthaluteres spilomelanurus																									
Acanthaluteres vittiger																									
Afurcagobius tamarensis			3								4			3										3	
Alabes dorsalis	1											1				2									
Ammotretis rostratus																									
Aplodactylus arctidens																									
Aracana aurita																									
Arenigobius bifrenatus																									
Arripis trutta														3											
Atherinid spp.																		3		4					
Blennid spp.																									
Brachaluteres jacksonianus																									
Brachionichthys hirsutus																									
Callorhinchus milii																									
Cyttus australis																									
Dinolestes lewini																									
Diodon nicthemerus									1													1			
Dotalabrus aurantiacus																									
Eocallionymus papilio														1											
Favonigobius lateralis																									
Forsterygion gymnotum			2	3		1			1					3	3				2	2		1	3		
Forsterygion varium							3	2	3										3	2		2			3
Galaxiid spp.																									
Girella zebra																									
Gobiid spp.										2									1			2			
Heteroclinus johnstoni																									
Heteroclinus perspicillatus														1	1										
Hippocampus abdominalis																									
Hippocampus bleekeri																								1	
Lactoria cornuta																									
Latridopsis forsteri																									
Lepidotrigla mulhalli																									
Lepidotrigla papilio																									
Leptatherina presbyteroides																									
Meuschenia australis																									
Meuschenia freycineti																									
Monacanthid spp.																									
Neoodax balteatus									2		1												1		
Neosebastes scorpaenoides																									
Nesogobius hinsbyi							2	2	3									2							3
Nesogobius maccullochi				3					2						2										3
Nesogobius sp. 6																									
Notolabrus fucicola																									
Notolabrus tetricus																				2					
Omegophora armilla										1															
Parablennius tasmanianus				1			1							2											
Parapriacanthus elongatus																			4			2			
Pegasus lancifer																									
Pelates sexlineatus																									
Pempheris multiradiata																									
Phyllopteryx taeniolatus																									
Pictilabrus laticlavius																									
Platycephalid spp.																									
Platycephalus bassensis										1													1	1	1
Pseudaphritis urvillii																									
Pseudolabrus psittaculus																									
Pseudophycis bachus																									
Pseudophycis barbata																									
Sarda australis																									
Scorpaena papillosa																						1			
Scorpis aequipinnis																									
Trachinops caudimaculatus			3	3		4	2	3	4										3	3		4	2		
Trachurus novaezelandiae																									
Trinorfolkia clarkei						1			1																
Tripterygiid spp.																					3				
Unidentified seahorse																									
Vincentia conspersa																									

Appendix 18 cont.: Rank abundances of fish recorded during timed surveys (sites 1-9) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	1				2				3				4				5											6						7											8				9									
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2		-1		0		-1		0			1		2		
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S		R		R		R		R			R		S		
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	1	2	3
Elasmobranchs	*Cephaloscyllium laticeps*																																																										
	Dasyatis brevicaudata																																																										
	Dipturus whitleyi																																																										
	Urolophus cruciatus																															1	1																							1			1
	Urolophus paucimaculatus																																																										
Species richness (total species per depth & habitat)		0	0	1	4	0	0	3	2	0	0	2	7	0	0	1	6	1	1	2	2	0	3	3	8	4	7	0	0	0	1	6	7	1	1	0	3	4	0	3	4	3	8	3	2	1	0	6	3	1	0	2	5	5	1	8	4	3	5
Total species richness (total species per site)		5				5				7				6				16											11						14											8				18									

