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Kamay Ferry Wharves Seagrass Monitoring Program: Final baseline report

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Document control

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Glossary and list of abbreviations

Term or abbreviation	Definition
ANOVA	Analysis of Variance
ARUP	Arup Pty Ltd
Baseline Surveys	The four Baseline Surveys completed as part of the Kamay Ferry Wharves seagrass pre-construction monitoring program
Buffer Area	Temporary construction footprint comprising a 15 metre buffer around the Construction Footprint (permanent)
Cardno	Cardno Pty Ltd, now Stantec
CHIRP	Compressed High-Intensity Radiated Pulse
Construction Footprint	Permanent construction footprint for the wharf structures
CPCe	Coral Point Count with Excel extensions
DoD	Depth of Disturbance
DPI	The NSW Department of Primary Industries
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EIS	Environmental Impact Statement
EIS study area	Study area adopted in the Project EIS (TfNSW 2021a)
FM Act	*Fisheries Management Act 1994* (NSW)
Halophila	Seagrass species from the genus *Halophila*, predominantly *Halophila ovalis* but may also include *Halophila decipiens*
Inner Transect	Transect extending across monitoring sites (PB-K05, PB-K06, PB-K07, PB-K08) along the inner edge (from the shoreline) of the largest seagrass bed at Kurnell, with monitoring sites positioned at increasing distances from the Construction Footprint
IOD	Indian Ocean Dipole
Monitoring sites	Monitoring sites established as part of the Kamay Ferry Wharves seagrass pre-construction monitoring program
Niche	Niche Environment and Heritage Pty Ltd
nMDS	Non-metric Multidimensional Scaling
Outer Transect	Transect extending across monitoring sites (PB-K01, PB-K02, PB-K03, PB-K04) along the outer edge (from the shoreline) of the largest seagrass bed at Kurnell, with monitoring sites positioned at increasing distances from the Construction Footprint
PCoA	Principle Coordinates Analysis
PERMANOVA	Permutational multivariate ANOVA
Posidonia	The seagrass species *Posidonia australis*
Project	The reinstatement of the ferry wharves at La Perouse and Kurnell in Botany Bay (the Project)
Project Boundary	Project area as delineated by Transport for New South Wales
Reference sites	Reference sites are identified within the Seagrass Monitoring Program as a basis to compare against trends or pattens identified among the potential impact sites. As it cannot be established that the reference sites are free from any other sources of

Term or abbreviation	Definition
	impact or stressors, other than the project construction, they cannot be considered 'control' sites.
Seagrass Monitoring Program	The Kamay Ferry Wharves seagrass pre-construction monitoring program
Survey Area	Survey area for the current assessment, incorporating subtidal areas of seagrass habitat within 50-100 metres of the Project Boundary
Shoot (seagrass)	A shoot is considered the section of seagrass from the sheath up and may consist of one or various leaves
TfNSW	Transport for New South Wales
The Ecology Lab	The Ecology Lab Pty Ltd
Zostera	Seagrass species from the genus Zostera, predominantly *Zostera capricorni* but may also include *Zostera muelleri*

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1. Introduction

1.1 Project background

Transport for New South Wales (TfNSW) is proposing to reinstate the ferry wharves at La Perouse and Kurnell in Botany Bay (the Project). The Project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework and is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC Act referral 2020/8825).

The Project would allow for an alternative to the road connection between La Perouse and Kurnell. Its main purpose would be to operate a public ferry service for visitors and the community. In addition, the Project would provide supplementary temporary moorings for tourism-related commercial vessels and recreational boating.

A Marine Biodiversity Assessment Report was prepared as part of the Environmental Impact Statement (EIS) (TfNSW 2021a). This report identified that the Project would result in impact to seagrasses, including the endangered *Posidonia australis* ecological community and population in Botany Bay, listed under the *Fisheries Management Act* 1994 (FM Act). Impacts on seagrasses will include some direct losses of seagrass within the permanent Construction Footprint and associated temporary 15 metre buffer (Buffer Area) from shading, along with disturbances during construction works and ongoing operation of the wharves and ferries (TfNSW 2021a). In addition, a large and significant bed of *P. australis* seagrass located adjacent to and beyond the Project Boundary at Kurnell is considered of ecological significance to the population in Botany Bay and an important conservation requirement of the Project.

The Project Boundary for the Baseline Surveys encompasses the Construction Footprints and Buffer Areas at Kurnell and La Perouse, as well as a broader area including the known seagrass areal extents in proximity to the Project works. The Baseline Surveys have been completed within this Project Boundary.

Investigations of seagrass in or nearby the Project Boundary at La Perouse and Kurnell have found seagrass bed areal extent and morphology (i.e. shoot density, leaf length) to be highly temporally and spatially variable, especially off Silver Beach at Kurnell. In some places, areal extent was wider than previously mapped (Larkum and West 1990, Otway and Macbeth 1999, NSW DPI 2021). At both La Perouse and Kurnell, several vessel moorings within or adjacent to the Project Boundaries are likely to be having, and may have ongoing, impacts on seagrass areal extent in these areas. At Kurnell in particular, exposure to large easterly swells is considered a major driver of temporal changes in seagrasses within the Project Boundary and expansion of the adjacent large *P. australis* bed to the east (Niche 2022b). The *Zostera* and *Halophila* species of seagrass are typically much more widely distributed within the Project Boundary. These species colonise new areas much earlier and more quickly than *P. australis* and undergo much greater temporal fluctuations in areal extent, density and dominance, which is typically driven by environmental conditions and establishment from the seed bank within the locality (Waycott et al 2014).

1.2 Project description

The Project includes the construction of two new wharves, one at La Perouse and one at Kurnell. The wharves would be designed to accommodate ferries up to 40 metres in length, along with recreational and commercial vessels up to 20 metres in length.

The total construction period is anticipated to take up to 13 months and will require the following:

- Use of a temporary crane and rig platform (onshore) to install nearshore piles and piers at La Perouse.

- Construction of a causeway to provide piling shoot access to install nearshore piles and piers at Kurnell.
- Repositioning and anchoring of a jack-up barge to provide a platform for construction works for the wharves.

1.3 Monitoring purpose

The EIS (TfNSW 2021a) has identified the need for establishment of a Seagrass Monitoring Program that includes Baseline Surveys and is designed to determine construction and operation impacts associated with the Project.

The pre-construction monitoring requires four Baseline Surveys and two years of data collection to obtain a sufficient baseline dataset. It is required to determine baseline areal extent and condition of seagrasses both within and adjacent to the Project Boundary to guide final offset requirements and provide a foundation by which any changes in the adjacent large *P. australis* bed following construction can be detected. The purpose of the Seagrass Monitoring Program is to identify any large-scale changes in seagrass composition and areal extent within the Project Boundary and monitor for any changes in the adjacent large bed of *P. australis* at Kurnell during construction and operation that may be attributable to the Project.

To date, this Seagrass Monitoring Program has successfully completed the four Baseline Surveys over two years, as required by the EIS, to establish a sufficient baseline to determine construction and operation impacts. This report presents the findings of the fourth baseline monitoring survey (referred to as Baseline 4) completed in summer 2022/23 (section 4). The report also details temporal trends or changes that have occurred across the seagrass beds throughout the baseline monitoring period (complete baseline dataset) (section 5).

1.4 Baseline monitoring to date

This report details the methods and findings of the Baseline 4 survey completed in December 2022 (summer 2022/23). The Baseline 1 survey was completed in winter 2021 (Niche 2021a), Baseline 2 in summer 2022 (Niche 2022a) and Baseline 3 in winter 2022 (Niche 2022b), Table 1.

Table 1: Baseline monitoring surveys completed to date

Survey	Season	Survey date	Period	Reference
Baseline 1	Winter 2021	July – September 2021	Pre-construction	Niche (2021a)
Baseline 2	Summer 2022	February – April 2022	Pre-construction	Niche (2022a)
Baseline 3	Winter 2022	August – September 2022	Pre-construction	Niche (2022b)
Baseline 4	Summer 2022/23	December 2022	Pre-construction	Current report

Survey sites and habitat mapping: La Perouse Baseline 4 (summer 2022/23)

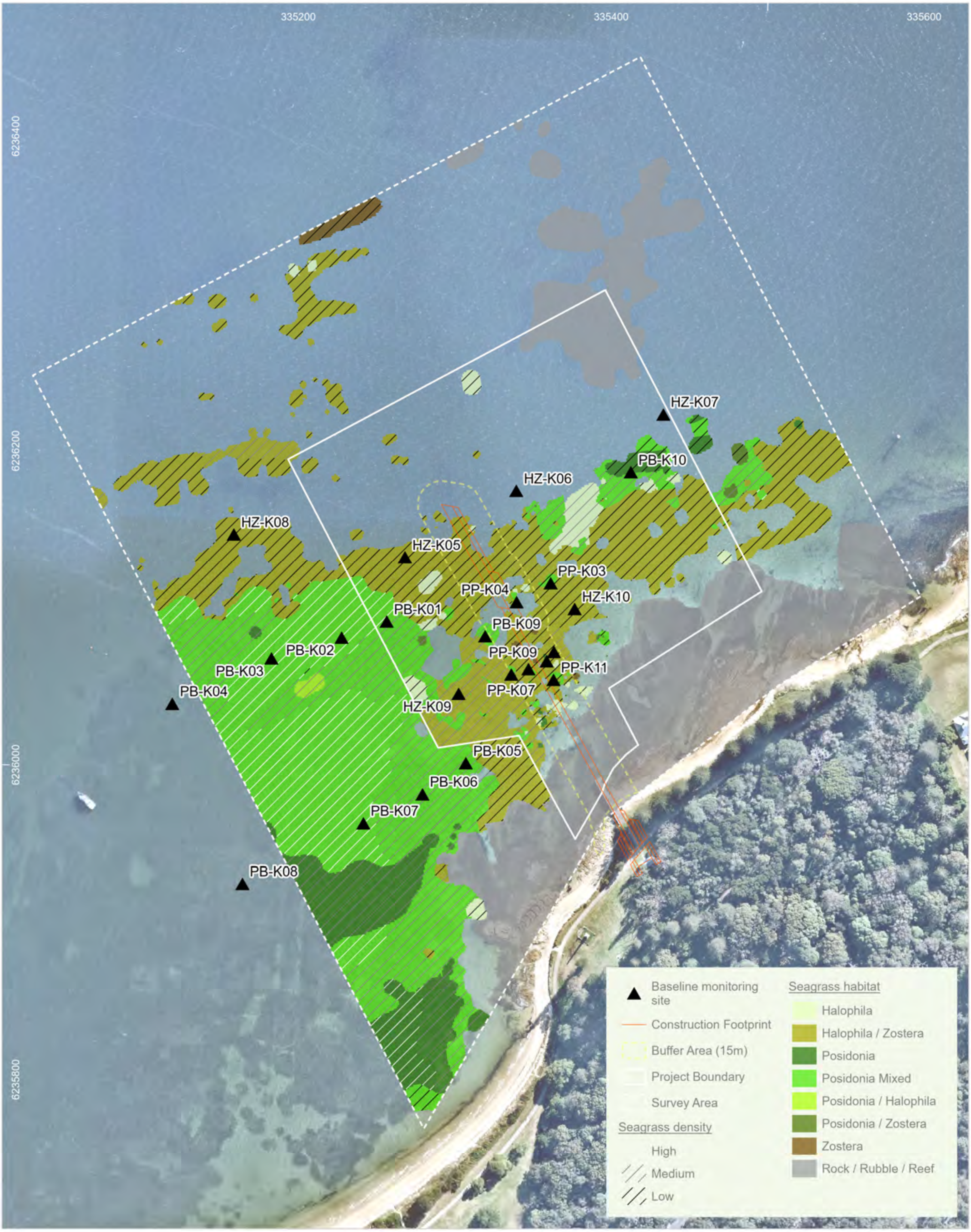
Kamay Ferry seagrass monitoring

0 50 m
WGS 1984 Web Mercator

Niche PM: Luke Stone
Niche Proj. #: 7476
Client: Transport for NSW

Figure 1

Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to WGS1984 Web Mercator Auxilliary Sphere is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020, using the relevant MGA zone.



Environment and Heritage

0 50
m
WGS 1984 Web Mercator

Niche PM: Luke Stone
Niche Proj. #: 7476
Client: Transport for NSW

Survey sites and habitat mapping: Kurnell
Baseline 4 (summer 2022/23)
Kamay Ferry seagrass monitoring

Figure 2

Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to WGS1984 Web Mercator Auxilliary Sphere is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020, using the relevant MGA zone.

2. Review of existing information

2.1 Past and present development in the locality

A public ferry service operated between the previous ferry wharves (located within the current Project Boundary) at La Perouse and Kurnell intermittently for 75 years until the wharves were damaged in 1974 by a heavy storm.

At both La Perouse and Kurnell, several vessel moorings located within or adjacent to the Project Boundaries are likely to be having, and may have ongoing, impacts on seagrass areal extent in these areas. A large seawall has been established at Frenchmans Beach immediately north of the Project Boundary at La Perouse, with wave refraction from this structure contributing to extensive shoreline erosion in 2022 (Niche 2022a).

There has also been a significant level of landscape modification in the wider locality of Botany Bay and across its catchment since European settlement. In recent times, major development projects within Botany Bay and along its shoreline include the:

- Port Botany Expansion project.
- Kurnell Ports and Berthing Facility, Prince Charles Parade, Kurnell and Botany Bay.
- Kurnell Desalination Plant and Associated Infrastructure.

The Port Botany Expansion project EIS (URS 2003) identified the following categories of human activities and potential effects relating to aquatic habitats and ecosystems within Botany Bay:

- Modification of aquatic habitats including port and airport developments, establishment of groyne fields at Lady Robinsons Beach and Silver Beach, stream realignment of waterways entering the Bay, dredging to facilitate navigation and fill material extraction as well as the widespread establishment of hard surfaces along intertidal and subtidal areas.
- Shipping activities and operations, including the potential for spillages, ballast water exchange, and the introduction of exotic species on ship hulls.
- Water quality and sediment contamination from industrial activities, resultant from catchment-wide activities as well as specific industrial contamination within the Bay.
- Fishing activities, both indirectly through habitat modification to support fishing activities and directly by removing individuals across a wide range of species.
- Introduction of exotic species associated with commercial shipping including toxic dinoflagellates, as well as *Caulerpa taxifolia* (an aquatic pest species under Schedule 1 of the *Biosecurity Regulation* 2017) for which the origin or source of introduction is unknown.

These human activities and developments have resulted in modifications to aquatic habitats ecosystems within Botany Bay.

Towra Point Aquatic Reserve is a marine protected area. The reserve is situated on the southern shores of Botany Bay, approximately 4 kilometres from the Project Boundary at Kurnell. The Towra Point Aquatic Reserve encompasses the majority of seagrass, mangroves and saltmarshes within Botany Bay (URS 2003). Previous capital works construction programs have altered erosion patterns at Towra Point, leading to the loss of seagrass beds. The key driver of change has been identified as dredging within the entrance to Botany Bay leading to increasing wave energy, height and direction at Towra Point (The Ecology Lab 2003).

Seagrass within Botany Bay

The aquatic ecological assessment undertaken by The Ecology Lab (2003) as part of the Port Botany Expansion project EIS presents a comprehensive summary of previous studies of seagrass within Botany Bay. The Ecology Lab (2003) identified four species of seagrass as being reported from Botany Bay, including *P. australis* along the southern shoreline, *Zostera capricorni* and *Halophila ovalis* along both the northern and southern shores, as well as *Halophila decipiens* occurring in Quibray Bay. The study compared the results of several studies completed between 1942 and 1995, finding fluctuations in the total area of seagrass beds in Botany Bay through time, including changes in the areal extent of individual seagrass beds throughout the bay. Key drivers of these changes in areal extent were identified as residential and industrial development, realignment of the Cooks River, and dredging to facilitate ship passage to and from the Caltex Oil Refinery terminal wharf altering wave patterns (The Ecology Lab 2003).

2.2 Seagrass areal extent and EIS findings

Chapter 10 of the Project EIS (TfNSW 2021a) described the seagrass community within the EIS study area prior to the commencement of this Seagrass Monitoring Program.

La Perouse

Seagrass areal extent within the La Perouse study area was described as patchy, with *Halophila* spp. being the main species. *Halophila* spp. was found throughout most of the soft sediment, particularly in the deeper areas. *Z. capricorni* was mainly confined to the southern corner along Frenchmans Bay and was intermixed with *Halophila* spp. Some small, isolated patches of *P. australis* were identified amongst the other seagrass species in the shallower areas closer to the shore.

Seasonal fluctuations in the density of *Halophila* spp. within Frenchmans Bay were observed between the two EIS seagrass surveys completed in autumn and spring 2020.

Kurnell

Seagrass areal extent was widespread throughout the study area at Kurnell, typically occurring in water depths of between one and five metres, with *P. australis*, *Z. capricorni* and *Halophila* spp. all identified within the study area. *Z. capricorni* and *Halophila* spp. were found in the deeper areas towards the east of the study area, with *Z. capricorni* also abundant in shallower waters close to the shoreline.

P. australis was typically confined to a large dense bed on the western side of the proposed wharf footprint in shallow water, with smaller isolated patches amongst other seagrasses in the shallow waters close to the shoreline to the east.

Seasonal fluctuations in the density of *Halophila* spp. were also observed at Kurnell between the EIS seagrass surveys completed in autumn and spring 2020 and attributed to storm damage occurring in winter 2020. A review of aerial imagery found that that the seagrass condition, areal extent and extent near Kurnell frequently changes due to storm events, as well as due to more regular seasonal fluctuations.

2.3 Baseline monitoring summary to date

Three Baseline Surveys were completed prior to Baseline 4. These were Baseline 1, completed in winter 2021 (Niche 2021a), Baseline 2 in summer 2022 (Niche 2022a) and Baseline 3 in winter 2022 (Niche 2022b).

Significant weather events during the baseline monitoring period in 2022

Above average rainfall conditions occurred throughout autumn and into winter 2022, with a significant weather event, including above average rainfall and a large easterly swell, occurring in July 2022, impacting upon Baseline 3 (Niche 2022b). This followed above average rainfall over summer and a large easterly swell in early March (Niche 2022a). Rainfall associated with these events resulted in major flood levels in the Georges River and Cooks River that lowered salinities, increased turbidity levels and reduced light availability due to high sediment loads, for extended periods. The large and powerful easterly swells associated with these weather events also resulted in significant coastal erosion, further increasing sedimentation and reducing water quality, and directly impacting on some areas. This, at times, has included direct disturbance to more exposed areas to the east around Kurnell. At La Perouse, although very protected, refraction of waves back into Frenchmans Bay has also resulted in significant seabed and shoreline disturbances (Niche 2022b). At Kurnell in particular, exposure to large easterly swells is considered a major driver of temporal changes in seagrasses within the Project Boundary and the adjacent large *P. australis* bed to the east. The results collected for Baseline 2 and Baseline 3 therefore need to be interpreted with consideration to the significant weather conditions experienced throughout 2022, which have been more broadly attributed to the prevailing La Niña weather pattern.

Seagrass areal extent and density

Overall seagrass areal extent and density declined between Baseline 1 and Baseline 3 (Niche 2022b). These declines amounted to a reduction of greater than 50% during that period of time and was in most part due to the declining areal extent of *Halophila* and/or *Zostera* seagrass beds. Where *Halophila* and/or *Zostera* seagrass beds persisted in Baseline 3, the seagrass density also substantially declined to coverages of less than 1% at the majority of the monitoring sites. In Botany Bay, these Z*ostera* and *Halophila* beds are known to be highly variable in areal extent, species composition and density (Larkum and West 1990). The significant weather events described above have coincided with known seasonal decreases in biomass of *Zostera* during the winter months (West 2000). Although less documented, seasonal fluctuations in *Halophila* in Botany Bay (Cummings Pers. Obs) is also likely responsible for much of these large reductions in seagrass areal extent and cover detected during Baseline 3.

Declines in *P. australis* areal extent were also described, but of a much lesser magnitude, and in most part were confined to Kurnell (Niche 2022b). The lesser impact of these weather events on *P. australis* areal extent is likely reflective of the deeper and much greater biomass of rhizomes of this species, which likely provide greater resilience to such disturbances. Although *P. australis* areal extent changes were considered relatively minimal in Baseline 3, a strong trend of reduced biomass was evident, with fewer shoot densities and reduced leaf lengths at the majority of sites. This is likely reflective of the poor environmental conditions for growth as a result of water quality disturbances such as reduced available light (Larkum 1976) and physical disturbances from sedimentation and seabed disturbance during and/or after these weather events.

Seagrass areal extent and biomass within the Project Boundary substantially decreased between Baseline 1 and Baseline 3, with the majority of this reduction associated with *Halophila* and *Zostera* beds. Changes in *P. australis* areal extent are much lesser and more variable, although a reduction in biomass does appear to be more evident. These changes are likely the result of seasonal reductions in biomass and weather-event-related disturbances.

3. Methods

3.1 Overview

The Seagrass Monitoring Program has been developed to align with the requirements identified within the Marine Biodiversity Offset Strategy (TfNSW 2021b). The program includes four survey approaches:

- Seagrass mapping: Seagrass areal extent mapping of seagrass composition and density within the Survey Area;
- Drop camera surveys: Collection of photo quadrats from within *Halophila* and *Zostera* seagrass beds for quantitative analysis of seagrass composition and density;
- *Posidonia* bed monitoring: Diver-based quadrat surveys of seagrass morphology (composition, biomass and condition) in *P. australis* beds (typically >100 m^2); and
- *Posidonia* patch monitoring: Seagrass morphology surveys of smaller *P. australis* patches (typically <100 m^2).

Specific monitoring sites are shown for La Perouse in Figure 1, and for Kurnell in Figure 2. A full list of site codes and GPS coordinates can be found in Appendix 1.

Four types/extents of survey area relative to the proposed construction works are defined within the overall area covered by the monitoring program (Figure 1 and Figure 2) to inform the assessment:

- Construction Footprint - refers to the permanent construction footprint for the wharf structures and is the primary area of anticipated direct impacts to seagrass. Direct impacts occurring within the Construction Footprint are likely to be permanent, due to the nature of the structures.
- Buffer Area - refers to the temporary construction footprint comprising a 15 m buffer around the Construction Footprint. Direct impacts to seagrass may occur within this area during construction, however no permanent structures will remain post-construction. Ongoing indirect impacts such as vessel wash and shading from vessels may also occur within this area.
- Project Boundary – refers to the Project area as delineated by TfNSW.
- Survey Area – refers to the area of survey for the current assessment, incorporating subtidal areas of seagrass habitat within 50-100 metres of the Project Boundary and including the Construction Footprint and Buffer Area.

3.2 Survey frequency and timing

Surveys are undertaken twice per year (biannually) with consideration of winter and summer seasons – this being the fourth baseline survey. The Baseline Surveys, including previous surveys associated with the EIS completed to date, are summarised in Table 2.