Appendix 18 cont.: Rank abundances of fish recorded during timed surveys (sites 10-18) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	10				11		12		13												14									15					16		17									18							
	Depth category	-1		0		2		2		-1		0			1			2			3	-1		0		1		2	3		-1		0		2	2		-1			0		1			2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			E			S		E	S	R		R		R		S	E		R		R		S	R		R			R		R	S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	1	1	2	1	2	1	2	1	2
Fish	*Acanthaluteres spilomelanurus*																																				3																	
	Acanthaluteres vittiger																									2																												
	Afurcagobius tamarensis																		3									1							3																		3	
	Alabes dorsalis				2																										1	1																						
	Ammotretis rostratus																																												1									
	Aplodactylus arctidens																																								1	2												
	Aracana aurita																													1						1								1	1									2
	Arenigobius bifrenatus																																																					
	Arripis trutta			3	3									2										1													3					1		4										
	Atherinid spp.											4																													4													
	Blennid spp.																													2																								
	Brachaluteres jacksonianus																												1																									
	Brachionichthys hirsutus																		1																																			
	Callorhinchus milii																																																					
	Cyttus australis																																																					
	Dinolestes lewini																																				4																	
	Diodon nicthemerus															1									1	2			2							1					2							1		2	1		
	Dotalabrus aurantiacus																																																	1	1		
	Eocallionymus papilio																																																					
	Favonigobius lateralis																																																					
	Forsterygion gymnotum			3	3							3	3	4										1	3					1							3	1			3	3		3	2	1								
	Forsterygion varium								1				2	3		3	4			2					3	2	4							3		3					3		3		3	3						2		
	Galaxiid spp.																																																					
	Girella zebra																																								1													
	Gobiid spp.															3	3	3																																				
	Heteroclinus johnstoni																																																					
	Heteroclinus perspicillatus			1										2																												2	1						1					
	Hippocampus abdominalis								1																																													
	Hippocampus bleekeri																																		1																			
	Lactoria cornuta																																														2							
	Latridopsis forsteri																									1																									4	2		
	Lepidotrigla mulhalli																																																					
	Lepidotrigla papilio																			1								1																										
	Leptatherina presbyteroides																								3																	3												
	Meuschenia australis																																																					
	Meuschenia freycineti																																																			1		
	Monacanthid spp.																																																					
	Neoodax balteatus															2	2		1	3	1					3	1			2						3	3							1							1	2		2
	Neosebastes scorpaenoides																																																					
	Nesogobius hinsbyi						3		3											2																									1									2
	Nesogobius maccullochi													2																																								
	Nesogobius sp. 6																									2																												
	Notolabrus fucicola																										1									2					2	2									1			
	Notolabrus tetricus													3											2	2	3									3	4				2	3			2				2		3	3		
	Omegophora armilla																									1											1																1	
	Parablennius tasmanianus				3							2	3	3											3								1	3								3	2		1				2					
	Parapriacanthus elongatus																																																					
	Pegasus lancifer																			1																																		
	Pelates sexlineatus																																																					
	Pempheris multiradiata																										2									2									2									
	Phyllopteryx taeniolatus																																																			2		
	Pictilabrus laticlavius																																				1																	
	Platycephalid spp.															1					1																																	
	Platycephalus bassensis					3	3	2	2									1	3									2									1							1	1	2							2	2
	Pseudaphritis urvillii																																																					
	Pseudolabrus psittaculus																													1																					1			
	Pseudophycis bachus						1													2																2																		
	Pseudophycis barbata																											1																										
	Sarda australis																																																					
	Scorpaena papillosa															1	2																																					
	Scorpis aequipinnis																																																					
	Trachinops caudimaculatus													2	3	4	4			3	2					4	4		3	4						4	1								4						4	3		
	Trachurus novaezelandiae															2																																						
	Trinorfolkia clarkei																										2																2											
	Tripterygiid spp.														2						2																																	
	Unidentified seahorse																2										1																											
	Vincentia conspersa																																																					

Appendix 18 cont.: Rank abundances of fish recorded during timed surveys (sites 10-18) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	10				11		12		13												14									15					16		17									18							
	Depth category	-1		0		2		2		-1		0			1			2			3	-1		0		1		2	3		-1		0		2	2		-1			0		1			2	-1		0		1		2	
	Habitat	R		R		S		S		R		R			E			S		E	S	R		R		R		S	E		R		R		S	R		R			R		R	S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	1	1	2	1	2	1	2	1	2
Elasmobranchs	*Cephaloscyllium laticeps*																																				2																1	
	Dasyatis brevicaudata																																																					
	Dipturus whitleyi													1																																								
	Urolophus cruciatus						2		1						1	1					1								1							2								2		1						1	2	2
	Urolophus paucimaculatus																																		2																			
Species richness (total species per depth & habitat)		0	0	3	4	1	4	1	5	0	0	3	3	9	3	8	7	2	4	7	5	0	0	2	5	9	9	4	3	7	1	1	1	2	3	9	12	1	0	0	7	9	4	6	10	4	1	0	4	0	8	10	5	5
Total species richness (total species per site)		5				4		5		26												26									6					18		21									21							