Table 2: Baseline Surveys and previous EIS surveys

Survey	Season	Survey dates	Reference
EIS survey surveys			
EIS survey	Winter 2020	June 2020	(Niche 2020a)
EIS survey	Winter 2020	August – September 2020	(Niche 2020b)
EIS survey	Summer 2020	December 2020	(Niche 2021b)
Pre-construction Baseline Surveys			
Baseline 1	Winter 2021	July – September 2021	Niche (2021a)
Baseline 2	Summer 2022	February – April 2022	Niche (2022a)
Baseline 3	Winter 2022	July – August 2022	Niche (2022b)

Survey	Season	Survey dates	Reference
Baseline 4	Summer 2022/23	December 2022	Current report

The Baseline 4 survey was completed throughout the month of December 2022 (summer 2022/23). Dates for each survey method undertaken are listed in Table 3.

Table 3: Baseline 4 (Summer 2022/23) seagrass monitoring survey dates

Methodology	Survey date Kurnell	Survey date La Perouse
Seagrass mapping	01/12/22 - 13/12/22	01/12/22 - 13/12/22
Drop camera surveys	21/12/22	21/12/22
Posidonia Bed Monitoring	06/12/22 – 09/12/22	07/12/22
Posidonia Patch Monitoring	06/12/22 – 09/12/22	07/12/22

3.3 Baseline master dataset

Since collection of Baseline 4 field data, all data associated with the program has been consolidated into a master dataset and subject to additional quality assurance prior to statistical analysis.

The master dataset has been provided as an additional electronic appendix to this report (Appendix 3) and forms the basis of all data summary and analysis presented within this report.

The master dataset should be considered the most accurate and up-to-date dataset to be used for future iterations of monitoring program planning, sampling and reporting.

3.4 Seagrass mapping

3.4.1 Objective

To determine a baseline measure of seagrass composition and areal extent within the Survey Area.

3.4.2 Survey areas

La Perouse

Subtidal areas of seagrass habitat within 50-100 metres of the Project Boundary (Figure 1).

Kurnell

Subtidal areas of seagrass habitat within 50-100 metres of the Project Boundary (Figure 2).

3.4.3 Methodology

Preliminary desktop works included review of the most recent Nearmap imagery (captured: 02/08/2022) and previously-prepared polygons of seagrass areal extent from previous surveys (Niche 2021a, Niche 2022a, Niche 2022b).

Previously-developed layers and associated Nearmap imagery were displayed in a GIS-based field collection device with GPS accuracy of approx. +/-3m. Verification of habitat was recorded on the device as point data using customised applications within the Field Maps Software package.

Visual observations to verify the seabed habitat were made using a combination of towed camera (Plate 1) transects through the Survey Area and spot observations using a bathoscope, drop camera or, in the cases of shallow areas and during periods of clear water, observation from the side of the boat. The towed camera was towed within 1 metre of the seabed and positioned so imagery was being provided from directly under the survey vessel where seagrass boundaries occurred or within ~2 metres of the stern of the survey vessel when verifying larger uniform areas. The towed and drop cameras allowed for *in situ* field verification of mapping by providing video imagery live to the topside monitor on the survey vessel. The vessel sonar, which included CHIRP ClearVu and SideVu sonar that incorporates a thin, wide beam to provide clear images of structure and any larger seagrasses (with lengths of approximately 10 cm or greater) below the vessel, was also used to aid mapping and target seabed areas with structure, especially during periods of reduced water visibility.

Field verification survey effort within seagrass habitat inside the Survey Area consisted of collection of 3,311 points at La Perouse and Kurnell during the Baseline 4 survey, with no greater than 22.6 metres between two verification points.

Post-collection analysis of field verification points was undertaken using ArcGIS Pro software to construct an updated set of habitat polygons. The dataset depicting the areal extent and extent of seagrass and non-seagrass habitats was created from interpolated point observations collected on site. Each point was assigned a value for the habitat type (seagrass or non-seagrass) and seagrass habitats were assigned a density value (Low, Medium, High). Polygon data were interpolated by distance, with spatially-associated points forming distinct patches of habitat and density. The data were then cleaned to remove errors, and a manual verification and editing pass was conducted by the Niche GIS team to better align boundaries to those observed in recent, high-resolution Nearmap imagery. Finally, the data were verified for accuracy by the Ecology team and edited where required to depict more detailed field notes for small patches of *P. australis* habitat, especially within the Construction Footprint and associated Buffer Area.

3.4.4 Data analysis

The following calculations were made using GIS Software for La Perouse and Kurnell:

- Seagrass area within the Survey Area
- Seagrass area within the Project Boundary
- Seagrass area within the Construction Footprint
- Seagrass area within the 15-m Buffer Area around the Construction Footprint.

3.5 Drop camera surveys

3.5.1 Objective

To determine the baseline community composition and density of *Zostera*- and *Halophila*-dominated seagrass beds in the Project Boundary.

3.5.2 Survey area

Each baseline monitoring site comprised a circular area with a radius of 10 metres from a central point, amounting to a total area of 314 m^2.

La Perouse

Four drop camera monitoring sites were re-surveyed at La Perouse (Figure 1):

- Two (2) potential ‘impact’ sites (HZ-LP-01 & HZ-LP-02) within the Project Boundary, established during the Baseline 1 survey.
- Two (2) ‘reference’ sites (HZ-LP-03 & HZ-LP-04) outside the Project Boundary, established during the Baseline 1 survey.

Kurnell

Six drop camera monitoring sites were re-surveyed at Kurnell (Figure 2):

- Four (4) potential impact sites, two in deeper areas near the seaward end of the wharf (HZ-K-05 & HZ-K-06) and two nearer to the shore in shallower water (HZ-K-09 & HZ-K-10), established during the Baseline 1 survey.
- Two (2) reference sites (HZ-K-07 & HZ-K-08) outside the Project Boundary, established during the Baseline 1 survey.

3.5.3 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located, a temporary float was positioned at the centre of the site. Each photo quadrat image was collected at a haphazardly-located position within 10 metres of the centre of the site.

Photoquadrats were collected using a drop camera custom designed for seagrass surveys (Plate 1) that can obtain a high-resolution image of a known area of the seabed. Care was taken each survey to avoid collecting photographs of the seabed that overlapped.

Photos that were of poor quality, taken when the frame was not stationary on the seabed, duplicates or identified to have overlapping imagery were removed from the dataset. A subset of 30 photos were was then randomly selected from the dataset and uploaded into Coral Point Count with Excel Extensions (CPCe) Software for analysis. Within the CPCe software a digital photoquadrat of each image was created to form an area of 0.25 m^2 (0.5 x 0.5 m) and 30 points were randomly overlaid on the image. Under each point a habitat category was assigned (Table 1).

Table 4: Major and sub-categories used with the CPCe Software.

Major category	Sub-categories
SEAGRASS (S)	Halophila, Zostera, Posidonia
ALGAE (A)	Macroalgae, Turfing Algae, Epiphytic Algae (when identified to be attached to the seagrass)
CORAL (C)	Hard Coral, Soft Coral
SUBSTRATE (SU)	Gravel & Shell, Rock & Rubble, Sand & Silt
OTHER BIOTA (OB)	Sessile Invertebrate
TAPE WAND SHADOW (TWS)	Tape, Wand (frame), Shadow (insufficient resolution), Macroalgae Wrack, Seagrass Wrack, Other Debris.

3.5.4 Data analysis

For each photoquadrat percent cover was calculated for each of the categories (except Tape, Wand and Shadow) and sub-categories (Plate 1), while Tape, Wand and Shadow were excluded from the percent cover calculations. Summaries for each site, including means and standard errors (SEs), were then calculated for:

- Seagrass cover by type;
- Sediment/silt cover;
- Turfing algae cover; and
- Epiphytic algae cover.

3.5.5 Statistical Analysis

Statistical analysis was performed using the PERMANOVA+ for Primer statistical software package (Anderson *et al.* 2008). PERMANOVA is a permutational approach to ANOVA that has a number of advantages over traditional statistical methods. The PERMANOVA procedure was used for both univariate (single variable) and multivariate (many variables) analyses. For univariate analyses parameters were investigated using the Euclidean distance matrix, while the multivariate analyses were based on Bray-Curtis similarities. Pairwise comparisons were performed to further investigate any significant results identified in the PERMANOVA for factors/terms of interest. In the case where the number of unique permutations for a particular test was less than 100, Monte Carlo probability values were used to assess the significance of the test as outlined by Anderson *et al.* (2008). The significance level was set at $p < 0.05$ for all statistical tests.

For multivariate datasets such as the full set of percent cover data collected via CPCe here and then analysed using multivariate PERMANOVA, Principal Coordinates Analysis (PCoA) can be used to provide a graphical representation. The PCoA analysis itself provides a measure of the amount of variation in the data that can be captured by the first two axes. Vector overlays based on the Spearman's Correlation Coefficients are added to the graphical output base to display the strongest drivers of differences. The PCoA routine allows for the multivariate dataset to be visualised using metric multidimensional scaling. This approach is more appropriate than traditional uses of non-metric Multidimensional Scaling (nMDS) when PERMANOVA is applied, as it models the actual dissimilarities of interest that provide a direct projection of the points considered using PERMANOVA (Anderson *et al.* 2008).

Spatial and temporal patterns in differences among the of *Zostera*- and *Halophila*-dominated seagrass beds were investigated using a three-factor design (Table 5) in the first instance. The three-factor design allowed for and considered seasonal effects. Following three-factor analysis, the Season term was excluded and a simplified two-factor design (Table 5) applied when:

- The p values associated with terms involving the Season factor (i.e., both Se and Se x Si) were greater then 0.25, as suggested by Winer *et al.* (1991) and Underwood (1997) as a conservative approach to pooling interaction terms and/or discarding main effects terms.
- When plots of data (for univariate analyses) did not show any seasonal patterns.

Where the simplified two-factor design was applied, it allowed for focused investigation of differences among the sequence of Surveys irrespective of Season.

Statistical analyses focused on temporal changes and included:

- Univariate PERMANOVA for Total Seagrass Cover.
- Multivariate PERMANOVA and PCoA (full data set and centroids) using the subcategories (Table 4) that included any records across the four surveys. Note: As the Epiphytic Algae subcategory was collected with Turfing Algae in the Baseline 2 survey, these two sub-categories were combined for these analyses.

Table 5: Experimental design applied to statistical analyses of the drop camera data.

Term	Type	Levels
THREE-FACTOR DESIGN		
Season - Se	Fixed	2 Seasons - Winter and Summer
Survey(Season) - Su(Se)	Nested/Random	2 Baseline surveys nested in each Season
Site - Si	Random	2 Sites at La Perouse, 6 Sites at Kurnell
Se x Si	Interaction Term	
Su(Se) x Si	Interaction term	
TWO-FACTOR DESIGN		
Survey - Su	Random	4 Baseline surveys
Site - Si	Random	2 Sites at La Perouse, 6 Sites at Kurnell

Term	Type	Levels
Su x Si	Interaction Term	

3.6 *Posidonia* bed monitoring

3.6.1 Objective

To determine the baseline community composition, biomass (density and leaf lengths) and condition of *P. australis* seagrass beds (>100 m^2) with potential to be impacted during construction and operation.

3.6.2 Survey area

Each monitoring site comprised a circular area with a radius of 5 metres from a central point, amounting to a total area of 79 m^2.

La Perouse

Two *P. australis* bed monitoring sites were re-surveyed at La Perouse (Figure 1):

- One (1) potential impact site (PB-LP11) within the Project Boundary, established during the Baseline 1 survey.
- One (1) reference site (PB-LP12) outside the Project Boundary, established during the Baseline 1 survey.

Kurnell

Ten *P. australis* bed monitoring sites were re-surveyed at Kurnell (Figure 2):

- Eight (8) potential impact sites within the large extensive bed of *P. australis* to the west of the Project Boundary (PB-K01 to PB-K08), established during the Baseline 1 survey. These sites are positioned to allow for a gradient-based approach to monitoring for impacts to the large bed of *P. australis* to the west of the Project Boundary. Sites are located along two longshore transects (one near shore and one offshore) at a range of distances from the Construction Footprint (to represent approximate intervals of 75 m, 100 m, 150 m and 230 m).
- Two (2) additional potential impact sites within much smaller beds of *P. australis* inside the Project Boundary (PB-K09 and PB-K10), established during the Baseline 1 survey.
- Reference sites will be determined at the completion of the baseline monitoring. It is envisaged they will be selected from monitoring sites in the main western bed outside the Project Boundary (e.g., PB-K03, -K04, -K07 and -K08). There is also potential to include the most easterly site in the Project Boundary as a reference site, where impact from the proposal is considered unlikely.

3.6.3 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located a temporary float was positioned at the centre of the site. Seagrass was surveyed via five 0.25 m^2 (0.5 x 0.5 m) quadrats, each haphazardly positioned within 5 metres of the centre of the site.

Within each quadrat the following data were recorded by experienced Scientific Divers:

- Shoot Density (counted from the sheath) for each seagrass species present (Note: *Halophila* also counted as shoots).
- Proportion (%) of shoots with visible sheaths for 10 randomly selected *P. australis* shoots.
- Visible Sheath Length for 10 randomly-selected *P. australis* shoots.
- Epiphyte Load (scored 1-5, see Appendix 2) for 10 randomly-selected leaves for each seagrass species present.

In addition to the above measurements a photograph was taken above each quadrat for archiving purposes.

3.6.4 Data analysis

Data calculations and summaries included means and SEs for the following:

- Shoot (*Posidonia*) count per 0.25 m^2.
- Leaf length (cm).
- Epiphyte load score.

In the cases of the Baseline 1 and 2 surveys, many seagrass sheaths for *P. australis* shoots were found to be covered by sediment and sheath measurements could not be obtained. For the purposes of the program it was deemed more appropriate to present sheath data as percent of shoots with visible sheaths rather than as measurements of sheath length. As such, sheath length is no longer recorded.

3.6.5 Statistical Analysis

Statistical analysis was performed using the PERMANOVA+ for Primer statistical software package (see Section 3.4.5).

Spatial and temporal patterns in differences among the *Posidonia* seagrass bed monitoring sites were investigated using a three-factor design (Table 6) in the first instance. The three-factor design allowed for and considered seasonal effects. Following the three-factor analysis, the Season term was excluded, and a simplified two-factor design (Table 6) applied when:

- The p values associated with terms involving the Season factor (i.e., both Se and Se x Si) were greater then 0.25, as suggested by Winer *et al.* (1991) and Underwood (1997) as a conservative approach to pooling interaction terms and/or discarding main effects terms.
- When plots of data (for univariate analyses) did not show any seasonal patterns.

Where the simplified two-factor design was applied, it allowed for focused investigation of differences among the sequence of Surveys irrespective of Season.

For analyses where the two-factor design could not be adopted (i.e., $p < 0.25$ for one or both of the terms involving Season), where appropriate the sums of squares and degrees of freedom for the lower interaction term (i.e., Su(Se) x Si) were pooled with those of the Residual term (i.e., where the p value for Su(Se) x Si was greater than 0.25 – Winer *et al.* 1991, Underwood 1997).

Statistical analyses focused on temporal changes and included:

- Univariate PERMANOVA for *Posidonia* shoots.
- Univariate PERMANOVA for *Posidonia* leaf length.
- Univariate PERMANOVA for *Posidonia* epiphyte ranking.
- Multivariate PERMANOVA and PCoA (full data set and centroids) for shoots of all three seagrass types (*Posidonia*, *Zostera* and *Halophila*).

For *Posidonia* Bed monitoring sites positioned along both the Inner and Outer Transects, regression analyses were also performed using the Excel Data Analysis Toolpack Add-on to investigate any linear relationships between response variables (seagrass parameters) and distance from the Construction FootprintOuter Transect. Regression analysis was done by Survey and for all Surveys combined, where a linear relationship between distance and a response variable (e.g. shoot density, leaf length) of interest was identified in the charts.

Table 6: Experimental Design applied to statistical analyses of data from the *Posidonia* beds.

Term	Type	Levels
THREE-FACTOR DESIGN		
Season - Se	Fixed	2 Seasons - Winter and Summer
Survey(Season) - Su(Se)	Nested/Random	2 Baseline surveys nested in each Season
Site - Si	Random	2 Sites at La Perouse, 10 Sites at Kurnell
Se x Si	Interaction Term	
Su(Se) x Si	Interaction Term	
TWO-FACTOR DESIGN		
Survey - Su	Random	4 Baseline surveys
Site - Si	Random	2 Sites at La Perouse, 10 Sites at Kurnell
Su x Si	Interaction Term	

3.7 *Posidonia* patch monitoring

3.7.1 Objective

To determine the baseline community composition, biomass (shoot density and leaf lengths) and condition of *P. australis* seagrass patches (<100 m^2) in close proximity to the Construction Footprint.

3.7.2 Survey area

Patches (<100 m^2) of *P. australis* seagrass that met the following criteria were surveyed:

- Inside or within 15 m of the Construction Footprint.
- Shoot density of at least five shoots per 1 m^2.
- Has an extent of at least 10 m^2 and minimum width of 2 m.

La Perouse

Two *P. australis* patches were re-surveyed at La Perouse, established during the Baseline 1 survey (Figure 1):

- PP-LP-01: Approximately 10 m east of the 15 m buffer.
- PP-LP-02: Approximately 15 m east of the 15 m buffer.

Kurnell

Six *P. australis* patches were re-surveyed at Kurnell, established during the Baseline 1 survey. (Figure 2):

- PP-K-03: Approximately 15 m east of the 15 m buffer.
- PP-K-04: Inside the Construction Footprint and 15 m buffer.
- PP-K-07: Approximately 3 m west of the 15 m buffer.
- PP-K-08: On the western edge of the 15 m buffer.
- PP-K-09: On the eastern edge of the 15 m buffer.
- PP-K-11: On the eastern edge of the 15 m buffer (note that this site has a *Zostera* patch in the middle that is not sampled).

3.7.3 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located a temporary float was positioned at the centre of the site. Seagrass was haphazardly surveyed via up to five 0.25 m^2 (0.5 x 0.5 metre) quadrats, each haphazardly positioned within 5 metres of the centre of the site.

Within each quadrat the following data were recorded by experienced Scientific Divers:

- Shoot density (counted from the sheath) for each seagrass species present (Note: *Halophila* counted as shoots).
- Leaf length of 10 randomly-selected leaves for both *Zostera* and *P. australis*.
- Percent of shoots with visible sheaths for 10 randomly-selected *P. australis* shoots.
- Epiphyte load (scored 1-5, see Appendix 2) for 10 randomly-selected leaves for each seagrass species present.

In addition to the above measurements a photograph was taken above each quadrat for archiving purposes.

3.7.4 Data analysis

Data calculations and summaries included means and standard errors for the following:

- Shoot (Shoot *Posidonia*) count per 0.25 m^2
- Leaf length (cm)
- Percent of shoots with visible sheaths
- Epiphyte load score.

3.7.5 Statistical Analysis

Statistical analysis was performed using the PERMANOVA+ for Primer statistical software package (see Section 3.4.5)

Temporal patterns in differences within the *Posidonia* seagrass patches were investigated for each patch separately using a two-factor design (Table 7) in the first instance. The two-factor design allowed for and considered seasonal effects. Following two-factor analysis, the Season term was excluded and a simplified one-factor design (Table 7) was used when:

- The p value associated with Season was greater than 0.25, as suggested by Winer *et al* (1991) and Underwood (1997) as a conservative approach to pooling interaction terms and/or discarding main effects terms.
- When plots of data (for univariate analyses) did not show any seasonal patterns.

Where the simplified one-factor design was applied, it allowed for focused investigation of differences among the sequence of Surveys irrespective of Season.

Statistical tests were limited to temporal changes in *Posidonia* shoot counts at each patch, which required a univariate PERMANOVA.

Table 7: Experimental Design applied to statistical analyses of data from the *Posidonia* patches

Term	Type	Levels
TWO-FACTOR DESIGN		
Season - Se	Fixed	2 Seasons - Winter and Summer
Survey(Season) - Su(Se)	Nested/Random	2 Baseline surveys nested in each Season

Term	Type	Levels
ONE-FACTOR DESIGN		
Survey	Random	4 Baseline surveys

3.8 Limitations

The monitoring program has been identified as subject to the following limitations:

- Seagrass mapping is subject to the accuracy of the GPS-enabled equipment utilised during the surveys (up to ± 5 metres) and dependent on the limitations of aerial photo rectification and registration, which is also limited to the resolution and clarity of the most recent imagery available.
- The significant weather events and associated rainfall in 2022 presented a limitation to the program. The effect of these significant weather events was most acute during the Baseline 2 and Baseline 3 surveys and had the following implications:
  - Disrupting the ability to sample on consecutive days and under similar conditions within the survey. This resulted in some survey methods being completed at different times across the survey due to the limited survey windows within climatic seasons (Table 2).
  - During Baseline 2, the seagrass mapping was completed prior to the drop camera surveys, resulting in some apparently contradictory results, such as mapped seagrass no longer being present or highly diminished (due to the significant weather events) at the time of the drop camera surveys (Niche 2022a).
  - Seagrass mapping at La Perouse during Baseline 2 was also impacted by adverse weather, resulting in the delayed collection of some data following the frequent weather events. Seagrass areal extents mapped during these two separate survey days are likely to have been different because of the high rainfall events and storms that occurred between those two days (Niche 2022a).
- Depth of Disturbance (DoD) rods were established at each of the *Posidonia* bed monitoring sites during Baseline 1 (Niche 2021a). Following significant weather events in summer 2021, 80% of the DoD rods were missing or disturbed at the time of Baseline 2 (Niche 2022a). Given the flooding events that occurred in the locality and lack of reliability in the data, the methodology was considered unlikely to be suitable for this program and discontinued (Niche 2022a).
- Seagrass area calculations presented in this report are based upon the GDA2020 MGA56 coordinate system. Therefore, there may be minor discrepancies between areas presented in this report and those in Baseline 1 and 2 (Niche 2022a, 2022b), which are based upon the GDA94 MGA56 coordinate system. The area calculations presented in this report and included in the master dataset (Appendix 3) should be considered to be the most accurate and up to date results.

The methods of data collection and analysis are considered to be comprehensive to the aims of the baseline monitoring program and the program is not subject to any significant limitations.

4. Results – Baseline 4 (summer 2022/23)

4.1 Seagrass areal extent

During the Baseline 4 monitoring surveys completed in summer 2022/23, a combined total of 30,880 m^2 of seagrasses was mapped within the Project Boundaries at La Perouse and Kurnell (Table 8, Figure 1, Figure 2). This total included 740 m^2 of seagrasses within Kurnell Construction Footprint (no seagrass was present within the La Perouse Construction Footprint) and an additional 3,137 m^2 within the two Buffer Areas combined. Outside of the Project Boundaries, an additional 48,130 m^2 of seagrass was mapped within the broader Survey Area at Kurnell, and 11,386 m^2 of seagrass at La Perouse.

At Kurnell, 740 m^2 of seagrass was mapped within the Construction Footprint, with 3086 m^2 of seagrass occurring within the Buffer Area. At La Perouse, no seagrass was recorded within the Construction Footprint, with only 51 m^2 of seagrass mapped within the Buffer Area.

The majority of seagrass mapped within the Project Boundaries at La Perouse and Kurnell combined was comprised of *Halophila* beds and *Zostera / Halophila* beds (Table 8, Figure 1, Figure 2). Sand or silt were the dominant habitats mapped within the Project Boundaries.

Table 8: Areal extent of seagrass types mapped at Kurnell and La Perouse during Baseline 4 (summer 2022/23) within the Survey Area, Project Boundary, Construction Footprint (area of direct impacts) and associated Buffer area (area of indirect impacts).

Area	Baseline 4 (summer 2022/23)		
	Kurnell (m^2)	La Perouse (m^2)	Total (m^2)
Survey Area			
Posidonia	6743	165	6908
Posidonia / Halophila	192	0	192
Posidonia / Zostera	176	0	176
Posidonia Mixed	28264	246	28511
Zostera	538	117	655
Zostera / Halophila	11992	10684	22676
Halophila	224	174	398
Rock / Rubble / Reef	22789	12238	35027
Sand or silt	64923	64636	129560
Project Boundary			
Posidonia	456	9	464
Posidonia / Halophila	0	0	0
Posidonia / Zostera	30	0	30
Posidonia Mixed	3492	151	3643
Zostera	26	462	488
Zostera / Halophila	12151	8294	20445
Halophila	1618	316	1934
Rock / Rubble / Reef	6337	9489	15826
Sand or silt	22199	42810	65009

Area	Baseline 4 (summer 2022/23)		
	Kurnell (m^2)	La Perouse (m^2)	Total (m^2)
Buffer Area - temporary construction footprint (15 m buffer)			
Posidonia	42	0	42
Posidonia / Halophila	0	0	0
Posidonia / Zostera	0	0	0
Posidonia Mixed	209	0	209
Zostera	72	0	72
Zostera / Halophila	2595	51	2645
Halophila	168	0	168
Rock / Rubble / Reef	1667	1626	3293
Sand or silt	2421	3762	6184
Construction Footprint - permanent			
Posidonia	0	0	0
Posidonia / Halophila	0	0	0
Posidonia / Zostera	0	0	0
Posidonia Mixed	7	0	7
Zostera	19	0	19
Zostera / Halophila	677	0	677
Halophila	37	0	37
Rock / Rubble / Reef	229	518	747
Sand or silt	374	1035	1409

Further data are provided in section 5.1 and Appendix 4.

4.2 *Zostera* and *Halophila* seagrasses

The key results for seagrass cover of *Zostera*- and *Halophila*-dominated beds in the Baseline 4 survey (summer 2022/23) are summarised below, with further data provided in Appendix 5:

- At Kurnell at least one species of seagrass was detected at eight of the ten *Zostera*- and *Halophila*-dominated beds, with no seagrass detected at sites HZ-K06 and HZ-K07 (Figure 3).
- At La Perouse there appeared to be no clear difference in overall seagrass cover between monitoring sites inside (HZ-LP01 and HZ-LP02) and those outside the Project Boundary (HZ-LP03 and HZ-LP04) (Figure 3).
- No *P. australis* seagrass was detected at any of the monitoring sites for both locations.
- *Zostera* and *Halophila* cover was very low at La Perouse (0.2% – 0.7%). Where present, *Zostera* and *Halophila* cover at Kurnell was higher, ranging between 4.4% and 25.5%).
- The monitoring sites for *Zostera*- and *Halophila*-dominated beds closer to shore at Kurnell (HZ-K09 and HZ-K10) recorded higher seagrass cover than the sites further from the shore (Figure 3). These beds closer to the shore feature relatively greater covers of *Zostera* than the other beds, with *Zostera* cover particularly high at HZ-K10.

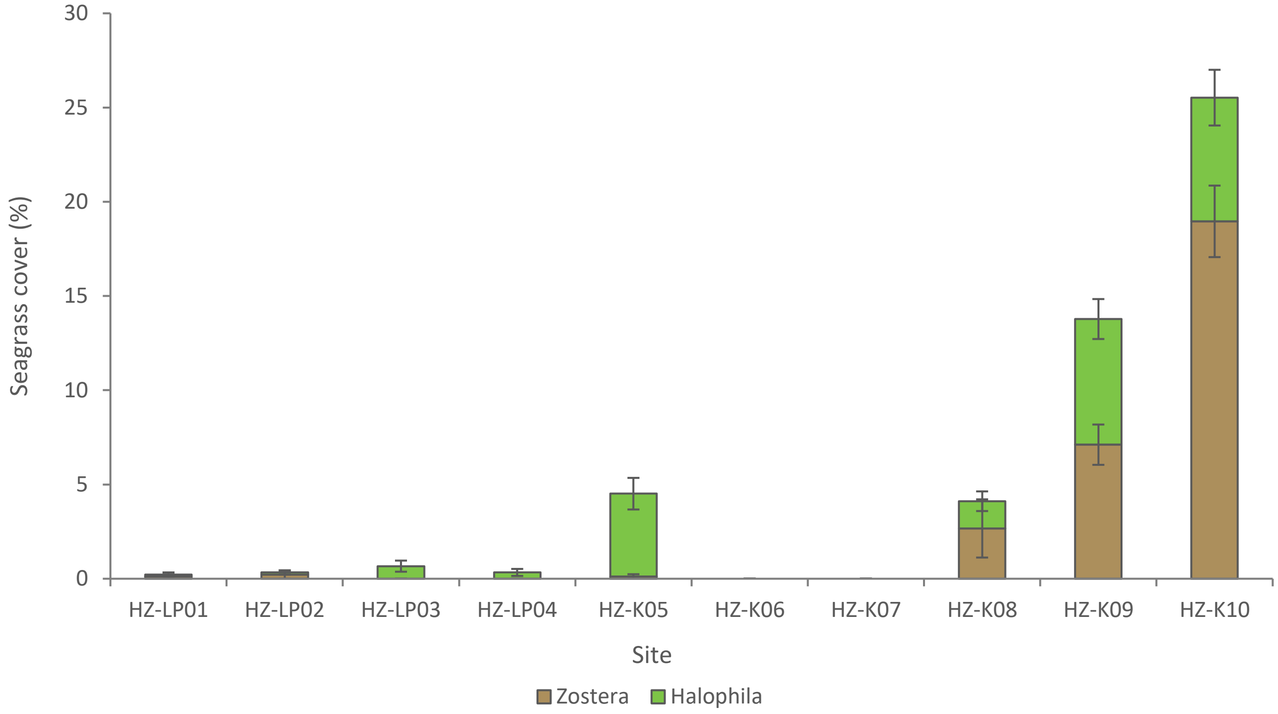


Figure 3: Baseline 4 (summer 2022/23) – mean *Halophila* and *Zostera* seagrasses cover (+/- SE total seagrass cover).

The results for sediment cover, turfing algae and epiphytic algae during Baseline 4 are presented in Table 9. The key findings include:

- At La Perouse, sediment cover was high in Baseline 4, ranging between 62.1% - 97.6% cover. Sediment cover at Kurnell was also generally high, ranging between 46.4% - 98.9% cover.
- Turfing algae was absent at almost all sites, with the exception being HZ-K-05 at Kurnell, where it was present in minor amounts.
- Epiphytic algae was recorded at two of the four sites at La Perouse (HZ-LP-02 and HZ-LP-03). In contrast, epiphytic algae was recorded at all monitoring sites at Kurnell.

Table 9: Mean covers of sediment, turfing algae and epiphytic algae at each site during Baseline 4 (summer 2022/23).

Site	Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)	
	Mean	Standard error	Mean	Standard error	Mean	Standard error
HZ-LP-01	0.0	0.0	0.0	0.0	82.3	3.8
HZ-LP-02	2.6	1.0	0.0	0.0	62.1	5.2
HZ-LP-03	0.1	0.1	0.0	0.0	94.3	1.2
HZ-LP-04	0.0	0.0	0.0	0.0	97.6	0.8
HZ-K-05	13.9	2.4	0.1	0.1	81.5	3.2
HZ-K-06	1.1	0.6	0.0	0.0	98.9	0.6
HZ-K-07	1.2	0.5	0.0	0.0	98.7	0.5
HZ-K-08	7.0	2.5	0.0	0.0	88.9	3.7
HZ-K-09	26.8	2.5	0.0	0.0	59.4	2.9
HZ-K-10	28.1	2.6	0.0	0.0	46.4	3.7

4.3 *Posidonia* seagrass

4.3.1 Shoot density

The key results from the shoot density surveys at *Posidonia* bed monitoring sites (PB-) and *Posidonia* patch monitoring sites (PP-) in Baseline 4 (summer 2022/23) (Table 10, Figure 4) are summarised below:

- All three species of seagrass were detected at the majority of monitoring beds and patches.
    - *P. australis* was present at all monitoring beds and patches.
    - *Zostera* was present at almost all monitoring beds and patches, with the exception being patch PP-LP01.
    - *Halophila* was absent at monitoring beds PB-K10, PB-LP11 and PB-LP12.
- Average *P. australis* shoot density in *Posidonia* beds at La Perouse and Kurnell ranged between 4.5 shoots per 0.25 m^2 (PP-LP01) and 35.2 shoots per 0.25 m^2 (PB-K08).
    - The highest *P. australis* densities were recorded at monitoring sites towards the centre of the main *Posidonia* bed at Kurnell (southwest of the Project Boundary), with the smaller *Posidonia* beds within the Project Boundary and to the east recording relatively lower densities.
    - At La Perouse the monitoring site within the Project Boundary (PB-LP-11) had a lower *P. australis* shoot density (7.0 shoots per 0.25 m^2) than the reference site (PB-LP12) (14.6 shoots per 0.25 m^2).
    - No *Halophila* seagrass was recorded at either of the La Perouse monitoring beds during this survey.

Further data are provided in sections 5.3 and 5.4, and Appendix 5.

Table 10: Average shoot density recorded at *Posidonia* bed monitoring sites and patches during Baseline 4.

Seagrass species	*Halophila* density (0.25 m^2)		*Zostera* density (0.25 m^2)		*Posidonia* density (0.25 m^2)	
	Mean	SE	Mean	SE	Mean	SE
***Posidonia* beds**						
PB-K01	18.2	5.7	1.8	1.2	8.2	1.4
PB-K02	24.6	7.8	27.6	24.7	10.2	1.8
PB-K03	24.4	7.1	34.2	12.0	13.0	2.3
PB-K04	27.6	8.2	56.4	23.4	13.2	1.7
PB-K05	1.8	1.1	238.8	33.2	11.8	1.0
PB-K06	1.8	0.9	43.8	13.9	15.4	1.6
PB-K07	6.2	3.3	16.8	11.6	22.6	2.8
PB-K08	47.4	28.4	64.0	36.5	35.2	6.3
PB-K09	17.0	8.9	41.2	24.1	6.4	0.9
PB-K10	0.0	0.0	1.2	1.2	5.4	2.0
PB-LP11	0.0	0.0	3.6	3.1	7.0	0.6
PB-LP12	0.0	0.0	0.4	0.4	14.6	1.4
***Posidonia* patches**						
PP-K03	5.0	2.4	121.6	14.2	8.2	0.9
PP-K04	2.8	2.1	27.4	11.1	10.6	1.1
PP-K07	3.2	1.8	134.4	18.7	8.0	0.9
PP-K08	9.0	6.8	97.4	17.0	6.0	0.5
PP-K09	8.0	4.6	117.3	15.4	10.3	2.9
PP-K11	0.2	0.2	180.2	54.5	9.8	2.2

Seagrass species	*Halophila* density (0.25 m²)		*Zostera* density (0.25 m²)		*Posidonia* density (0.25 m²)	
	Mean	SE	Mean	SE	Mean	SE
PP-LP01	0.8	0.8	0.0	0.0	4.8	1.4
PP-LP02	3.8	2.6	24.2	17.2	12.0	3.6

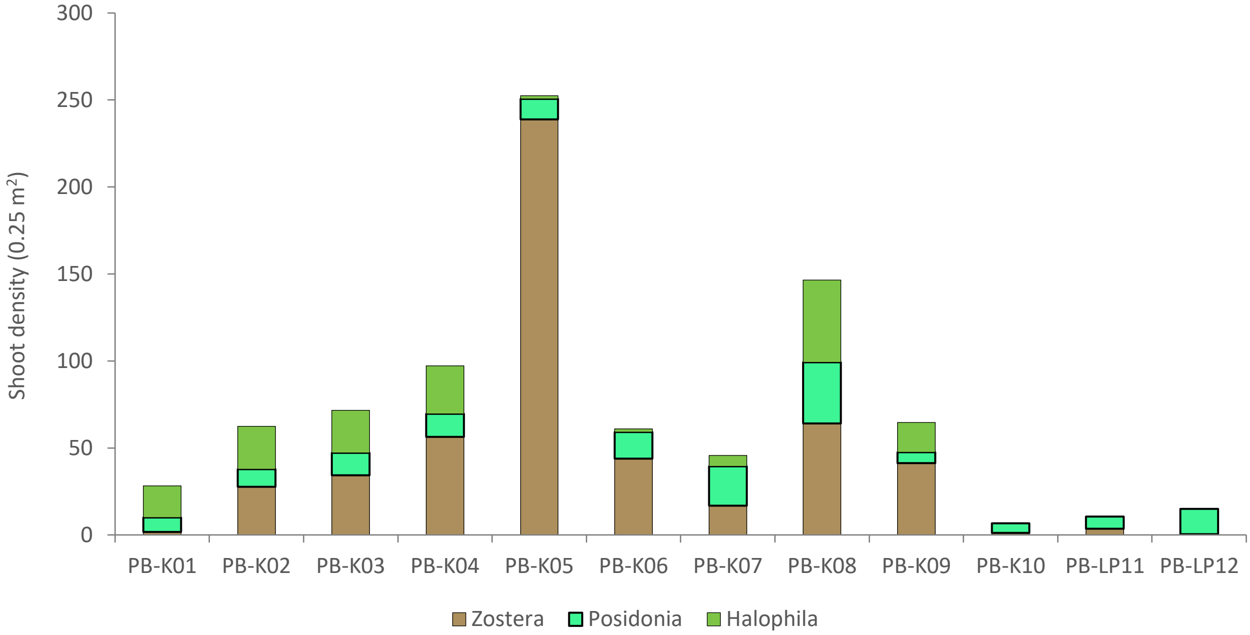


Figure 4: Mean shoot density of seagrass within the *Posidonia* bed monitoring sites in Baseline 4.

4.3.2 Leaf lengths

The key results for leaf lengths in *Posidonia* bed monitoring sites and patches in the Baseline 4 survey (Table 11) are summarised below:

- Average leaf lengths for *P. australis* were somewhat variable across monitoring sites at Kurnell, ranging between 11.7 cm (PB-K03) and 38.6 cm (PB-K09). Those monitoring beds with lowest average leaf lengths (PB-K03, PB-K04) occur towards the outer edges of the main seagrass bed located to the west of the Construction footprint (Figure 2), while those within this main bed recorded relatively higher average leaf lengths (PB-K05, PB-K06, PB-K07, PB-K08).
- Average leaf lengths for *P. australis* at La Perouse were more consistent, ranging between 29.2 cm (PP-LP01) and 38.6 cm (PB-LP11).
- The average leaf lengths recorded for *Zostera* across both locations ranged between 3.3 (PP-K11) and 30.6 (PB-K03).

Table 11: Mean values for leaf length measurements, visible seagrass sheaths (*P. australis* only) and epiphyte cover scores during Baseline 4 (summer 2022/2023).

Average	Leaf length (cm)		Epiphytic cover score			Sheath visible (%)
Species	*Zostera*	*Posidonia*	*Halophila*	*Zostera*	*Posidonia*	*Posidonia*
***Posidonia* beds**						
PB-K01	5.3	25.3	2.4	1.0	3.1	0.0
PB-K02	8.7	33.6	2.0	1.8	3.3	4.0
PB-K03	30.6	11.7	2.8	1.4	4.5	0.0
PB-K04	29.1	16.9	2.1	1.8	3.0	0.0
PB-K05	5.5	38.4	1.6	1.3	2.8	2.0

Average	Leaf length (cm)		Epiphytic cover score			Sheath visible (%)
Species	***Zostera***	***Posidonia***	***Halophila***	***Zostera***	***Posidonia***	***Posidonia***
PB-K06	9.2	31.3	2.0	2.3	3.5	42.0
PB-K07	10.5	30.5	2.7	2.3	2.9	52.0
PB-K08	10.4	30.8	1.4	1.2	2.5	20.0
PB-K09	15.2	38.6	3.1	2.3	3.4	36.2
PB-K10	4.2	27.0	-	1.0	2.3	0.0
PB-LP11	4.4	38.6	-	1.9	3.1	0.0
PB-LP12	4.6	34.6	-	2.0	3.3	-
Posidonia patches						
PP-K03	7.9	32.6	1.8	1.9	2.9	28.1
PP-K04	9.1	25.8	2.1	1.8	3.1	14.0
PP-K07	8.4	28.1	2.1	2.1	3.0	45.0
PP-K08	8.2	23.5	2.4	2.1	2.7	69.5
PP-K09	10.6	38.4	2.1	1.9	2.8	-
PP-K11	3.3	30.5	1.0	1.2	2.0	2.5
PP-LP01	-	31.0	2.2	-	3.0	0.0
PP-LP02	5.2	29.2	2.0	1.8	3.5	100.0

Further data are provided in sections 5.3 and 5.4, and Appendix 5.

4.3.3 Seagrass sheaths

The average percentage of visible sheaths was found to be highly variable across the sites in Baseline 4 (Table 11). For *Posidonia* beds, PB-K07 recorded the highest average percentage of visible sheaths at 52.0%. A number of *Posidonia* beds recorded no visible sheaths (PB-K01, PB-K03, PB-K04, PB-K10, PB-LP11). Average percentage of visible sheaths was also found to be highly variable across *Posidonia* patches. The highest average percentage of visible sheaths among these monitoring patches was 100.0% (PP-LP02) and the lowest was 0.0% (PP-LP01).

4.3.4 Epiphyte cover

The epiphyte cover results for Baseline 4 (Table 11) show that epiphytic growth was typically higher on *P. australis* shoots than on *Halophila* or *Zostera*. The epiphyte cover scores across the *Posidonia* bed and patch monitoring sites ranged between 2.0 (PB-K11) and 4.5 (PB-K03) for *P. australis*. For *Zostera,* the range was between 1.0 (PB-K01 and PB-K10) and 2.3 (PB-K06, PB-K07, PB-K09), while the range for *Halophila* seagrass was between 1.0 (PP-K11) and 3.1 (PB-K09).

5. Results – Temporal trends (Baseline 1 to Baseline 4)

5.1 Seagrass areal extent

5.1.1 La Perouse

The combined total mapped areal extent of all seagrass beds with *P. australis* present '*Posidonia / Posidonia mixed*' (including *Posidonia*, *Posidonia / Halophila*, *Posidonia / Zostera* and *Posidonia* mixed beds) at La Perouse for each of the four Baseline Surveys are presented in Table 12, with areal extents for the remaining seagrass categories combined presented as '*Halophila / Zostera*'. Time series comparisons across the baseline monitoring period are presented in Figure 5, with mapped seagrass areal extents presented in Figure 6.

The key results of *P. australis* mapping at La Perouse include the following:

- No *P. australis* has been identified within the Construction Footprint or Buffer Area at La Perouse (Table 12).
- Within the Project Boundary at La Perouse, an overall decline in the area of *P. australis* has occurred between Baseline 1 and Baseline 4, despite a relative increase in Baseline 4 when compared to the Baseline 2 and Baseline 3 surveys (Figure 5).
- Similar trends among surveys appear to have occurred within the Survey Area and within the Project Boundary in the cases of *P. australis* seagrass areas and *Halophila / Zostera* areas (Figure 5).

Table 12: *P. australis* seagrass (including *Posidonia, Posidonia / Halophila, Posidonia / Zostera* and *Posidonia* Mixed beds) areas and *Halophila / Zostera* areas mapped during Baseline Surveys to date at La Perouse.