Appendix 18 cont.: Rank abundances of fish recorded during timed surveys (sites 19-24) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	Site	19								20										21		22									23		24								
	Depth category	-1		0			1		2	-1			0			1		2		2		-1			0		1		2		2		-1		0			1		2	
	Habitat	R		R			R		R	S	R		R			R		S	E	S		R			R		R		S	E	S		R		R			R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	1	1	2	1	2	3	1	2	1	2	1	1	1	2	1	2	1	2	3	1	2	1	1
Fish	*Acanthaluteres spilomelanurus*																																								
	Acanthaluteres vittiger							2							1											3	3	3													
	Afurcagobius tamarensis																																								
	Alabes dorsalis																																								
	Ammotretis rostratus																																								
	Aplodactylus arctidens				2		1																															1	1		
	Aracana aurita									1			1			1	1															1			1			2			
	Arenigobius bifrenatus																																								
	Arripis trutta																	4																							
	Atherinid spp.																																								
	Blennid spp.																																								
	Brachaluteres jacksonianus						1																					1													
	Brachionichthys hirsutus																																								
	Callorhinchus milii																														1										
	Cyttus australis																			1																					
	Dinolestes lewini						4		4				2				3										4			3					3			4			
	Diodon nicthemerus												1														1											1			
	Dotalabrus aurantiacus						2	2	2				1			1	1										1			1											1
	Eocallionymus papilio																																								
	Favonigobius lateralis																																								
	Forsterygion gymnotum																																								
	Forsterygion varium						1									1		1																							
	Galaxiid spp.																																								
	Girella zebra																																								
	Gobiid spp.																																								
	Heteroclinus johnstoni							1																																	
	Heteroclinus perspicillatus																									1															
	Hippocampus abdominalis																																								
	Hippocampus bleekeri																																								
	Lactoria cornuta																																								
	Latridopsis forsteri						3	1	2							1											1	2							2			3	2		1
	Lepidotrigla mulhalli																														1										
	Lepidotrigla papilio																																								
	Leptatherina presbyteroides									4																															
	Meuschenia australis														1																				1						
	Meuschenia freycineti																																		1						
	Monacanthid spp.																																								
	Neoodax balteatus					1	3	2	3																		2	2		2											2
	Neosebastes scorpaenoides							1												1											1										
	Nesogobius hinsbyi																				3									2											
	Nesogobius maccullochi																															3									
	Nesogobius sp. 6																																								
	Notolabrus fucicola			2			2						3	1	2	2	2								2	2	2	4							3	2	1	1	2		
	Notolabrus tetricus			2	2	2	4	3	3	1			3			3	3	3								2	2	3		3					2		2	3	3		3
	Omegophora armilla						1																																		
	Parablennius tasmanianus												1		1											2															
	Parapriacanthus elongatus																																								
	Pegasus lancifer																																								
	Pelates sexlineatus																																2	2							
	Pempheris multiradiata						3											2									3	2													
	Phyllopteryx taeniolatus																										1														2
	Pictilabrus laticlavius						2	3	3							2		2																							
	Platycephalid spp.																																								
	Platycephalus bassensis									2										3	3								1		3	3									
	Pseudaphritis urvillii																																								
	Pseudolabrus psittaculus																																								
	Pseudophycis bachus																				1																	1			
	Pseudophycis barbata																																								
	Sarda australis																																				2				
	Scorpaena papillosa						2																																		
	Scorpis aequipinnis				1																																				
	Trachinops caudimaculatus				3		4		4	4			3			4	3										5			3											
	Trachurus novaezelandiae																																								
	Trinorfolkia clarkei							1																															1		
	Tripterygiid spp.																																								
	Unidentified seahorse																																								
	Vincentia conspersa																																								

Appendix 18 cont.: Rank abundances of fish recorded during timed surveys (sites 19-24) in February-March 2010. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m... Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2009/2010	**Site**	**19**								**20**										**21**		**22**									**23**		**24**								
	Depth category	**-1**		**0**			**1**		**2**	**-1**			**0**			**1**		**2**		**2**		**-1**			**0**		**1**		**2**		**2**		**-1**		**0**			**1**		**2**	
	Habitat	**R**		**R**			**R**		**R**	**S**	**R**		**R**			**R**		**S**	**E**	**S**		**R**			**R**		**R**		**S**	**E**	**S**		**R**		**R**			**R**		**S**	**E**
	Species / Replicate search	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**
Elasmobranchs	*Cephaloscyllium laticeps*																																								
	Dasyatis brevicaudata																											1													
	Dipturus whitleyi																																								
	Urolophus cruciatus																				2									1											
	Urolophus paucimaculatus								1	2								1			1											2									1
Species richness (total species per depth & habitat)		**0**	**0**	**2**	**4**	**2**	**14**	**9**	**8**	**6**	**0**	**0**	**8**	**1**	**4**	**8**	**6**	**6**	**0**	**3**	**5**	**0**	**0**	**0**	**1**	**5**	**11**	**8**	**1**	**7**	**4**	**4**	**1**	**1**	**7**	**1**	**3**	**8**	**5**	**0**	**6**
Total species richness (total species per site)		**20**								**18**										**7**		**18**									**7**		**17**								