Seagrass area (m^2)	Baseline 1	Baseline 2	Baseline 3	Baseline 4
Buffer Area				
Halophila / Zostera	3526	2505	78	51
Posidonia / Posidonia mixed	0	0	0	0
Construction Footprint				
Halophila / Zostera	991	673	0	0
Posidonia / Posidonia mixed	0	0	0	0
Project Boundary				
Halophila / Zostera	27235	24921	9502	9072
Posidonia / Posidonia mixed	170	135	137	159
Survey Area				
Halophila / Zostera	29480	22359	10241	10975
Posidonia / Posidonia mixed	550	431	254	411

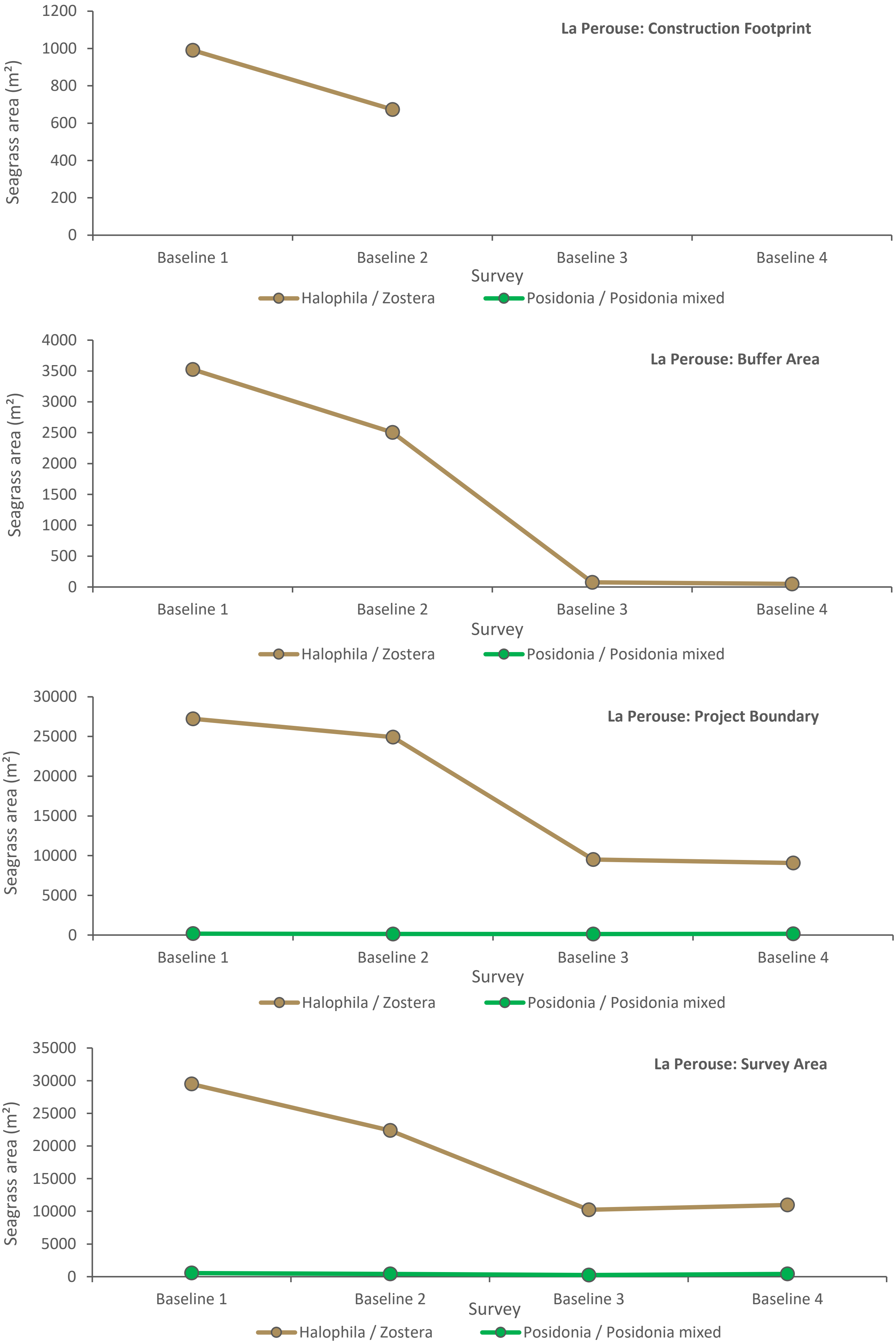
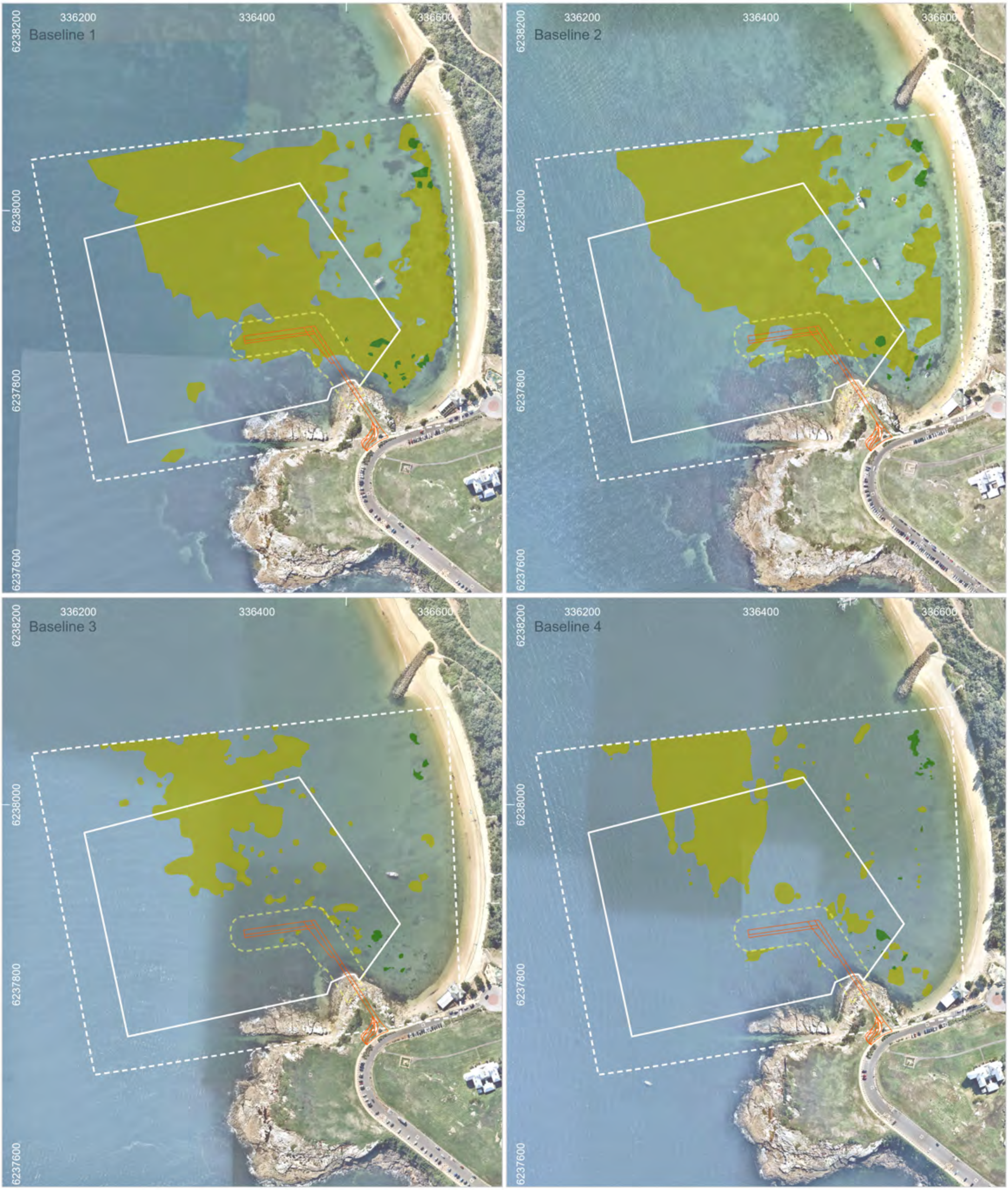


Figure 5: *Posidonia / Posidonia* Mixed and *Halophila / Zostera* areas over all Baseline Surveys at La Perouse



Construction Footprint
Buffer Area (15m)
Survey Area
Project Boundary
Seagrass habitat
Halophila / Zostera
Posidonia / Posidonia Mixed

niche Environment and Heritage

0 100
m
WGS 1984 Web Mercator

Survey sites and habitat mapping: La Perouse
Baseline comparison
Kamay Ferry seagrass monitoring

Niche PM: Luke Stone
Niche Proj. #: 7476
Client: Transport for NSW

Figure 6

Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to WGS1984 Web Mercator Auxilliary Sphere is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020, using the relevant MGA zone.

5.1.2 Kurnell

The combined total mapped areal extent of all seagrass beds with *P. australis* present '*Posidonia / Posidonia mixed*' (including *Posidonia*, *Posidonia / Halophila*, *Posidonia / Zostera* and *Posidonia* mixed beds) at Kurnell for each of the four Baseline Surveys are presented in Table 13, with areal extents for the remaining seagrass categories combined presented as '*Halophila / Zostera*'. Time series comparisons across the baseline monitoring period are presented in Figure 7, with mapped seagrass areal extents presented in Figure 8.

The key results of *P. australis* mapping at Kurnell include the following:

- In Baseline 4, a total 258 m^2 of *P. australis* seagrass was mapped within the Construction Footprint and Buffer Area combined (Table 12, Figure 6), with a total of 7 m^2 within the Construction Footprint alone.
- There has been an overall decline in the mapped areal extent of *P. australis* within the Construction Footprint during the Baseline Surveys (Figure 7). In contrast, there has been an overall increase in area of *P. australis* within the Buffer Area since Baseline 2. An overall decrease in *P. australis* areal extent has also been detected within the Project Boundary from Baseline 1 to Baseline 4, despite a relative increase between Baseline 1 and Baseline 2.
- In the Survey Area there has been a relatively minor overall increase in *P. australis* seagrass area across the surveys, despite a spike detected in Baseline 2 and subsequent decrease in Baseline 3.
- Similar trends of declining *Halophila / Zostera* areas occurred in the Survey Area and within the Project Boundary, with this decline most acute between Baseline 2 and Baseline 3 (Figure 7). However, a more acute decline in areas of *Halophila / Zostera* appears to have continued from Baseline 3 to Baseline 4 in the Survey Area compared to within the Project Boundary.

Table 13: *P. australis* seagrass (including *Posidonia, Posidonia / Halophila, Posidonia / Zostera* and *Posidonia* Mixed beds) areas and *Halophila / Zostera* areas mapped during Baseline Surveys at Kurnell to date.

Seagrass area (m^2)	Baseline 1	Baseline 2	Baseline 3	Baseline 4
Buffer Area				
Halophila / Zostera	3975	4365	3597	2835
Posidonia / Posidonia mixed	228	220	263	251
Construction Footprint				
Halophila / Zostera	975	1027	818	733
Posidonia / Posidonia mixed	20	14	5	7
Project Boundary				
Halophila / Zostera	24363	21491	13852	13795
Posidonia / Posidonia mixed	4231	4876	4362	3978
Survey Area				
Halophila / Zostera	37417	35959	22957	12754
Posidonia / Posidonia mixed	34825	36995	34841	35376

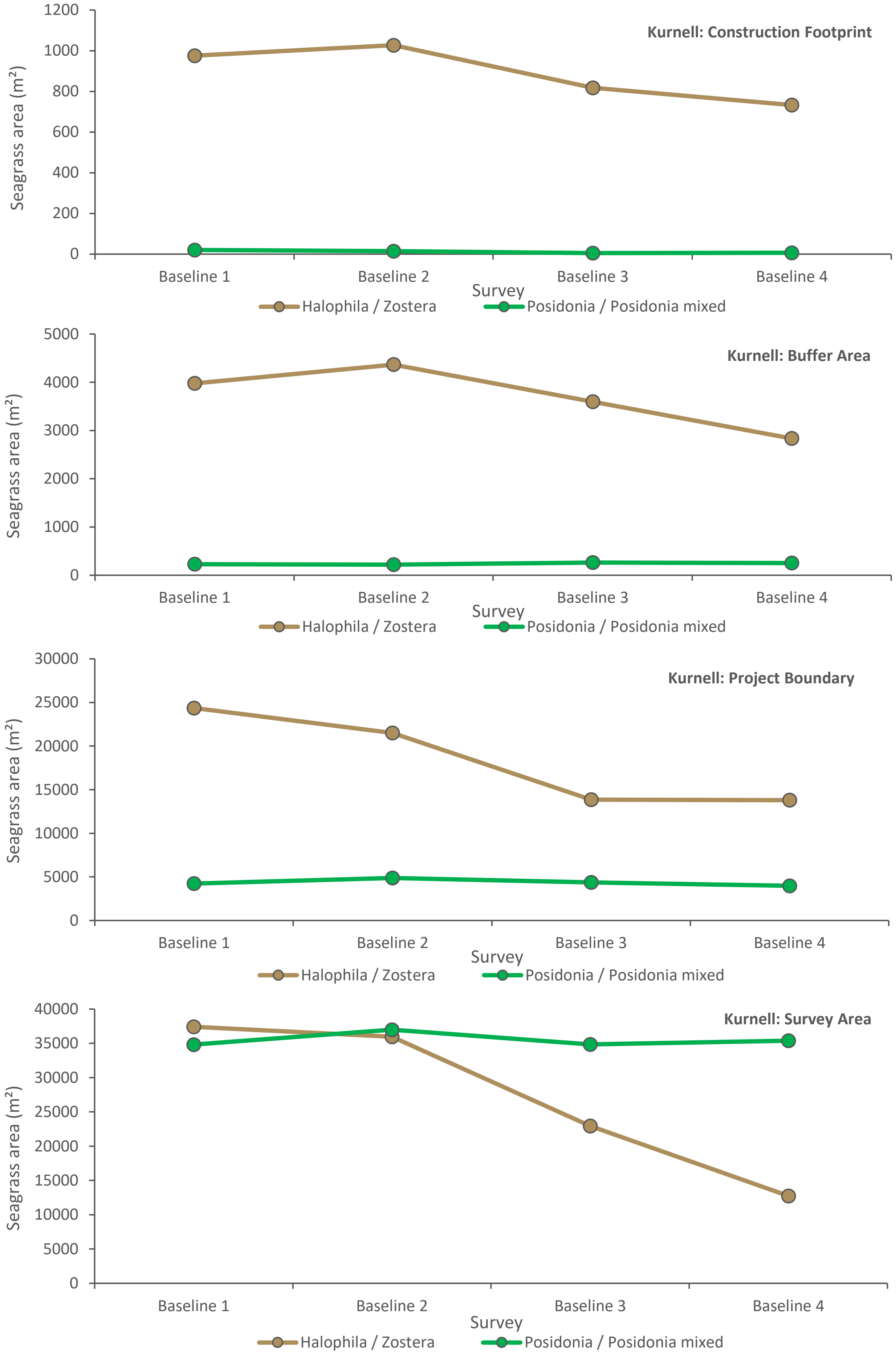
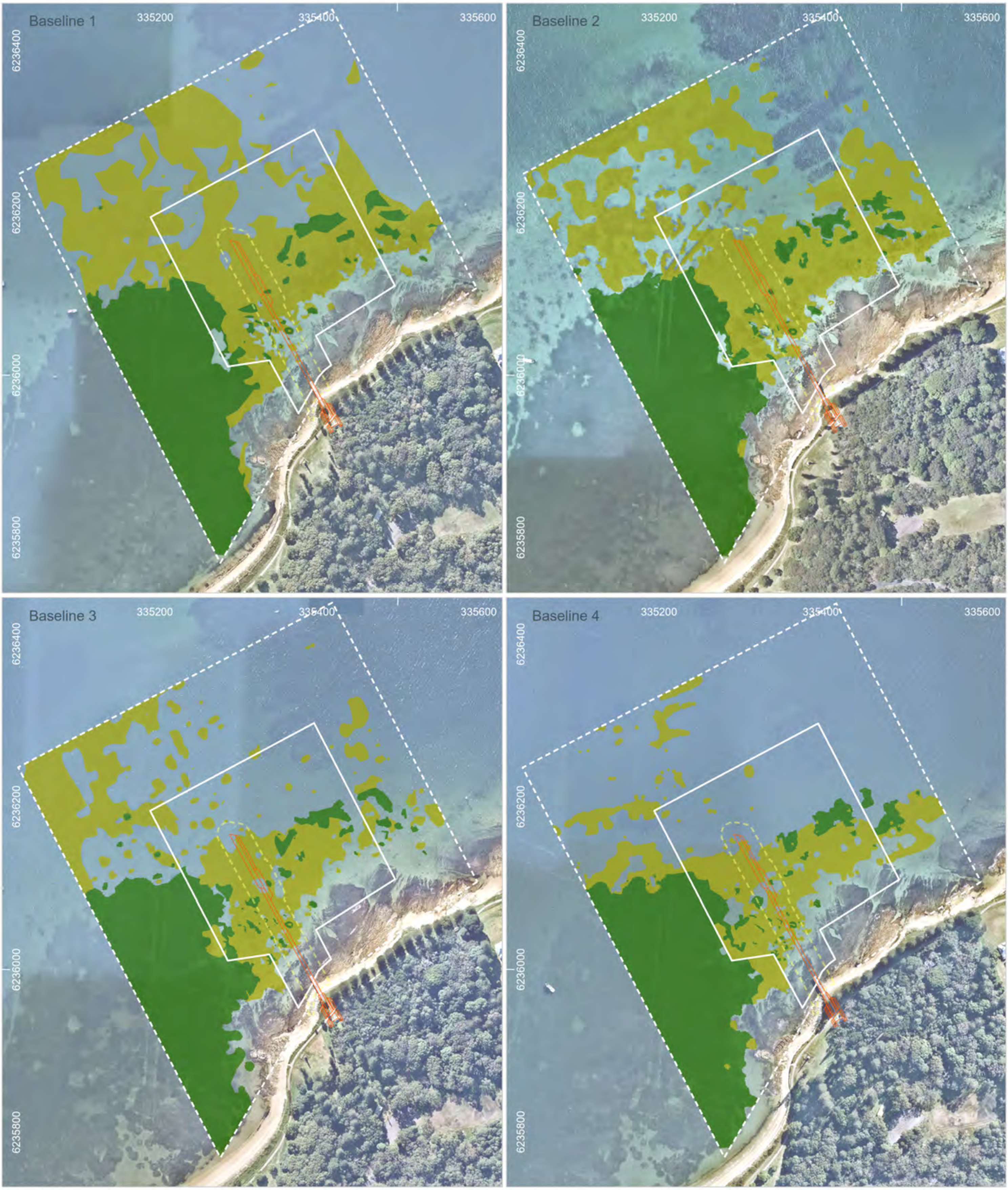


Figure 7: *Posidonia* / *Posidonia* Mixed and *Halophila* / *Zostera* areas over all Baseline Surveys at Kurnell



Construction Footprint

Buffer Area (15m)

Survey Area

Project Boundary

Seagrass habitat

Halophila / Zostera

Posidonia / Posidonia Mixed

niche Environment and Heritage

0 100 m

WGS 1984 Web Mercator

Niche PM: Luke Stone
Niche Proj. #: 7476
Client: Transport for NSW

Survey sites and habitat mapping: Kurnell
Baseline comparison

Kamay Ferry seagrass monitoring

Figure 8

Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to WGS1984 Web Mercator Auxilliary Sphere is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020, using the relevant MGA zone.

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5.2 *Zostera* and *Halophila* seagrass beds

5.2.1 La Perouse

At La Perouse drop camera monitoring sites there has been a large decrease in *Zostera* and *Halophila* seagrass cover, from between 14% and 24% cover in Baseline 1 down to 7% or less in Baseline 4 (Figure 9). The two-factor univariate PERMANOVA found a significant interaction term (df=9, f=4.75, p=0.0001, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and among sites were dependent on survey. The Pairwise Tests confirmed that significant differences among surveys were between Baseline 1 and all other surveys across all sites, while there were some further significant differences among surveys from Baseline 2 to Baseline 4 for some (e.g., LP04), but not all sites (Appendix 6). That is, *Zostera* and *Halophila* seagrass cover decreased similarly and significantly from Baseline 1 to Baseline 2 for all sites (Figure 9). Those decreases were then sustained from Baseline 2 through to Baseline 4, although some sites exhibited further significant decreases during that time, albeit to a lesser extent than the Baseline 1 to 2 decreases (e.g., LP04).

Another notable observed difference was that *Zostera* and *Halophila* seagrass cover was found to be greater at the sites outside the Project Boundary (HZ-LP03 and HZ-LP04) than those within the Project Boundary (HZ-LP01 and HZ-LP02) during the first two Baseline surveys (Figure 9). This was supported by the general pattern of statistically significant differences detected between pairs of sites during the first two surveys for seagrass cover, as indicated by the paired tests (Appendix 6).

Analysis of the full set of percent cover data via three-factor multivariate PERMANOVA also found a significant interaction term (df=6, f=15.70, p=0.0001, Appendix 6), indicating patterns of differences between surveys (within season) were dependent on site, and among sites were dependent on survey. The PCoA graph shows that while there is some limited overlap of the clusters of data points for Baseline 1 (green) and Baseline 2 (blue), there is clearly a degree of separation overall (Figure 10). In contrast, there is almost no overlap of clustering between Baseline 1 and Baselines 3 (aqua) or 4 (red), which substantially overlap each other. The length and direction of the radiating *Halophila* line matches the direction of disparity of the Baseline 1 cluster, indicating that the difference is primarily being driven by temporal differences in the presence of *Halophila*.

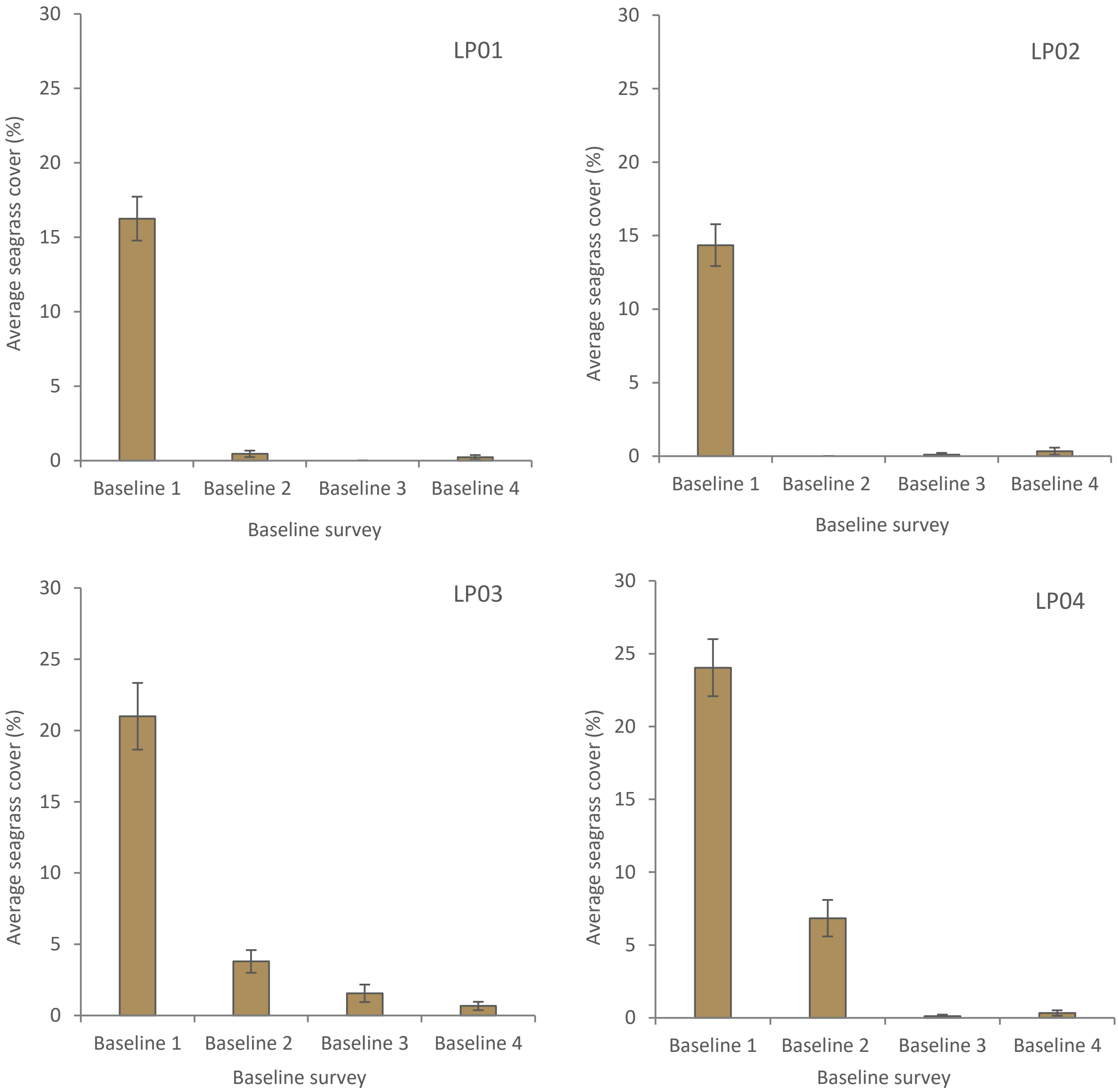
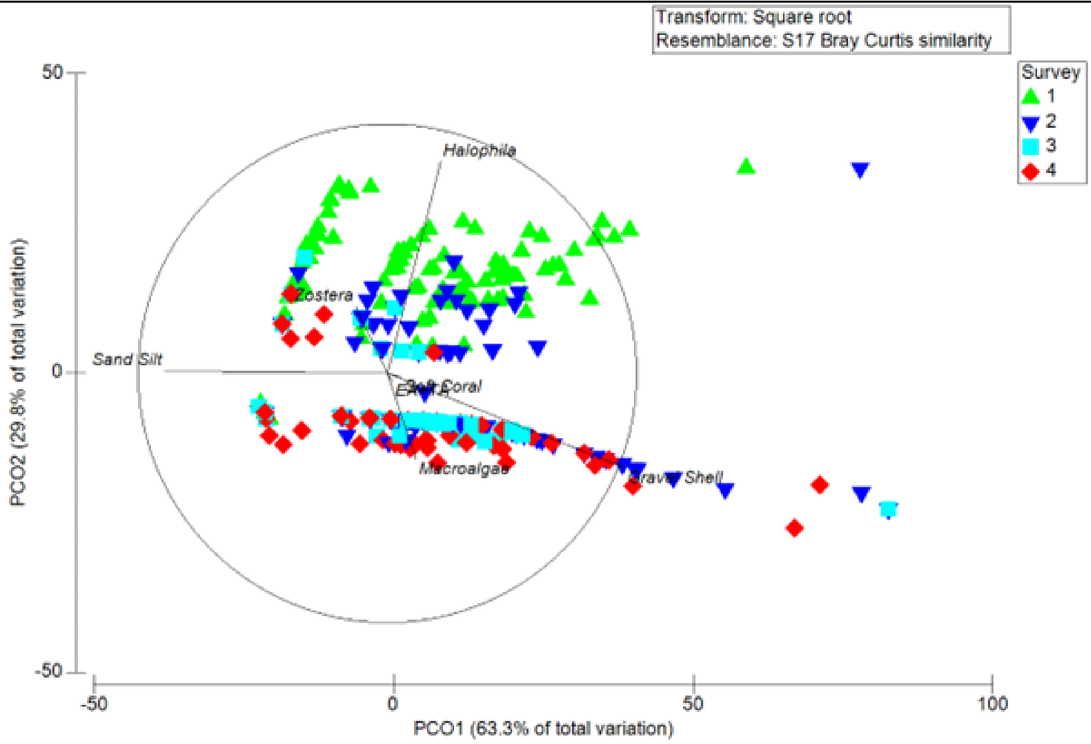


Figure 9: Mean seagrass cover within the *Zostera* and *Halophila* dominated bed sites across the Baseline Surveys at La Perouse.



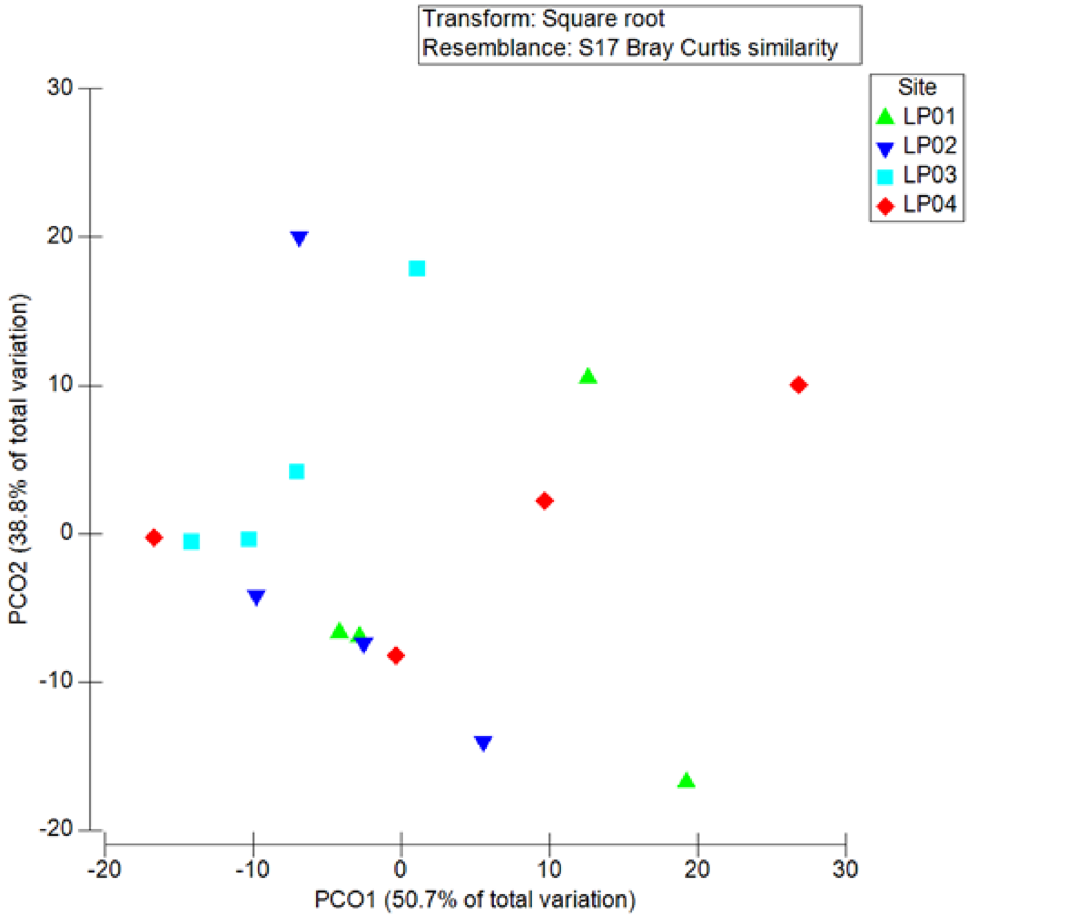


Figure 10: PCoA Graphs for La Perouse. Top: All data displayed by survey. Bottom: Centroids of Site and Survey combined displayed by site.

5.2.2 Kurnell

At Kurnell drop camera monitoring sites the *Zostera* and *Halophila* seagrass cover has been much more variable. At the sites further from shore (HZ-K05 to HZ-K08) cover has remained less than 5%, while two sites close to shore (HZ-K09 and HZ-K10) have displayed much greater change, ranging from cover above 40% to less than 5%. In general, there appears to have been a common pattern of decline in cover between Baseline 1 and 3, then a trend of increase to the most recent survey (Figure 11). As was the case for La Perouse, the statistical analysis detected a significant interaction term (df=15, f=39.85, p=0.0001, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and among sites were dependent on survey. The Pairwise Tests confirmed that these differences were typically between Baseline 3 and other surveys, with the exception of HZ-K06 where no significant differences between surveys were detected (Appendix 6).

In general, seagrass cover was found to be greater at the shallower sites closer to shore (HZ-K09 and HZ-K10) than those further from shore (Figure 11). Statistically significant differences were also detected among sites for seagrass cover and the full set of percent cover data in the cases of each of the four surveys (Appendix 6).

Analysis of the full set of percent cover data via three-factor multivariate PERMANOVA resulted in a similar finding (df=10, f=28.895, p=0.0001, Appendix 6), with patterns of differences among surveys dependent on site, and among sites dependent on survey. The PCoA graph indicates that the most recent survey (Baseline 4) was much more variable than earlier surveys, with both *Zostera* and *Halophila* having a strong negative relationship with the X Axis (Figure 12).

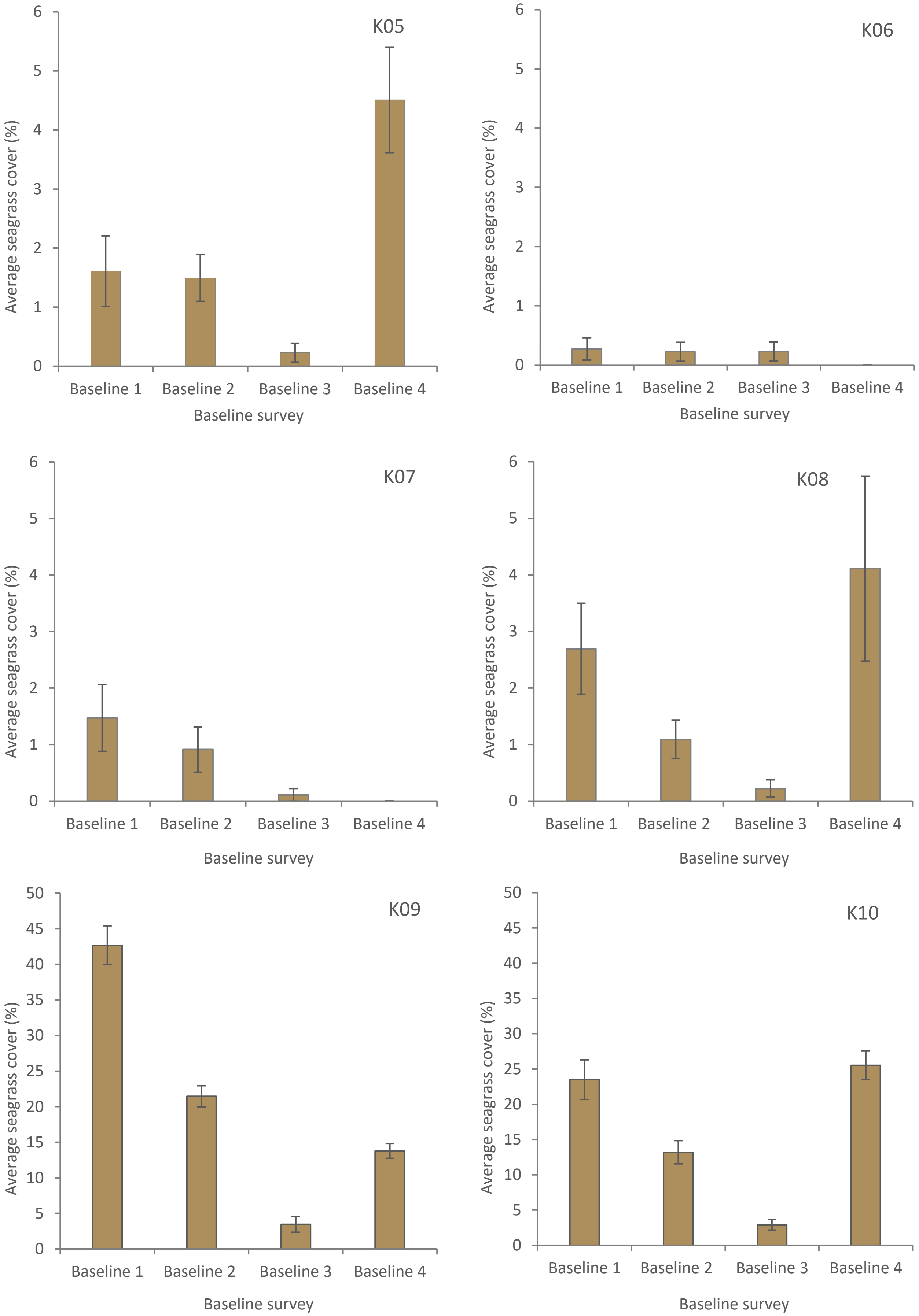


Figure 11: Mean seagrass cover within the *Zostera* and *Halophila* dominated bed sites across the Baseline Survey at Kurnell.

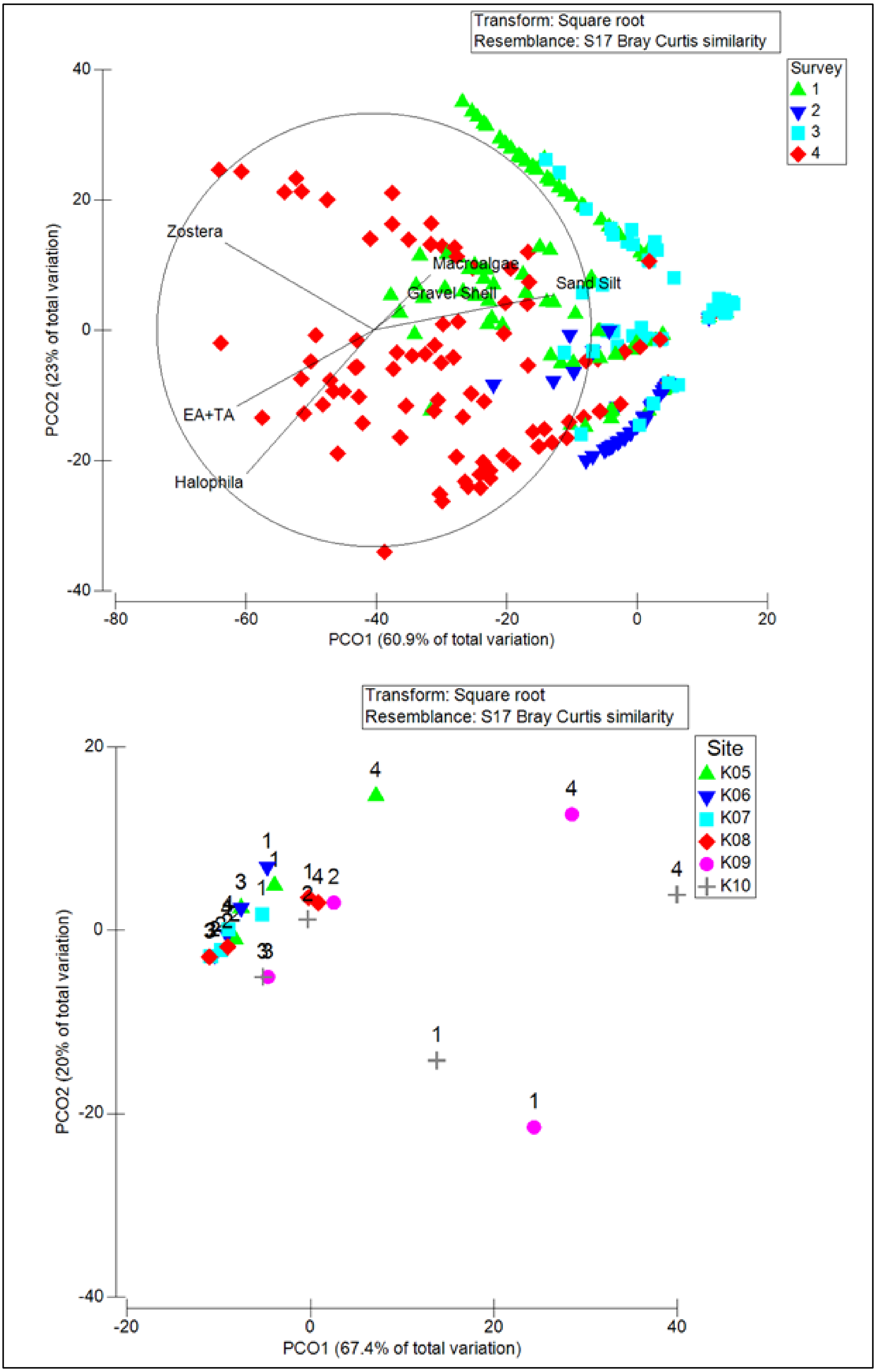


Figure 12: PCoA Graphs for Kurnell. Top: All data displayed by survey. Bottom: Centroids of Site and Survey combined displayed by site.

5.3 *Posidonia* bed monitoring

5.3.1 La Perouse

Posidonia Shoots

Posidonia shoot density within the *Posidonia* Bed monitoring sites at La Perouse was generally higher for the first two Baseline Surveys than later surveys, and at site PB-LP12 than at PB-LP11 (Figure 13). The statistical analysis detected significant differences for the Survey (df=3, f=41.48, p=0.0092) and Site (df=1, f=24.35, p=0.0257) main effects terms, indicating differences across the four surveys irrespective of site, and differences between the two sites irrespective of survey (Appendix 6). Subsequent Pairwise Tests determined that the significant temporal difference detected was driven by a general decrease in shoot density from Baseline 1 in comparison with Baseline 4 at both sites (i.e., B1=B2>B3>B4, Appendix 6).

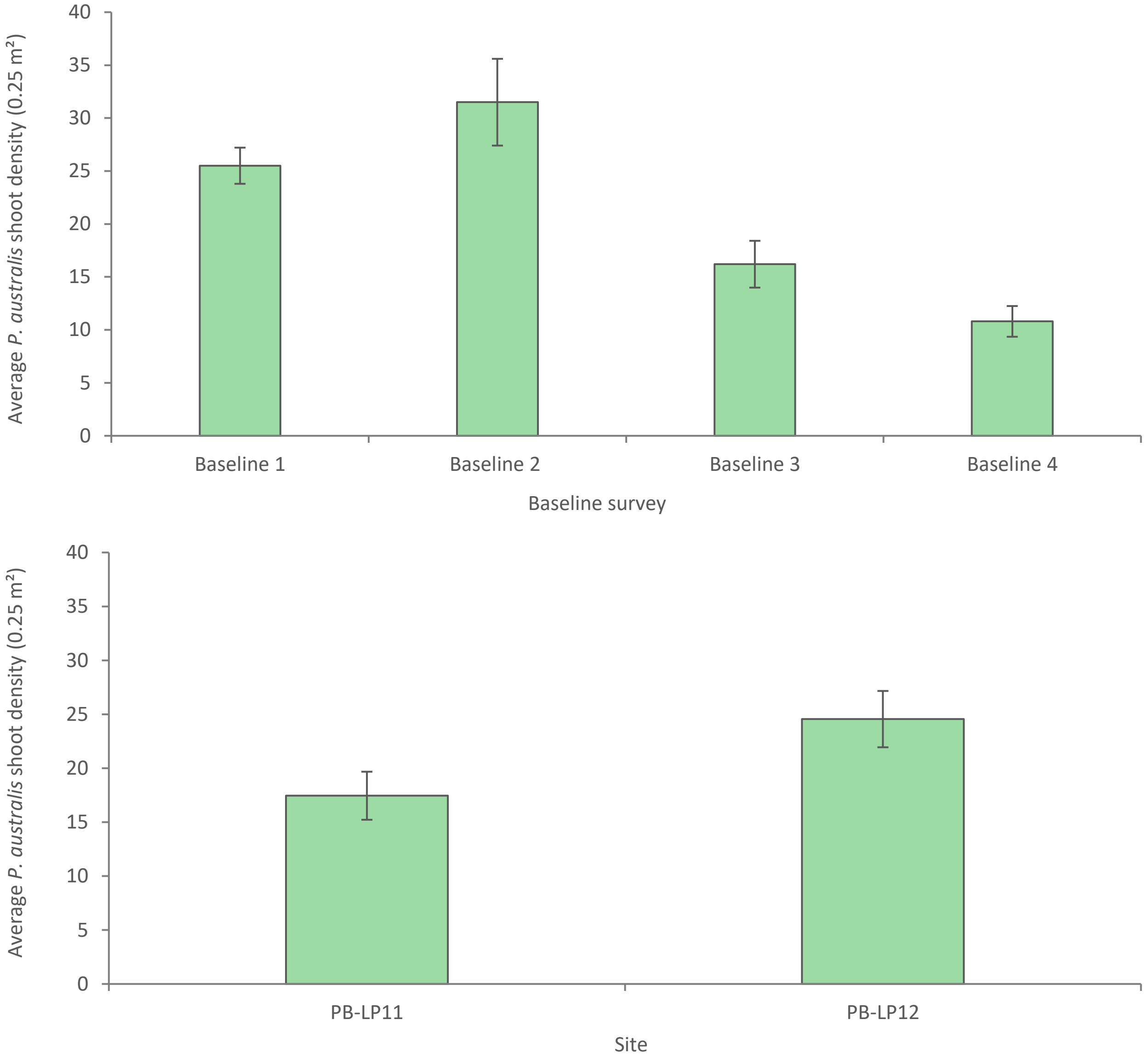


Figure 13: Mean shoot density of *Posidonia* shoots at the La Perouse *Posidonia* bed monitoring sites. Top: Between surveys. Bottom: Between sites.

Posidonia Leaf Length

At La Perouse, leaf lengths at PB-LP11 notably decreased from the first two Baseline surveys (which were generally similar) to the last two Baseline Surveys (also generally similar), while leaf lengths at PB-LP12 were generally more variable across the four surveys (Figure 14). The statistical analysis detected a significant interaction (df=3, f=7.73, p=0.0005, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and between sites were dependent on survey. The Pairwise Tests showed that at PB-LP11 leaf lengths were significantly different among all surveys, while at PB-LP12 leaf lengths were significantly shorter for the Baseline 3 survey than for all other surveys (Appendix 6).

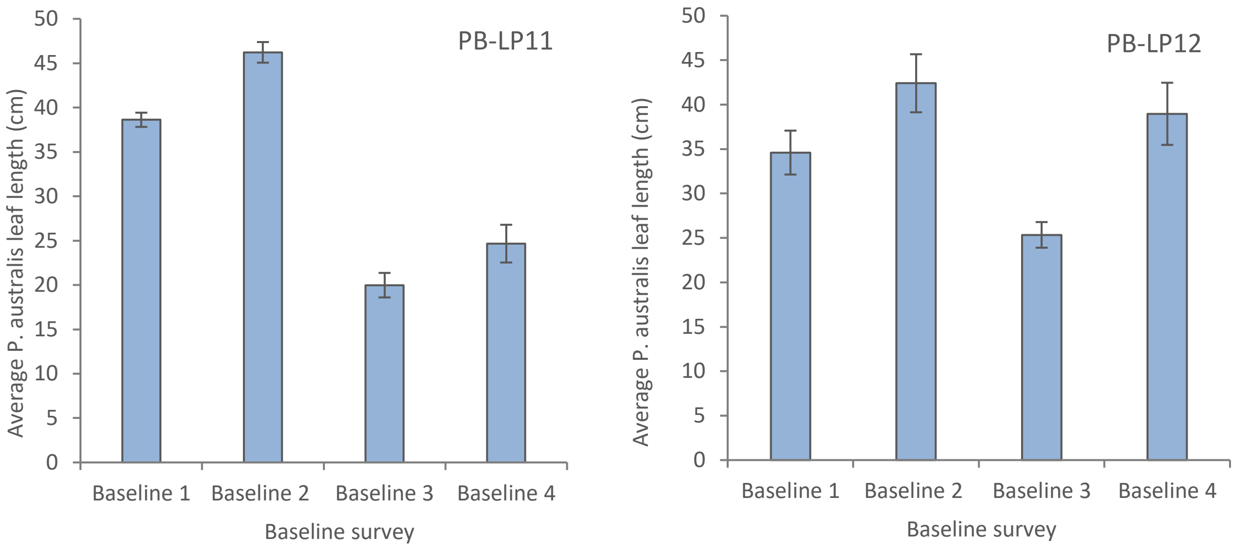


Figure 14: Mean leaf length of *Posidonia* at the La Perouse *Posidonia* bed monitoring sites.