Appendix 19: Rank abundances of fish recorded during timed surveys (sites 1-9) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	1				2				3				4				5											6						7										8				9								
	Depth category	-1		1		-1		0		-1		1		-1		1		-1		0			1					2	-1		0	1			-1		0			1				2	-1		0		-1		0			1		2	
	Habitat	R		R		R		R	E	R		R		R		R		R		R			R			E		S	R		R	R		S	R		R			R		E		S	R		R		R		R			R		S	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	3	1	2	3	1	2	1	1	2	1	1	2	1	1	2	1	2	3	1	2	1	2	1	1	2	1	2	1	2	1	2	3	1	2	1	2
Elasmobranchs	*Cephaloscyllium laticeps*																																																								
	Dasyatis brevicaudata																											1																													
	Urolophus cruciatus																																																								1
Fish	*Acanthaluteres spilomelanurus*																															1																								1	
	Acanthaluteres vittiger															1																	2															1								1		
	Alabes dorsalis																								1				1										1										1				2	2				
	Aldrichetta forsteri																																																								
	Aplodactylus arctidens																																																								
	Aracana aurita																																																								
	Arenigobius bifrenatus			2																																																					
	Arripis georgianus																			2																																					
	Arripis trutta																																											1													
	Atherinid spp.																																																								
	Atypichthys strigatus																																																								
	Brachaluteres jacksonianus																																																								
	Brachionichthys hirsutus																																																								
	Cheilodactylus spectabilis																																																								
	Conger verreauxi																																																								
	Creocele cardinalis																																																								
	Diodon nicthemerus																																									1					1										
	Dotalabrus aurantiacus																																																								
	Favonigobius lateralis																																																								
	Forsterygion gymnotum											3	3			3	2			2				2													3			3		1										1		2	1		
	Forsterygion varium											3	2			3	3			3	1		2	2		2	3						2				3	2		3		2	3				2				2			3	1	2	1
	Gymnapistes marmoratus				1																										1																										
	Heteroclinus johnstoni																																					1																			
	Heteroclinus tristis																																																								
	Hippocampus abdominalis																																																								
	Hippocampus bleekeri																																																								
	Latridopsis forsteri																																																								
	Lepidotrigla papilio																																																								
	Meuschenia australis																																									1												1			
	Meuschenia freycineti																																																								
	Neoodax balteatus															3	3			1						3	2					2	3							1														3		3	3
	Nesogobius hinsbyi			3				2				2								2						1						3					1			1																3	
	Nesogobius maccullochi				2																																					1															2
	Nesogobius spp.																																	1																							
	Notolabrus fucicola																																																								
	Notolabrus tetricus																																																					3			
	Pagrus auratus																																																								
	Parablennius tasmanianus																1								1		1				1		2							2							2	2					1		1		
	Pempheris multiradiata															2							1																															2			
	Pictilabrus laticlavius																																																								
	Platycephalid spp.																																																								
	Platycephalus bassensis																											2						2																							
	Platycephalus richardsoni																																											2													
	Platycephalus speculator																																											2													
	Pseudocaranx georgianus																																																								
	Pseudophycis bachus																																																								
	Rhombosolea tapirina																																																								
	Scorpaena papillosa																															1																									
	Scorpis lineolata																																																								
	Siphonognathus attenuatus																																																								
	Siphonognathus beddomei																																																								
	Trachinops caudimaculatus											4	5							2		1	3	1		3	3						2							3																	
	Trachinops taeniatus																4																																								
	Trachurus declivis																																											3													
	Trinorfolkia clarkei											1															1																														
	Upeneichthys vlamingii																										1																														
	Vincentia conspersa																1																																								
Mammals	*Arctocephalus pusillus*																																																								
Species richness (total species per depth & habitat)		0	0	2	2	0	0	1	0	0	0	5	3	0	0	5	6	0	0	6	1	1	3	3	2	4	6	2	1	0	2	4	5	2	0	0	3	2	1	6	0	5	1	4	0	0	4	2	0	0	1	2	2	6	4	4	4
Total species richness (total species per site)		4				1				5				8				13											12						15										5				13								

Appendix 19 cont.: Rank abundances of fish recorded during timed surveys (sites 10-18) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

2024	Site	10				11		12		13												
	Depth category	-1		0		2		2		-1		0			1				2			3
	Habitat	R		R		S		S		R		R			R	E			S		E	S
	Species / Replicate search	1	2	1	2	1	2	1	2	1	2	1	2	3	1	1	2	3	1	2	1	1
Elasmobranchs	Cephaloscyllium laticeps																			1		
	Dasyatis brevicaudata																					
	Urolophus cruciatus					1											2	1	1	2		1
Fish	Acanthaluteres spilomelanurus															3	1					
	Acanthaluteres vittiger			2					2									2			1	
	Alabes dorsalis																					
	Aldrichetta forsteri																					
	Aplodactylus arctidens																					
	Aracana aurita																					
	Arenigobius bifrenatus																					
	Arripis georgianus																					
	Arripis trutta																					
	Atherinid spp.																					
	Atypichthys strigatus																					
	Brachaluteres jacksonianus																		1			
	Brachionichthys hirsutus								1												1	
	Cheilodactylus spectabilis																					
	Conger verreauxi																					
	Creocele cardinalis																					
	Diodon nicthemerus				1											2	1					
	Dotalabrus aurantiacus			1																		
	Favonigobius lateralis																					
	Forsterygion gymnotum																2				1	
	Forsterygion varium			3	2			2	2						2	3	3	2	2		3	
	Gymnapistes marmoratus																					
	Heteroclinus johnstoni																					
	Heteroclinus tristis																1					
	Hippocampus abdominalis																					
	Hippocampus bleekeri							1														
	Latridopsis forsteri																					
	Lepidotrigla papilio					1																
	Meuschenia australis			1																		
	Meuschenia freycineti																					
	Neoodax balteatus			2				3	2						2	3	3	2				
	Nesogobius hinsbyi																					
	Nesogobius maccullochi					3	1	2	1										2			3
	Nesogobius spp.																					
	Notolabrus fucicola																					
	Notolabrus tetricus			1											1	2	2	2				
	Pagrus auratus																				1	
	Parablennius tasmanianus			1	1																	
	Pempheris multiradiata																2				2	
	Pictilabrus laticlavius			2													2	2				
	Platycephalid spp.																					
	Platycephalus bassensis					1	2												3	2	2	
	Platycephalus richardsoni																					
	Platycephalus speculator					3													2			3
	Pseudocaranx georgianus																					
	Pseudophycis bachus																					
	Rhombosolea tapirina																			1		
	Scorpaena papillosa																					
	Scorpis lineolata																					
	Siphonognathus attenuatus																					
	Siphonognathus beddomei																					
	Trachinops caudimaculatus			2													1	3				
	Trachinops taeniatus																					
	Trachurus declivis																					
	Trinorfolkia clarkei																3					
	Upeneichthys vlamingii																					
	Vincentia conspersa																1					
Mammals	Arctocephalus pusillus																					
Species richness (total species per depth & habitat)		0	0	9	3	5	2	4	5	0	0	0	0	0	3	5	13	7	6	4	7	3
Total species richness (total species per site)		10				5		6		22												

2024	Site	14									15						16
	Depth category	-1		0		1		2	3		-1		0			2	2
	Habitat	R		R		R		S	E		R		R			S	R
	Species / Replicate search	1	2	1	2	1	2	1	1	2	1	2	1	2	3	1	1
Elasmobranchs	Cephaloscyllium laticeps																1
	Dasyatis brevicaudata																
	Urolophus cruciatus																1
Fish	Acanthaluteres spilomelanurus																
	Acanthaluteres vittiger					2	3						1				
	Alabes dorsalis																
	Aldrichetta forsteri																
	Aplodactylus arctidens																
	Aracana aurita																
	Arenigobius bifrenatus																
	Arripis georgianus																
	Arripis trutta			3													
	Atherinid spp.																
	Atypichthys strigatus																
	Brachaluteres jacksonianus																
	Brachionichthys hirsutus							1						1			
	Cheilodactylus spectabilis																
	Conger verreauxi																
	Creocele cardinalis																
	Diodon nicthemerus																
	Dotalabrus aurantiacus																
	Favonigobius lateralis																
	Forsterygion gymnotum														2		
	Forsterygion varium					2	1		2				2		3		3
	Gymnapistes marmoratus																
	Heteroclinus johnstoni																
	Heteroclinus tristis																
	Hippocampus abdominalis												1		1		
	Hippocampus bleekeri																
	Latridopsis forsteri																
	Lepidotrigla papilio																
	Meuschenia australis																
	Meuschenia freycineti						1										
	Neoodax balteatus			1		3							4	1	3		2
	Nesogobius hinsbyi								2								
	Nesogobius maccullochi																
	Nesogobius spp.																
	Notolabrus fucicola																1
	Notolabrus tetricus					1	1								2		2
	Pagrus auratus																
	Parablennius tasmanianus												2	2			
	Pempheris multiradiata					2											1
	Pictilabrus laticlavius																
	Platycephalid spp.													2			
	Platycephalus bassensis								2							2	
	Platycephalus richardsoni																
	Platycephalus speculator																
	Pseudocaranx georgianus							3									
	Pseudophycis bachus					1											
	Rhombosolea tapirina																
	Scorpaena papillosa								1						1		
	Scorpis lineolata																
	Siphonognathus attenuatus																
	Siphonognathus beddomei														1		
	Trachinops caudimaculatus												2		2		
	Trachinops taeniatus																
	Trachurus declivis																
	Trinorfolkia clarkei														3		
	Upeneichthys vlamingii														1		
	Vincentia conspersa					1											
Mammals	Arctocephalus pusillus																
Species richness (total species per depth & habitat)		0	0	2	0	7	4	2	4	0	0	0	6	4	10	1	7
Total species richness (total species per site)		14									15						7