Posidonia epiphytes

At La Perouse, epiphyte load scores indicated moderate to high epiphyte cover across all Baseline Surveys (Figure 15), with scores at PB-LP12 higher and more variable for winter surveys (Baseline 1 and 3) than for summer surveys (Baseline 2 and 4) (Figure 16). The three-factor PERMANOVA detected a significant interaction for Season x Site (df=1, f=27.44, p= 0.0002, Appendix 6), indicating that patterns of differences between seasons were dependent on site, and between sites were dependent on seasons, while a significant difference between Surveys (within Seasons) was also detected (df=2, f=6.57, p=0.0038, Appendix 6). The Pairwise Tests did not detect any significant differences between Seasons for either Site, only between Sites within the Winter Season but not Summer (Appendix 6). Pairwise tests also detected a significant difference between the two Winter Surveys irrespective of Site, but not for the Summer Surveys.

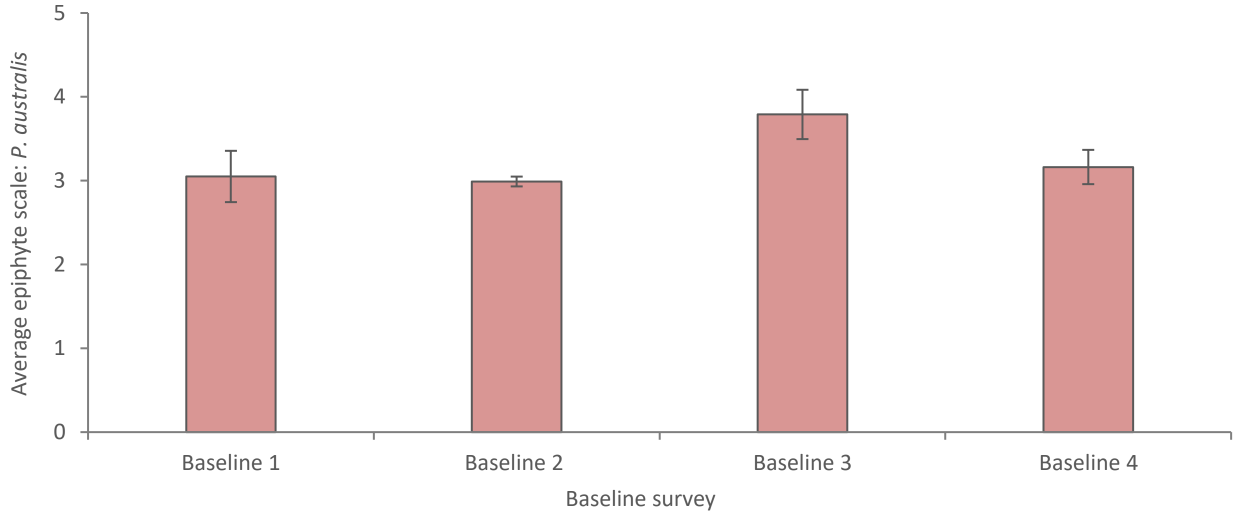


Figure 15: Mean epiphyte load scores of *Posidonia* at the La Perouse *Posidonia* bed monitoring sites between surveys.

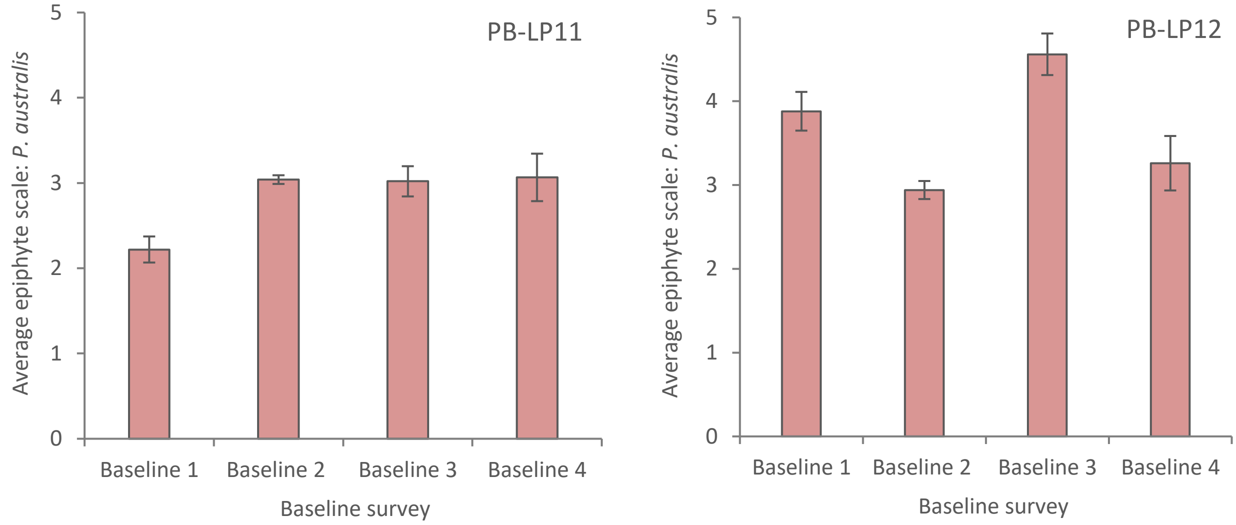


Figure 16: Mean epiphyte load scores of *Posidonia* at the La Perouse *Posidonia* bed monitoring sites.

Posidonia Bed composition

The *Posidonia* beds at La Perouse consisted primarily of *Posidonia*, with the level of presence of *Zostera* and *Halophila* amongst the *Posidonia* being much more variable (Figure 6, Appendix 4). Multivariate analysis of the data detected a significant interaction (df=3, f=5.19, p=0.0007, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and between sites were dependent on survey. Pairwise Tests indicated that bed composition at PL-LP11 significantly differed among most surveys, with the exception being Baseline 3 and Baseline 4 surveys, which did not significantly differ from each other (Appendix 6). In contrast, bed composition at PB-LP12 was found to be significantly different only for the Baseline 4 vs Baseline 1 and Baseline 4 vs Baseline 2 comparisons. Significant differences between sites were also detected for Surveys 1, 3 and 4 (Appendix 6).

The PCoA graph indicates that lower *Zostera* and *Halophila* shoot counts in Baseline 3 and Baseline 4 were a major driver of differences in seagrass bed composition within the La Perouse *Posidonia* Bed monitoring sites. Differences in seagrass composition between sites is illustrated by the PCoA of the Centroid data, which shows PB-LP11 to be much more variable (Figure 17).

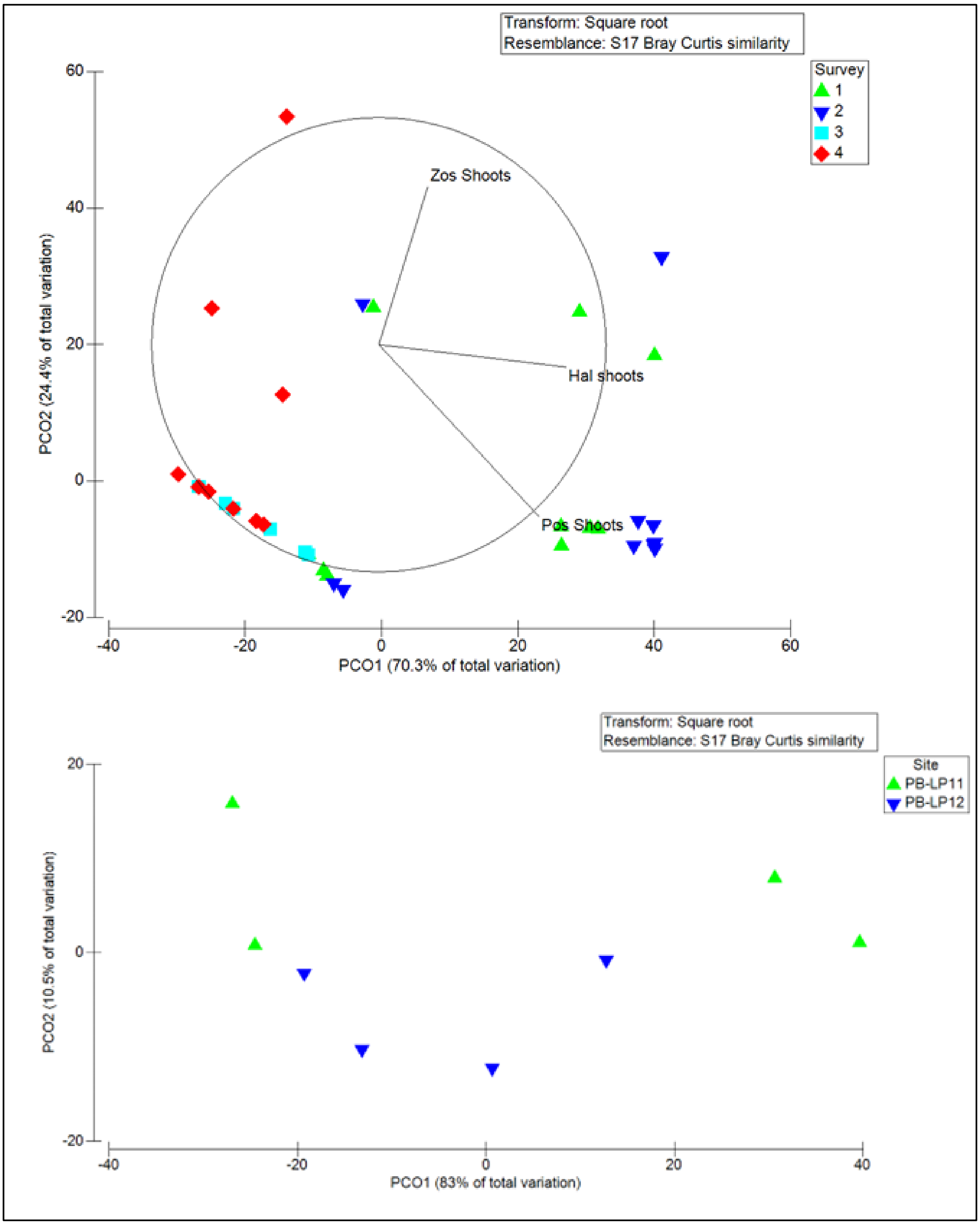


Figure 17: PCoA Graphs for seagrass composition at La Perouse *Posidonia* Bed monitoring sites. Top: All data displayed by survey. Bottom: Centroids of Site and Survey combined displayed by Site.

5.3.2 Kurnell

***Posidonia* shoots**

Posidonia shoot density within the *Posidonia* Bed monitoring sites at Kurnell was variable among Baseline surveys and among sites (Figure 18). The statistical analysis detected a significant interaction (df=27, f=12.96, p=0.0001, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and between sites were dependent on survey. Pairwise Tests determined that the patterns of significant differences among surveys varied by site, and vice versa (Appendix 6).

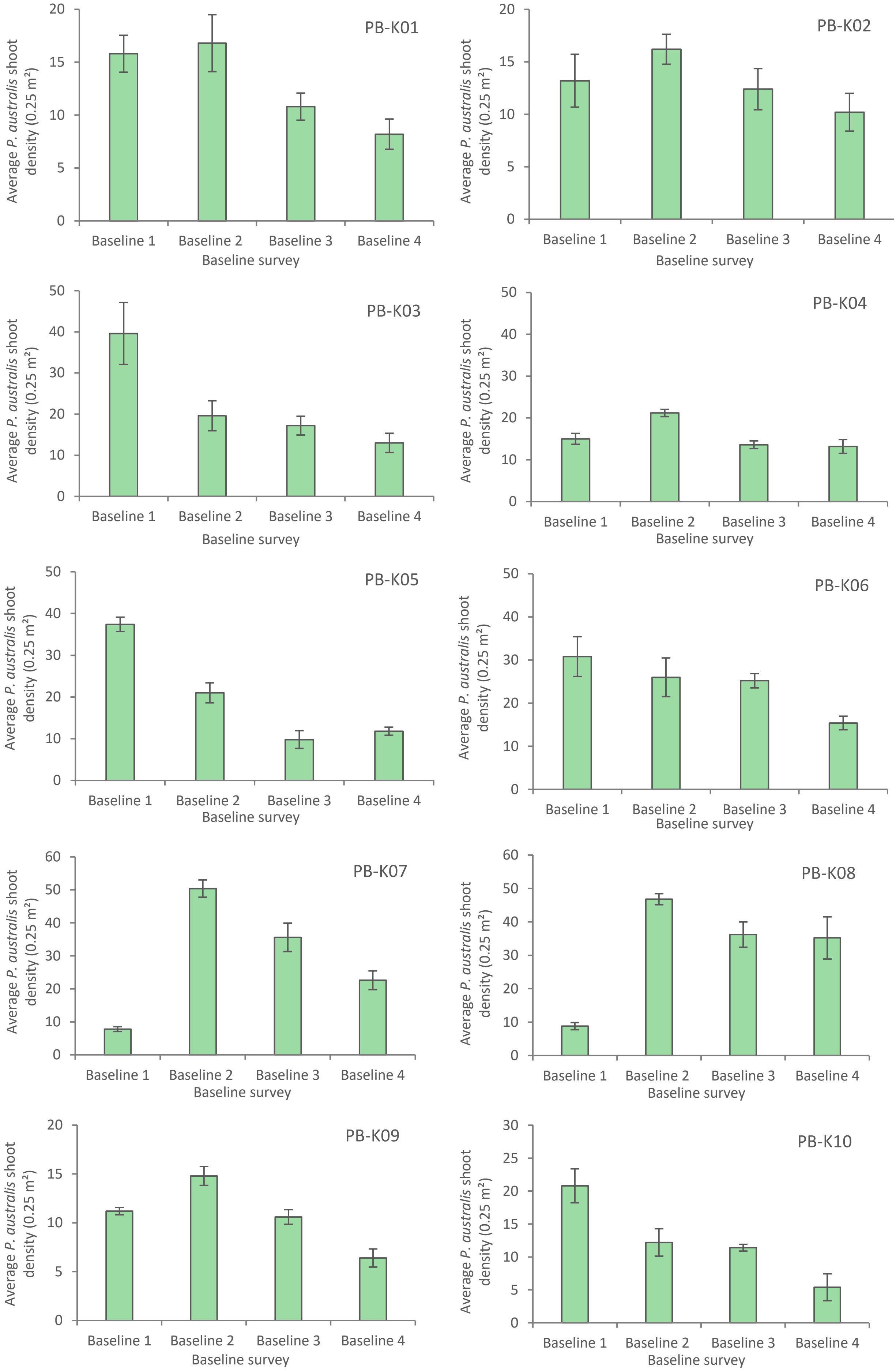


Figure 18: Mean shoot density of *Posidonia* shoots at the Kurnell *Posidonia* bed monitoring sites.

Significant linear regression relationships between shoot density (response variable) and distance from the proposed Construction Footprint (independent variable) were detected for the Inner Transect across all Baseline surveys, while no significant liner relationships were detected at all for the Outer Transect (Figure 19, Appendix 6). For the mostly positive linear relationships detected for the Inner Transect, the coefficient of determination measure of goodness-of-fit (i.e., R-squared) was of moderate strength (< 0.5) for the first two surveys (but note that shoot density was found to have a negative relationship with distance in Baseline 1), and weak (0.4-0.5) in the last two surveys. However, the relationship between distance and the combined data was very weak (<0.1), likely due to the negative linear relationship that occurred for Baseline 1 (Appendix 6).

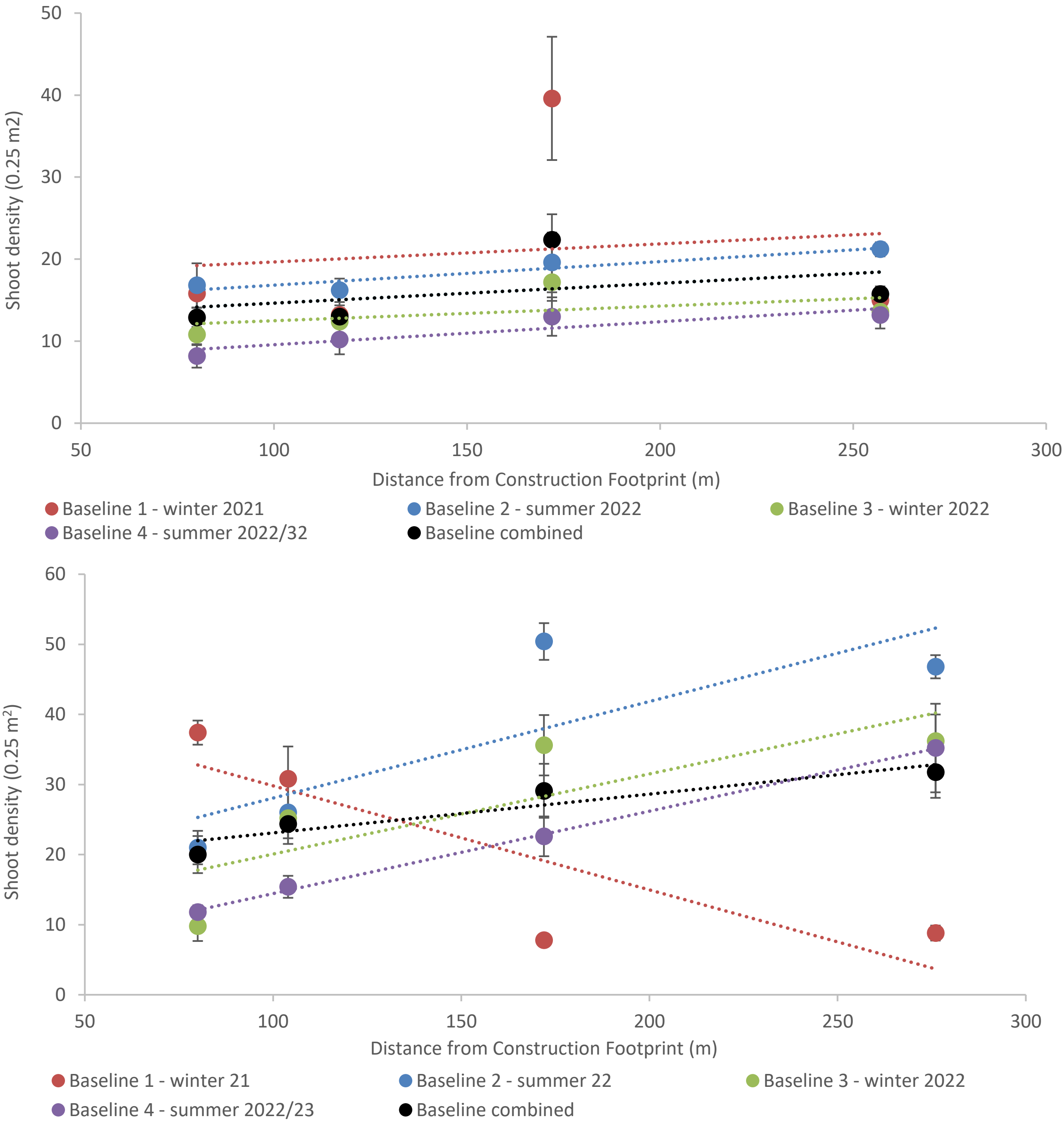
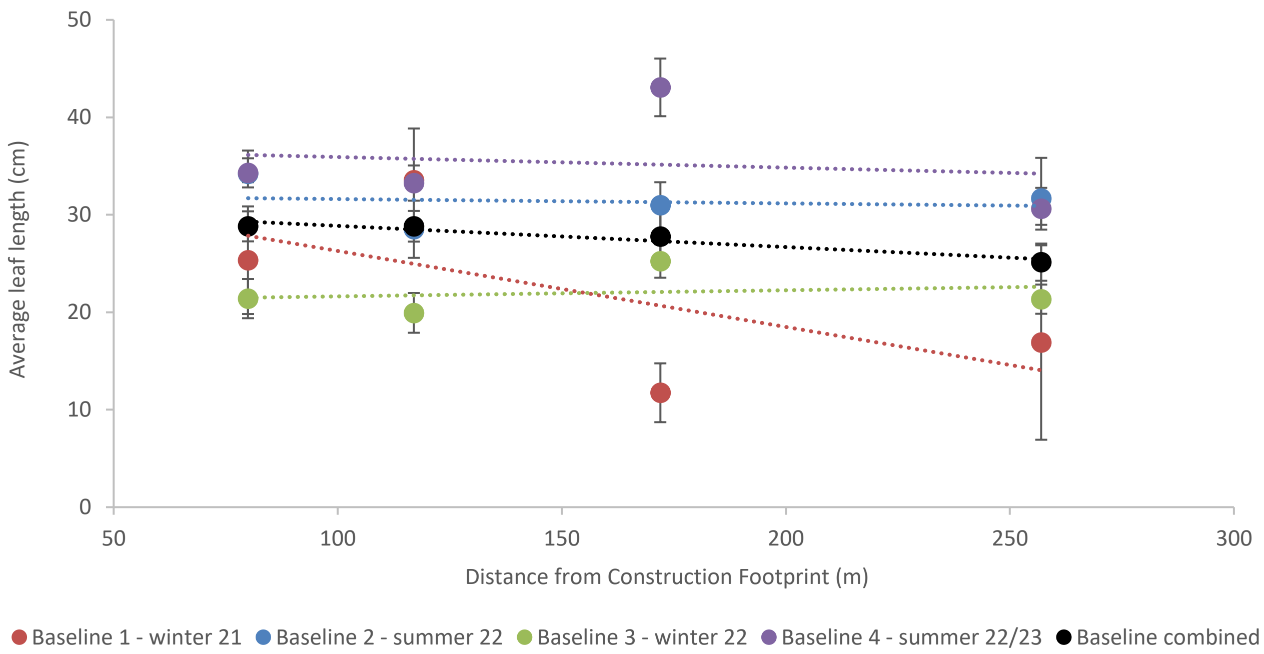


Figure 19: Relationship between *Posidonia* shoot density and distance from the Construction Footprint at Kurnell *Posidonia* bed monitoring sites, Outer Transect (Top), Inner Transect (Bottom). Indicative line-of-best-fit is shown for each Baseline survey and for all surveys combined, irrespective of whether the regression analysis was statistically significant or not.