2024	Site	17									18							
	Depth category	-1		0		1				2	-1		0		1		2	
	Habitat	R		R		R		S	E	R	R		R		R		E	
	Species / Replicate search	1	2	1	2	1	2	1	1	1	1	2	1	2	1	2	1	2
Elasmobranchs	Cephaloscyllium laticeps														1	1		
	Dasyatis brevicaudata																	
	Urolophus cruciatus																1	
Fish	Acanthaluteres spilomelanurus								1									
	Acanthaluteres vittiger																	1
	Alabes dorsalis												2					
	Aldrichetta forsteri				3													
	Aplodactylus arctidens													1	1			
	Aracana aurita					1												
	Arenigobius bifrenatus				2													
	Arripis georgianus																	
	Arripis trutta																	
	Atherinid spp.																	
	Atypichthys strigatus															3		
	Brachaluteres jacksonianus																	
	Brachionichthys hirsutus																	
	Cheilodactylus spectabilis														1			
	Conger verreauxi													1	1			
	Creocele cardinalis												1					
	Diodon nicthemerus												1			1		
	Dotalabrus aurantiacus								2				1			1		
	Favonigobius lateralis																	
	Forsterygion gymnotum						1											
	Forsterygion varium					2	3		3	3			2			1		2
	Gymnapistes marmoratus																	
	Heteroclinus johnstoni																	
	Heteroclinus tristis																	
	Hippocampus abdominalis																	
	Hippocampus bleekeri																	
	Latridopsis forsteri														1			
	Lepidotrigla papilio																	
	Meuschenia australis																	
	Meuschenia freycineti																	
	Neoodax balteatus					2	3		3						2	2	1	2
	Nesogobius hinsbyi																	
	Nesogobius maccullochi																	
	Nesogobius spp.																	
	Notolabrus fucicola												2	1	2			
	Notolabrus tetricus				2		2	1	1				3	2	3	3	3	1
	Pagrus auratus																	
	Parablennius tasmanianus			1			1											
	Pempheris multiradiata								3	3					4	4		3
	Pictilabrus laticlavius														2	1		2
	Platycephalid spp.																	
	Platycephalus bassensis																	
	Platycephalus richardsoni																	
	Platycephalus speculator																	
	Pseudocaranx georgianus																	
	Pseudophycis bachus												1					
	Rhombosolea tapirina																	
	Scorpaena papillosa																	
	Scorpis lineolata														2	3		
	Siphonognathus attenuatus																	
	Siphonognathus beddomei																	
	Trachinops caudimaculatus																	3
	Trachinops taeniatus																	
	Trachurus declivis																	
	Trinorfolkia clarkei						2		3									
	Upeneichthys vlamingii																	
	Vincentia conspersa																	
Mammals	Arctocephalus pusillus																	
Species richness (total species per depth & habitat)		0	0	1	3	3	6	1	7	2	0	0	8	4	11	10	3	7
Total species richness (total species per site)		12									21							

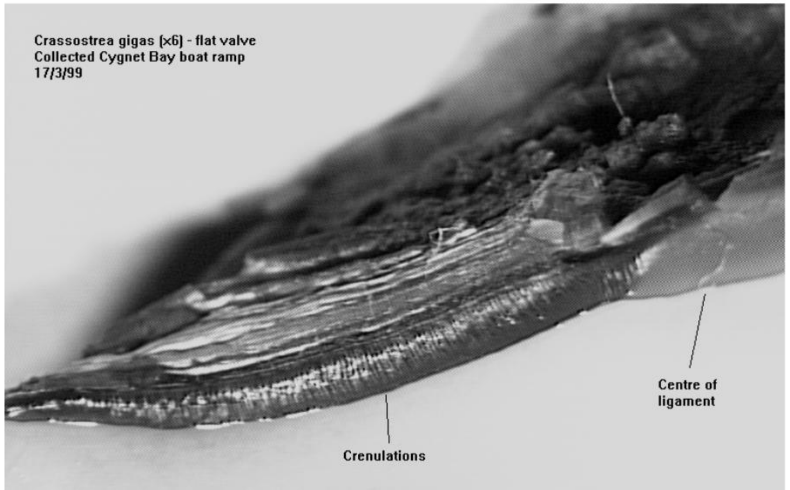
Appendix 19 cont.: Rank abundances of fish recorded during timed surveys (sites 19-24) in 2023-2024. Depth categories: -1= intertidal; 0 = 0–0.9m; 1= 1–4.9m; 2 = 5–8.9 m; 3 = 9–15m. Habitat categories: R = reef; E = ecotone (reef-sand); S = sand.

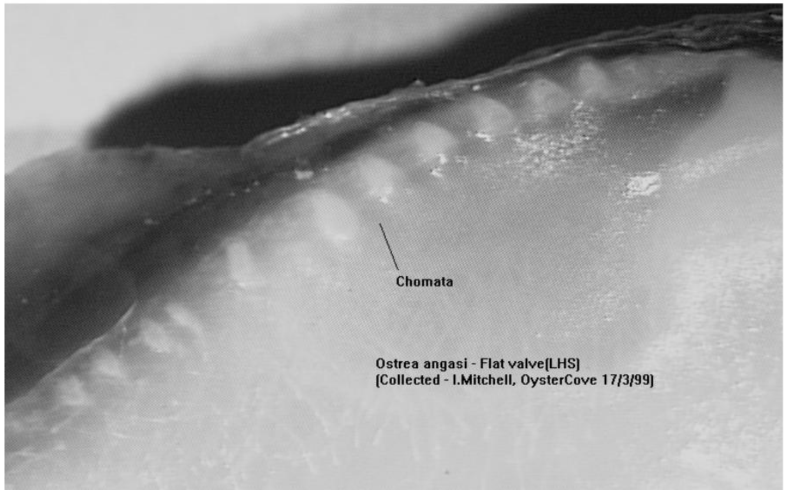
2024	Site	19										20									21		22								23		24							
	Depth category	-1		0			1		2			-1		0			1		2		2		-1		0	1			2		2		-1		0		1		2	
	Habitat	R		R			R		R		S	R		R			R		S	E	S		R		R	R			S	E	S		R		R		R		S	E
	Species / Replicate search	1	2	1	2	3	1	2	1	2	1	1	2	1	2	3	1	2	1	1	1	2	1	2	1	1	2	3	1	1	1	2	1	2	1	2	1	2	1	1
Elasmobranchs	*Cephaloscyllium laticeps*						2	1																																
	Dasyatis brevicaudata																																							
	Urolophus cruciatus																																							
Fish	*Acanthaluteres spilomelanurus*																									2														
	Acanthaluteres vittiger																																							
	Alabes dorsalis																																							
	Aldrichetta forsteri																																							
	Aplodactylus arctidens				3		1	1	1									1																			1	3		1
	Aracana aurita																													2								1		
	Arenigobius bifrenatus																																							
	Arripis georgianus																																							
	Arripis trutta																																							
	Atherinid spp.			4																																				
	Atypichthys strigatus								3	2																											3	3		
	Brachaluteres jacksonianus																																							
	Brachionichthys hirsutus																					1																		
	Cheilodactylus spectabilis				2			1									1	1								1											2			2
	Conger verreauxi																																							
	Creocele cardinalis																																							
	Diodon nicthemerus							1																														1		
	Dotalabrus aurantiacus						2	1	1	3							1										1			1										
	Favonigobius lateralis																					1																		
	Forsterygion gymnotum																																							
	Forsterygion varium								1	3								1		3										2					2	2	4	3		3
	Gymnapistes marmoratus																																							
	Heteroclinus johnstoni																																							
	Heteroclinus tristis																																							
	Hippocampus abdominalis																																							
	Hippocampus bleekeri																																							
	Latridopsis forsteri								2	3																												3		
	Lepidotrigla papilio																																							
	Meuschenia australis																																							
	Meuschenia freycineti																																							
	Neoodax balteatus																									3				1										
	Nesogobius hinsbyi																																							
	Nesogobius maccullochi																																							
	Nesogobius spp.																																							
	Notolabrus fucicola			2	2	3				2							1	1		1						2	1								2		1	3		
	Notolabrus tetricus			3	3	1	3	2	3	3							2			3						2	3			2					1	3	2	3		3
	Pagrus auratus																																							
	Parablennius tasmanianus																																							
	Pempheris multiradiata								3	3																				1							3	3		2
	Pictilabrus laticlavius				1		3	3	3	2							1	1								2											2			1
	Platycephalid spp.																																							
	Platycephalus bassensis																				1										1								2	
	Platycephalus richardsoni																																							
	Platycephalus speculator																																							
	Pseudocaranx georgianus																																							
	Pseudophycis bachus																																							
	Rhombosolea tapirina																					1							1											
	Scorpaena papillosa																1																					1		
	Scorpis lineolata								3	3							2																				1	3		
	Siphonognathus attenuatus																		1																					
	Siphonognathus beddomei									1																2				1										
	Trachinops caudimaculatus							3		3																														
	Trachinops taeniatus																																							
	Trachurus declivis																																							
	Trinorfolkia clarkei							2																																
	Upeneichthys vlamingii										2																													2
	Vincentia conspersa																																							
Mammals	*Arctocephalus pusillus*																													1										
Species richness (total species per depth & habitat)		0	0	3	5	2	5	9	9	11	1	0	0	0	0	0	7	5	1	3	1	3	0	0	0	7	3	0	1	8	1	0	0	0	3	2	9	11	1	7
Total species richness (total species per site)		18										10									4		13								1		15							

Appendix 20. Results of oyster samples randomly collected for taxonomic validation. Depth code is -1 = intertidal, 0 = 0-1 m depth, 1 = 1-5 m depth, 2 = 5-10 m depth.