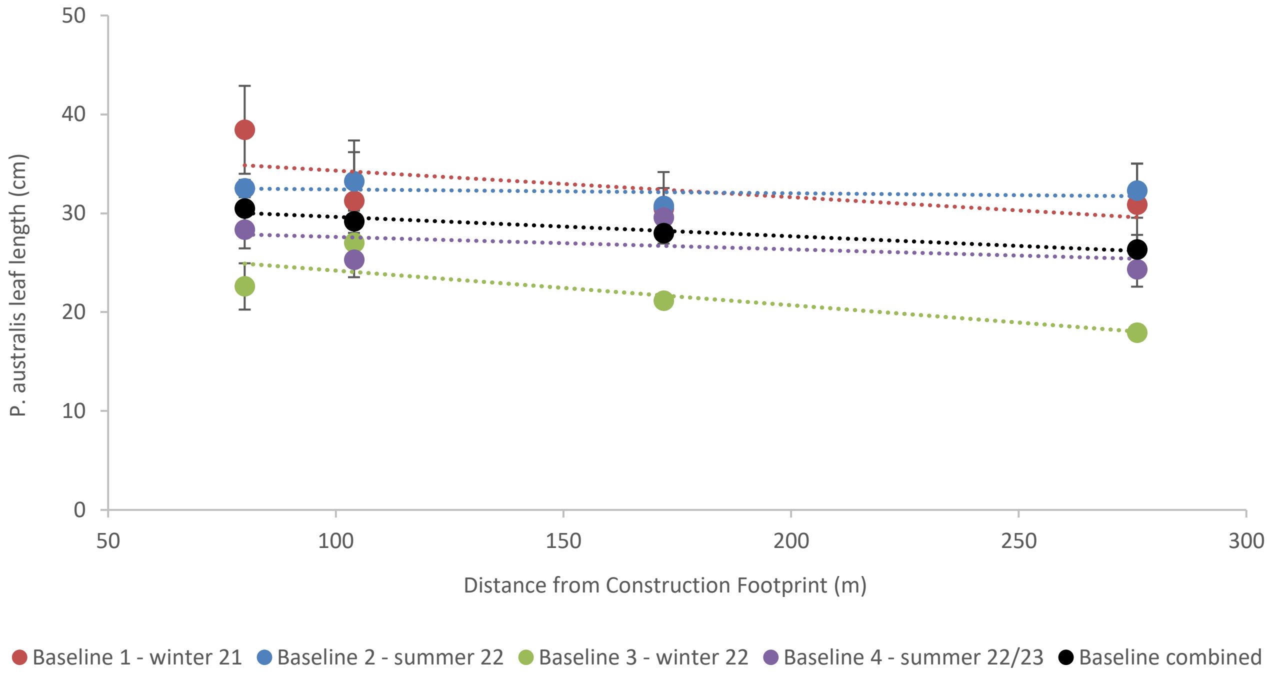


Figure 20: Relationship between *Posidonia* Leaf length and distance from the Construction Footprint at Kurnell *Posidonia* bed monitoring sites, Outer Transect (Top), Inner Transect (Bottom). Indicative line-of-best-fit is shown for each Baseline survey and for all surveys combined, irrespective of whether the regression analysis was statistically significant or not.

Posidonia leaf length

At Kurnell, *Posidonia* leaf lengths were variable among surveys and among sites, however a pattern of reduced leaf length in Baseline 3 in comparison to Baseline 2 and Baseline 4 was evident across almost all sites, with the exception being PB-K06 (Figure 21). The three-factor PERMANOVA detected a significant interaction (df=18, f=7.76, p=0.0001, Appendix 6), indicating that patterns of differences between surveys (within seasons) were dependent on site, and among sites were dependent on survey. Pairwise Tests found that leaf length for surveys within both the Winter season (Baselines 1 and 3) and Summer season (Baselines 2 and 4) were significantly different from each other at some sites (Appendix 6).

A significant negative linear regression relationship between leaf length (response variable) and distance from the proposed Construction Footprint (independent variable) was detected for the Outer Transect only for Baseline 1, with analyses for the other three surveys and the combined data not indicating any significant relationships (Figure 20, Appendix 6). A similar result, but with Baseline 3 having the significant negative linear relationship, was evident for the Inner Transect. The coefficient of determination measure of goodness-of-fit (i.e., R-squared) was of weak strength for the Outer Transect in Baseline 1 and Inner Transect in Baseline 3 (<0.4) (Appendix 6).

***Posidonia* Epiphytes**

At Kurnell the epiphyte load scores indicated moderate to high epiphyte cover across all surveys (Figure 22). The statistical analysis detected a significant interaction (df=27, f=6.69, p=0.0001, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and among sites were dependent on survey. Pairwise Tests determined that there were significant differences among surveys for almost all sites, with the exceptions being PB-K02 and PB-K09, while significant differences occurred among some pairs of sites for most Surveys, with the exception being Baseline 3 (Appendix 6).

***Posidonia* bed composition**

The *Posidonia* beds at Kurnell consisted primarily of *Posidonia*, with *Zostera* and *Halophila* also present, albeit much more variably so (Figure 8, Appendix 4). Multivariate analysis of the data detected a significant interaction (df=27, f=5.47, p=0.0001, Appendix 6), indicating that patterns of differences among surveys were dependent on site, and among sites were dependent on survey. The Pairwise Tests detected significant differences among surveys at all sites, and vice versa (Appendix 6).

The PCoA graph indicates that higher *Zostera* and *Halophila* shoot counts (especially *Halophila* in Baseline 2) were the major drivers of temporal differences in seagrass composition within Kurnell *Posidonia* Bed monitoring sites. Differences in seagrass composition among sites is illustrated by the PCoA of the Centroid data, which shows sites PB-K01 to PB-K05 to typically be less variable than Sites PB-K06 to PB-K10 (Figure 23).

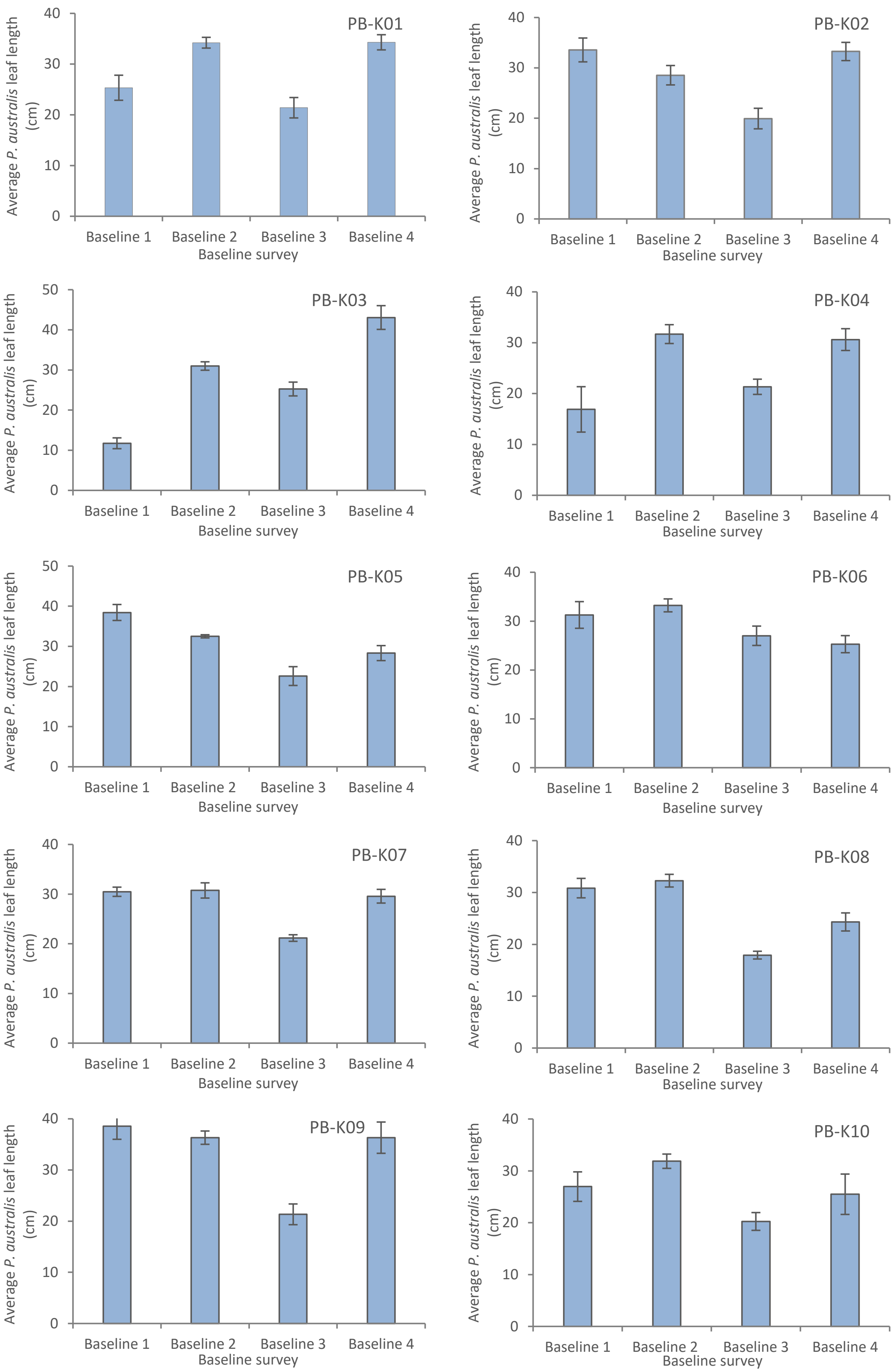


Figure 21: Mean leaf length of *Posidonia* at the La Perouse *Posidonia* bed monitoring sites.

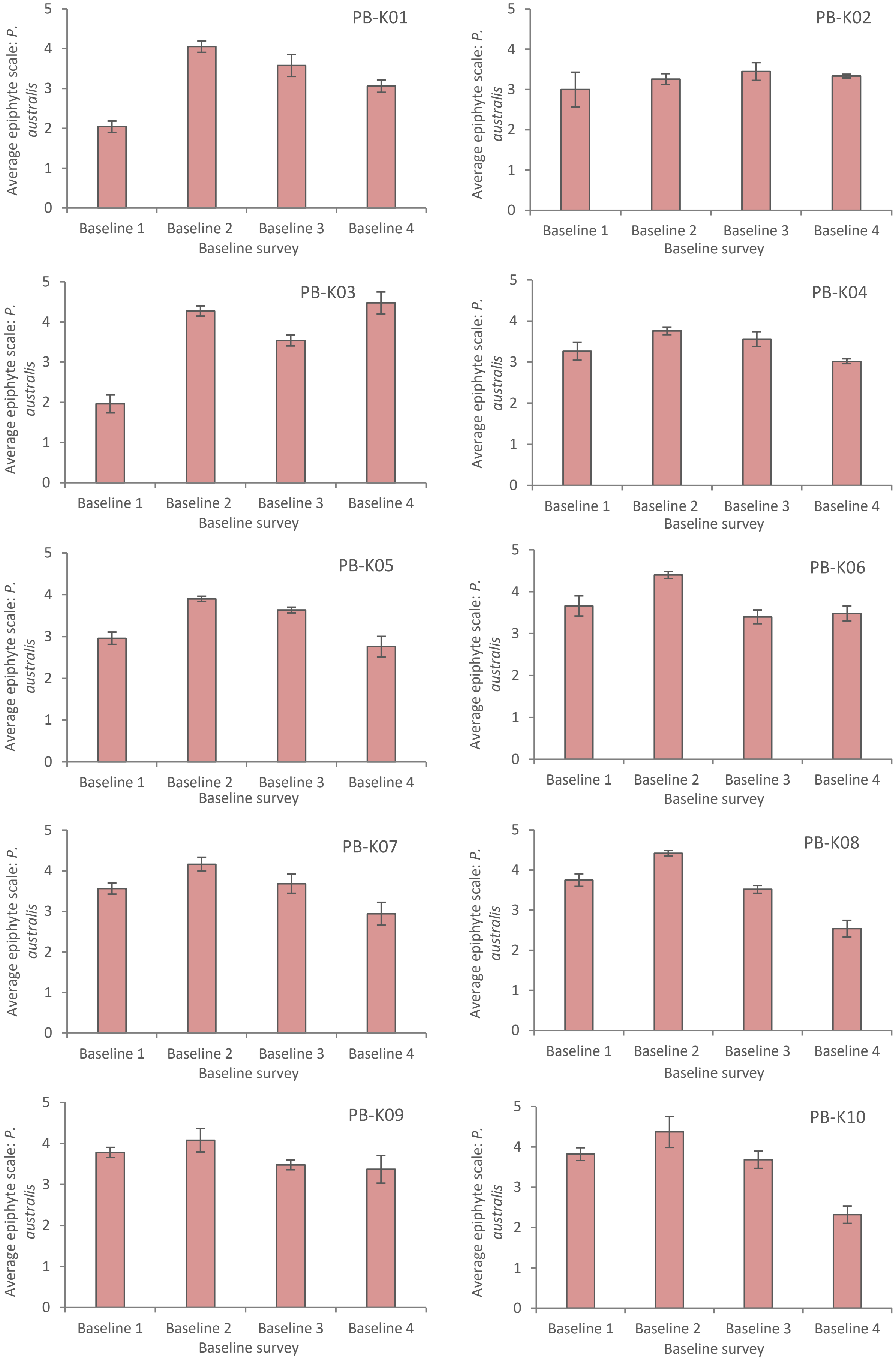


Figure 22: Mean epiphyte load scores for *Posidonia* at the Kurnell *Posidonia* bed monitoring sites.

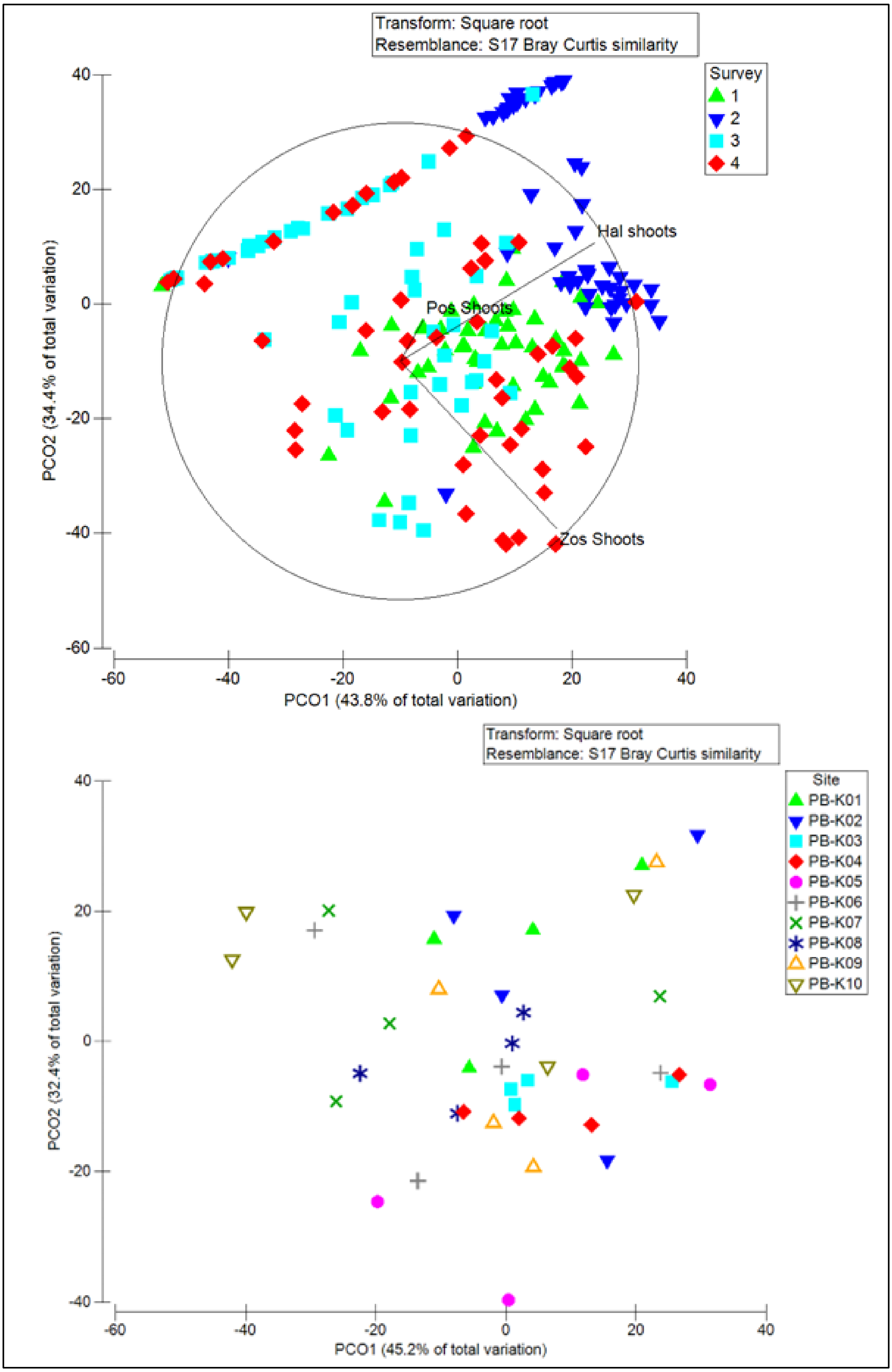


Figure 23: PCoA Graphs for seagrass composition at Kurnell *Posidonia* Bed monitoring sites. Top: All data displayed by survey. Bottom: Centroids of Site and Survey combined displayed by Site.

5.4 *Posidonia* patches

5.4.1 *La Perouse*

PP-LP01

PP-LP01 Is a patch of *Posidonia* approximately 25 metres to the east of the Construction Footprint.

An overall decline in *Posidonia* patch size has occurred between Baseline 1 and Baseline 4. The greatest decline occurred between Baseline 1 and Baseline 2. While patch size increased from Baseline 2 to Baseline 3, a minor decline then occurred between Baseline 3 and Baseline 4 (Figure 24).

There was a trend of decreasing *Posidonia* shoot counts from Baseline 2 to Baseline 4 within this patch (Figure 25). This was supported by the detection of a significant difference among surveys (df=3, f=5.59, p=0.0223). Subsequent pairwise tests then found significant differences between Baseline 4 and Baseline 1, and between Baseline 4 and Baseline 2, while all other pairs of surveys did not significantly differ (Appendix 6).

PP-LP02

PP-LP02 is a patch of *Posidonia* approximately 40 metres to the east of the Construction Footprint.

There has been a trending decline in *Posidonia* patch size between Baseline 1 and Baseline 4, with the greatest decline occurring between Baseline 1 and Baseline 2 (Figure 24).

*Posidonia s*hoot counts at this site have remained relatively similar across most surveys, at 10-15 shoots per 0.25m^2, with the exception being Baseline 2, where counts were over 20 shoots per 0.25 m^2 (Figure 25). This was supported by the detection of a significant difference among surveys (df=3, f=4.73, p=0.0198). Pairwise tests found that shoot counts for Baseline 2 were significantly higher than for all other surveys (Appendix 6).

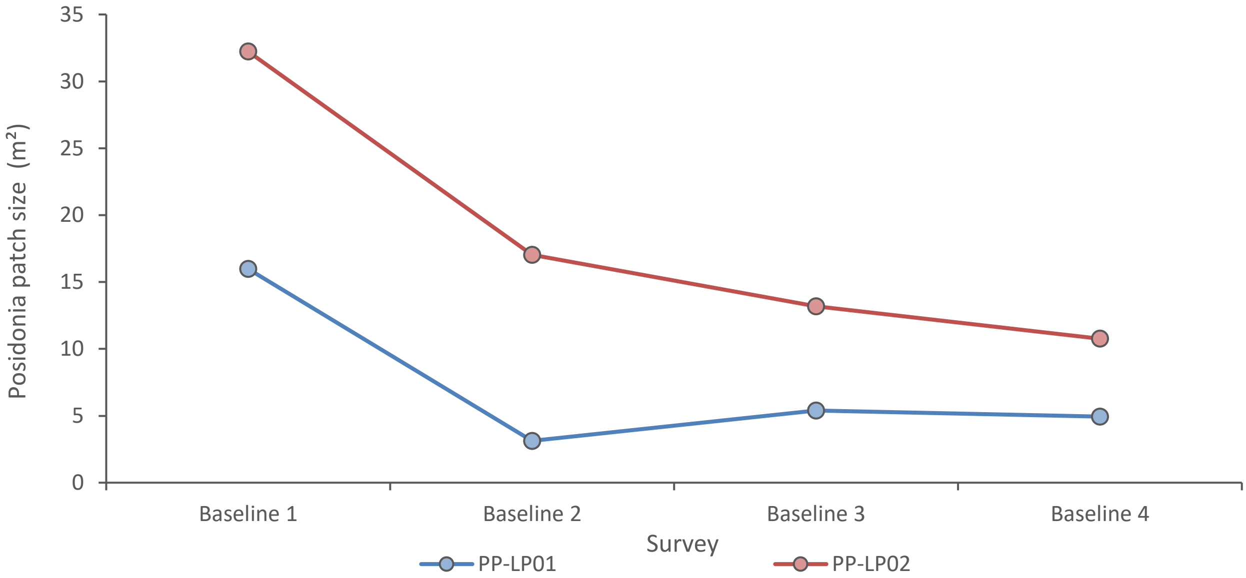


Figure 24: *Posidonia* patch size at the La Perouse *Posidonia* patch monitoring sites

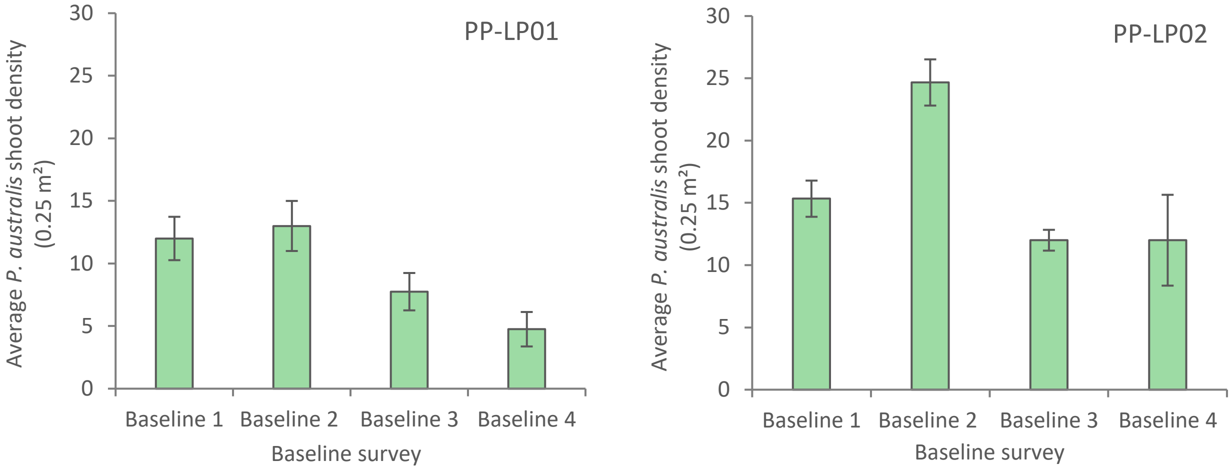


Figure 25: Mean *Posidonia* shoots at the La Perouse *Posidonia* patch monitoring sites.

5.4.2 *Kurnell*

PP-K03

PP-K03 is a patch of *Posidonia* approximately 30 metres to the east of the Construction Footprint.

Posidonia patch size at PP-K03 has been relatively stable across the four Baseline surveys. A small trending increase occurred between Baseline 1 and Baseline 3, before a decline to Baseline 4 (Figure 26).

There was a trend of decreasing *Posidonia* shoot counts from Baseline 1 to Baseline 3 within this patch (Figure 27). This was supported by the detection of a significant difference between surveys (df=3, f=13.78, p=0.0006). Pairwise tests found that this difference was due to shoot counts being significantly higher for Baseline 1 than all other surveys, and significantly higher for Baseline 2 than Baselines 3 and 4 (Appendix 6).