Site	**Depth code**	***Ostrea angasi***	***Crasostrea gigas***	***Intermediate***
Cadbury Point	**1**	*0*	*15*	
Bedlam Walls north	**0**	*2*	*15*	
Bedlam Walls north	**1**	*3*	*6*	*2*
Blackman's Bay Blowhole	-1	0	7	
Blackman's Bay Blowhole	0	1	6	
Blackman's Bay Blowhole	1	6	0	
Blackman's Bay Blowhole	2	3	6	2
White Rock	-1	0	11	
White Rock	0	0	2	
White Rock	1	1	8	
White Rock	2	2	9	
Tranmere Point	-1	0	4	
Tranmere Point	0	0	4	
Tranmere Point	1	2	0	
Tranmere Point	2	NA	NA	
Crayfish Point	-1	NA	NA	
Crayfish Point	0	0	2	
Crayfish Point	1	2	3	
Crayfish Point	2	3	5	
Alum Cliffs	-1	0	7	
Alum Cliffs	0	NA	NA	
Alum Cliffs	1	1	5	
Alum Cliffs	2	0	10	
Rosny Point	-1	0	5	
Rosny Point	0	0	5	
Rosny Point	1	2	3	
Rosny Point	2	NA	NA	
Geilston	-1	0	7	
Geilston	0	0	5	
Geilston	1	NA	NA	
Geilston	2	NA	NA	
Bellerive Bluff	-1	0	6	
Bellerive Bluff	0	5	0	1
Bellerive Bluff	1	0	3	1
Bellerive Bluff	2	NA	NA	
Sum of samples		33	163	

Appendix 21. Diagnostic features for differentiating between *Crassostrea gigas* and *Ostrea angasi*. Top image shows distinct hinge crenulations visible on the flat valve of *C. gigas* adjacent to the centre of the ligament, visible internally once the shell is opened. The lower image shows distinct chomata (teeth) on the flat valve of *O. angasi*, adjacent to the ligament once the shell is opened. Image credit to Iona Mitchell.





Appendix 22. Results of *O. angasi* specific taqman qPCR test was performed in triplicate for each sample taken. Depth code is -1 = intertidal, 0 = 0-1 m depth, 1 = 1-5 m depth, 2 = 5-10 m depth.

Site	Depth	Morph ID	Notes	Angasi qPCR result	Mean cq	Stdev cq
Crayfish Point	1	Angasi	Molecular ID uncertain	Equivocal	NA	NA
Rosny Point	1	Angasi	Molecular ID uncertain	Equivocal	NA	NA
Crayfish Point	2	Angasi	Molecular ID uncertain	Equivocal	NA	NA
Bedlam Walls	2	Angasi	Morph ID doesn't match molecular ID	Negative	NA	NA
Bellerive Bluff	0	Angasi	Morph ID is same as molecular ID	Positive	27.49794	0.081604
Bedlam Walls	2	Angasi	Morph ID is same as molecular ID	Positive	27.15422	0.042087
Bellerive Bluff	0	Angasi	Morph ID is same as molecular ID	Positive	27.43168	0.218543
Rosny Point	1	Angasi	Morph ID is same as molecular ID	Positive	25.98565	0.288709
Tranmere Point	1	Angasi	Morph ID is same as molecular ID	Positive	27.07966	0.230846
White Rock	1	Angasi	Morph ID is same as molecular ID	Positive	27.78405	0.177997
White Rock	2	Angasi	Morph ID is same as molecular ID	Positive	26.70605	0.205183
Bedlam Walls	0	Angasi	Morph ID is same as molecular ID	Positive	26.80519	0.158581
Blackman's Bay Blowhole	2	Pacific	Molecular ID uncertain	Inhibited	NA	NA
Geilston	0	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Rosny Point	0	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Rosny Point	-1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bedlam Walls	2	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bedlam Walls	0	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Alum Cliffs	-1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bellerive Bluff	-1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Geilston	-1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Tranmere Point	-1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Cadbury Point	1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Cadbury Point	1	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bedlam Walls	0	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bedlam Walls	0	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Bedlam Walls	2	Pacific	Morph ID is same as molecular ID	Negative	NA	NA
Blackman's Bay Blowhole	2	Pacific	Morph ID doesn't match molecular ID	Positive	26.52947	0.279779
Bedlam Walls	2	Unknown	Morph ID uncertain	Negative	NA	NA
Bellerive Bluff	1	Unknown	Morph ID uncertain	Positive	26.52709	0.159374
Bellerive Bluff	0	Unknown	Morph ID uncertain	Positive	26.85987	0.20236
Bedlam Walls	2	Unknown	Morph ID uncertain	Positive	26.57376	0.224183