PP-K04

PP-K04 is a patch of *Posidonia* that extends from the eastern side of the Construction Footprint.

Posidonia patch size at PP-K04 has been relatively stable across the four Baseline surveys. A small trending increase occurred between Baseline 1 and Baseline 3, before declining in Baseline 4 (Figure 26).

Posidonia shoot counts were similar across all surveys, ranging between 10-14 shoots per 0.25 m^2 (Figure 27). This was supported by the statistical analysis, which did not detect any significant difference among surveys (df=3, f=0.91, p=0.465 Appendix 6).

PP-K07

PP-K07 is a patch of *Posidonia* approximately 10 metres to the west of the Construction Footprint.

Posidonia patch size at PP-K07 declined substantially between Baseline 1 and Baseline 2. A small increase then occurred between Baseline 2 and Baseline 3, before a decline to Baseline 4 (Figure 26).

Posidonia shoot counts were typically between 5-10 shoots per 0.25 m^2 for each survey, with the exception being a higher shoot density in Survey 2 (Figure 27). However, the statistical analysis did not detect any significant difference among surveys (df=3, f=2.86, p=0.059 Appendix 6).

PP-K08

PP-K08 is a patch of *Posidonia* adjacent to the western edge of the Construction Footprint.

Posidonia patch size at PP-K08 declined substantially between Baseline 1 and Baseline 2. A small increase then occurred between Baseline 2 and Baseline 3, before a decline to Baseline 4 (Figure 26).

Posidonia shoot counts for the most recent two surveys (Baseline 3 and Baseline 4) were similar, but substantially lower than counts for Baseline 1 and Baseline 2, which were also similar (Figure 27). This was supported by the detection of a significant difference among surveys (df=3, f=12.46, p=0.0008). Pairwise tests collectively indicated that the decrease in shoot counts from Baseline 2 to Baseline 3 was significant (Appendix 6).

PP-K09

PP-K09 is a patch of *Posidonia* adjacent to the eastern edge of the Construction Footprint.

Posidonia patch size at PP-K09 declined substantially between Baseline 1 and Baseline 2. A small increase then occurred between Baseline 2 and Baseline 3, before a decline to Baseline 4 (Figure 26).

Posidonia shoot counts were typically similar, ranging between 10-15 shoots per 0.25 m^2 across surveys (Figure 27). This was supported by the statistical analysis, which did not detect any significant difference among surveys (df=3, f=1.11, p=0.3487 Appendix 6).

PP-K11

PP-K11 is a patch of *Posidonia* approximately 5 metres to the east of the Construction Footprint.

Posidonia patch size at PP-K11 declined substantially between Baseline 1 and Baseline 2. A small increase then occurred between Baseline 2 and Baseline 3, before a decline to Baseline 4 (Figure 26).

Posidonia shoot counts were typically very similar (approx. 15 shoots per 0.25 m^2) across the first three surveys, although there was a notable decline in shoot density from Baseline 3 to Baseline 4 (Figure 27). The statistical analysis did not detect any significant difference between Surveys (df=3, f=1.11, p=0.3487 Appendix 6), indicating that declines observed in the most recent survey were not statistically significant.

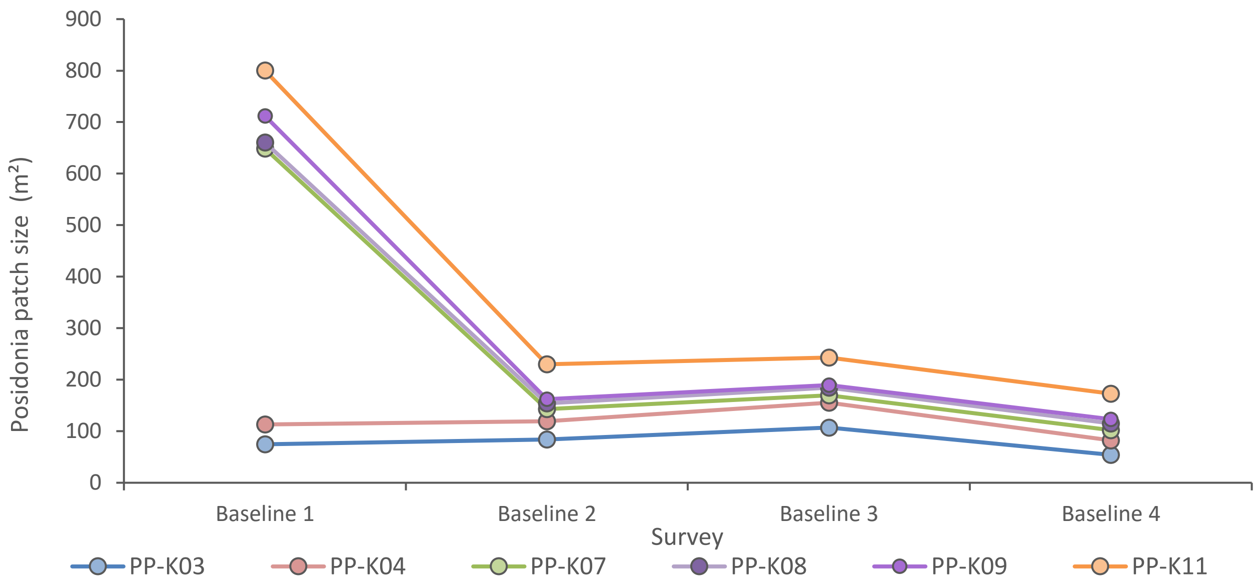


Figure 26: *Posidonia* patch size at the Kurnell *Posidonia* patch monitoring sites

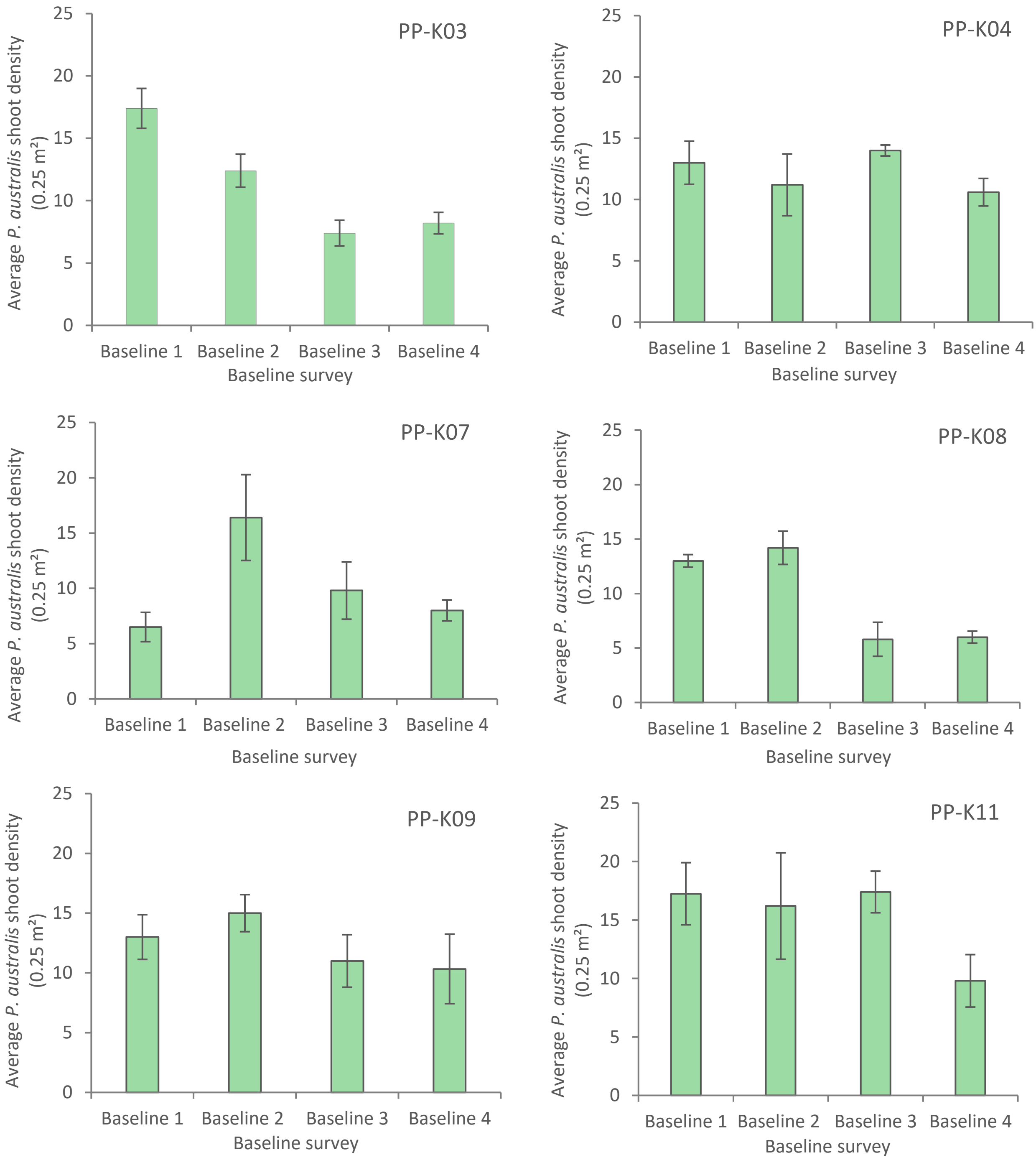


Figure 27: Mean *Posidonia* shoots at the Kurnell *Posidonia* patch monitoring sites.

6. Discussion

6.1 Summary of baseline findings

6.1.1 Seagrass areal extent

Seagrasses within the Project Boundaries at both La Perouse and Kurnell are dominated by *Halophila* and *Zostera* beds, which have typically declined in areal extent since the start of Baseline Surveys. *Posidonia* seagrass beds have a much lesser contribution to areal extent of seagrasses within both Project Boundaries, although the areal extent and extent of *Posidonia* remained relatively stable across the Baseline Surveys.

At La Perouse only 51 m^2 of seagrass (all *Halophila/Zostera*) was present by the end of the Baseline Surveys – all confined to the Buffer Area and expected to be impacted by the Project. This represented approximately 1% of the total areal extent of seagrass mapped in this area by the end of Baseline 1. Notably, the magnitude of declines in seagrasses at La Perouse were not as large in the wider Survey Area, with declines since Baseline 1 of approximately 33%. Mapping indicates these declines were the greatest in the nearer-to-shore areas associated with the rock platform and Frenchmans Beach.

Declines in seagrass cover were generally not as great at Kurnell, with seagrass area inside the Construction Footprint and Buffer Area peaking during the Baseline 2 Survey at 5,626 m^2, and reducing to 3,826 m^2 by the end of the Baseline Surveys (i.e., a decrease of around 32%). This included 258 m^2 of *Posidonia* within the Construction Footprint and Buffer Area in Baseline 4, which represents a small overall trend of increase from the 248 m^2 recorded in Baseline 1. These patterns in seagrass areal extent change were similar in the wider Project Boundary and Study Area at Kurnell, although declines (resulting from a reduction in *Halophila / Zostera*) appeared to be marginally greater in those areas.

6.1.2 *Halophila / Zostera* seagrasses

Monitoring of the *Halophila / Zostera* seagrass beds found that the seagrass beds at both La Perouse and Kurnell were characterised by, in most instances throughout the Baseline surveys, very low seagrass cover (less than 5%), with these levels of cover also highly variable through time. These seagrass beds changed substantially through time irrespective of season at both La Perouse and Kurnell, while spatial variability was also highly evident, especially with respect to differences according to proximity to the shoreline.

At La Perouse, seagrass cover was substantially greater in Baseline 1 than in the other Baseline surveys, with some sites having up to 25% cover in the former survey. By Baseline 4 substantial decreases from Baseline 1 became evident with, for example, levels below 1% cover at monitoring sites adjacent to the Construction Footprint and 5% at potential reference sites. This indicates a clear general decline in *Halophila / Zostera* cover at La Perouse since the commencement of the Baseline Surveys. Interestingly, seagrass cover estimates at the reference sites, which are further from shore, were typically greater but similarly variable.

At Kurnell, the variability in seagrass cover among the *Halophila / Zostera* seagrass beds was much greater than at La Perouse, with temporal trends across the Baseline Surveys less evident. In spatial terms, the original sites located nearer to the shore, including the potential impact and reference sites, appeared very different to the additional near-to-shore sites added in Baseline 1 following the establishment of much denser seagrass bed. Those original sites recorded lower levels of variability and seagrass cover. The additional sites were found to be much more variable and, with the exception of Baseline 3, supported *Halophila / Zostera* seagrass cover of greater than 10%.

6.1.3 *Posidonia* seagrass

Across the Baseline Surveys there was a general trend of decreasing *Posidonia* shoot density within the *Posidonia* beds and patches over time at both locations. These reductions were not consistent across all monitoring sites, indicating that the drivers of any decrease in shoot density were not acting on the *Posidonia* beds and patches equally across the two Survey Areas. The *Posidonia* seagrass beds and patches at both La Perouse and Kurnell typically consist of mixed seagrasses. *P. australis*, the canopy forming species, typically had leaf lengths in excess of 20 cm. *Halophila* and/or *Zostera* occupied the lower stratum and were typically much more variable in occurrence and density.

At La Perouse the *Posidonia* beds declined in shoot density from 100-120 *Posidonia* shoots per m^2 in the first year of monitoring to 40-60 shoots per m^2 in the second year. Shoot density was also typically higher at the reference site. Declines in *Posidonia* shoot density were also notable amongst the smaller patches, which may be more vulnerable to edge effects and overall declines in patch size found amongst the patches of *Posidonia* monitored at La Perouse.

Posidonia seagrass at Kurnell included the main bed that commences near to the Project Boundary to the west and various scattered smaller beds and patches that occur across and beyond the Project Boundary to the east. In the main bed, *Posidonia* shoot density was higher (up to 200 shoots per m^2) in shallower areas, typically increasing with distance from the Construction Footprint. In the two monitoring sites amongst the smaller beds and patches to the east, *Posidonia* shoot density was typically lower and more variable, at 20-120 shoots per m^2. Declines in *Posidonia* shoot density across Baseline Surveys were also evident at some monitoring sites, especially those nearer to the edge of the main bed and those amongst beds to the east, as well as some of the patches. Furthermore, detailed observations of individual patch size during the dive surveys at Kurnell indicated that a decline in *Posidonia* areal extent and extent through time at much smaller scales undetected by mapping occurred amongst smaller patches of *Posidonia* within the Project Boundary after Baseline 1.

6.2 Drivers of change

There are a number of potential drivers of change in seagrass areal extent, extent and morphology, including reproductive capacity, environmental conditions, natural environmental disturbances and direct human disturbances that act on seagrasses in Botany Bay. Historical review of aerial imagery since the 1930s has attributed major changes in seagrass areal extent to various stressors that have included oyster shell dredging, release of pollutants, catchment inputs, changes in sedimentary conditions and processes, and large storm events (Larkum and West 1990). These various stressors have resulted in not only seagrass loss but also community composition change, with faster colonising and growing *Zostera* seagrasses typically displacing the slower colonising and growing *P. australis* (Larkum and West 1990), with more recent research indicating the rate of annual change in *P. australis* in Botany Bay is as high as -2.5% (West and Glasby 2021).

Seagrasses can exhibit both asexual and sexual reproduction. Asexual reproduction typically includes the spread of underground rhizomes and roots that produce new shoots (Waycott et al. 2014), while on occasions this may also include dispersal of broken-away fragments that establish in new locations (McMahon et al. 2014). Sexual reproduction, like all plants, includes flowering, pollination, setting and germinating of seeds (Waycott et al. 2014), with many seagrasses having the ability to lay dormant in the sediments until optimal environmental conditions occur (Orth et al. 2000). In Botany Bay, *P. australis* is believed to be typically reliant on asexual reproduction so, given the slow rates of rhizome growth for this species (Larkum and West 1990), any increases in areal extent may take years to detect. In comparison, species of *Halophila* and *Zostera* in Botany Bay may at times display much more rapid growth rates and cyclic changes, taking advantage of seed dormancy. The seeds of *Halophila* and *Zostera* seagrasses may lie dormant for up to 24 and 12 months respectively (Orth et al. 2000), with the latter typically being negatively buoyant, limiting dispersal to close proximities (approx. 10 m) but allowing for rapid settlement into the sediment for later germination when environmental conditions allow (Smith et al 2014). Rapid increases in *Halophila* and *Zostera* seagrass establishment and areal extent were apparent at times during the Baseline Surveys, especially during Baseline 1 in shallower areas fringing the shoreline at Kurnell. While not detected in the EIS surveys (TfNSW 2021a), this is likely reflective of the ability of these species to rapidly establish from the seed bank in Botany Bay.

Botany Bay has undergone significant disturbances and changes over the decades and, in its present state, is a highly modified estuary. These disturbances and changes have included dredging of the entrance, which has increased wave penetration and height, and extensive catchment development resulting in increased catchment runoff and inputs – all subsequently impacting on seagrass beds (Larkum and West 1990). Land reclamation in Botany Bay has altered coastal processes including sediment transport and shoreline erosional patterns (URS 2003), while armouring of shorelines to protect natural and built assets has altered wave climate and increased the risk of refraction to protected areas (Aijaz and Treloar 2003).

The Baseline Surveys for the Seagrass Monitoring Program were undertaken through a strong La Nina weather pattern that impacted on the eastern Australian coastline for 18-24 months, bringing above average rainfall that lowered salinities, increased turbidity levels and reduced light availability due to high sediment loads in Botany Bay for extended periods. Furthermore, this long-term weather pattern resulted in a number of significant weather and flood events within the Botany Bay catchment and coincided with a number of low pressure systems that formed off the Sydney Coast, resulting in large, powerful easterly swells entering Botany Bay. Turbidity is a major stressor of seagrass health, with light penetration considered one of the most important variables controlling the areal extent and abundance of seagrass in estuaries (Cardno 2018). These weather events appear to have had significant influence on seagrass assemblages and has likely driven decline of seagrasses within the Project Boundaries at both locations. At La Perouse, significant shoreline erosion occurred following storm and major Georges River flooding events that occurred during the Baseline 2 survey (i.e., between Feb to April 2022) (Niche 2022a) and the Baseline 3 survey (i.e., between July and August 2022) (Niche 2022b). Further, seagrass mapping had to be finalised and the drop camera survey completed after the major weather event in February / March 2022 (Baseline 2). This weather event included unprecedented rainfall for the Sydney Region that resulted in prolonged flooding and sedimentation, as well as extensive shoreline erosion as a result of refraction of waves into Frenchmans Bay from the seawall between Molineux Point and Bumbora Points. At the time of April 2022 sampling for the Baseline 2 survey at La Perouse, a usually uniform and gradually sloping seabed that supported low density seagrasses was unusually found to be highly variable, undulating with clear scour and deposition marks (Cummings Pers Ob). In contrast, mapping works for Baseline 2 at Kurnell were completed before the onset of that weather event, however drop camera surveys were not undertaken until April. Notably, the limited observations of seagrasses and the seabed made during the drop camera surveys at Kurnell in April did indicate that physical disturbance of the seabed appeared less acute in comparison with observations made at La Perouse. Data collected following that weather event across Baseline 2 and 3 indicated that large declines in seagrass extent occurred, especially at La Perouse in shallower nearshore areas with mixed *Halophila* and *Zostera* beds. Interestingly, beds and patches of *P. australis* were in most cases found to persist, although disturbance of the seabed was still perceptible. The Baseline data and observations indicate that the deeper-rooted *P. australis* (Waycott et al. 2014) is likely more tolerant and has greater capacity to persist in such adverse conditions than shallower rooted species such as *Halophila* and *Zostera.*

Other human-induced disturbances with potential to impact on seagrasses at La Perouse and Kurnell may include reduced water quality, vessel propeller scarring in shallow areas, and recreational and commercial vessel moorings. Reduced water quality can result in increased turbidity and nutrients, promoting growth of epiphytic and smothering algal species that can gradually reduce seagrass health (Abal and Dennison 1996), and increase susceptibility to leaf loss (Horn et al. 2009), especially for the slower growing species such as *P. australis*. Epiphyte data collected across the Baseline Surveys typically indicated that *P. australis* was consistently moderately- to heavily-fouled by epiphytic growth. This may lead to further declines in *P. australis* health in coming surveys or may be reflective of typical epiphytic growth that occurs on *P. australis* in Botany Bay. Small scale disturbances may also occur to *P. australis* beds from propeller scarring in shallow waters. Beds occurring in very shallow areas adjacent to sandy beaches are likely to be at most risk, especially in the reference site at La Perouse and shallower areas within the main bed to the west of the Project Boundary at Kurnell. Vessel moorings have been found to have significant impacts on seagrasses, especially *P. australis* in estuaries within the Sydney Region, including Botany Bay (West 2011). Throughout the Baseline Surveys various recreational vessel moorings were found to occur in seagrass habitat in Frenchmans Bay at La Perouse, while at Kurnell some commercial moorings appear to occur very close to and potentially encroach into the north-western side of the main *P. australis* bed. These moorings have potential to further impact on seagrasses, especially within the Project Boundary at La Perouse, where regular repositioning and or relocation appears to be occurring.

6.3 Suitability of the reference sites

6.3.1 *Halophila / Zostera* beds

At La Perouse the proposed reference sites (HZ-LP03 and HZ-LP04), which had slightly greater seagrass densities then the potential impact sites (HZ-LP01 and HZ-LP02), are considered to be suitable reference sites. The reference sites are expected to provide robust comparisons between Baseline Surveys and the during- and post- construction surveys.

At Kurnell the proposed reference sites (HZ-K07 and HZ-K08) were found to be similar in seagrass densities and variability to the potential impact sites further from shore (HZ-K05 and HZ-K06), however both seagrass density and variability were observed to be relatively much greater at the potential impact sites closer to shore (HZ-K09 and HZ-K10). The relative suitability of the latter sites for comparison with the reference sites, which are further from shore and not as variable, may be lower. Thus, interpretations of comparisons between Baseline surveys and during- and post-construction surveys will need to be done with some caution and consideration of these differences.

6.3.2 *Posidonia* beds

At La Perouse *P. australis* has a very limited areal extent, being mostly confined to small beds – one within and one outside the Project Boundary. The sizes of these beds are only sufficient for one monitoring site within each. As a result of this, replication of monitoring sites and capture of spatial variability inside and outside the Project Boundary at La Perouse is not possible. Thus, for these *P. australis* beds at La Perouse the BACI approach will not be as robust and so interpretation of analysis results will be more reliant on comparisons among periods and among surveys within periods. Furthermore, the reference site (PB-LP-12) is in very shallow water and close proximity to the beach, where it is more vulnerable to erosional impacts, wave energy and human disturbances. This may also be reflected by the increased variability in seagrass assemblage found at this site during the Baseline surveys. This will need to be considered when comparing any future changes in *P. australis* in this bed against patterns of change at the site within the Project Boundary.

At Kurnell, *P. australis* monitoring sites included two smaller beds – one inside the Project Boundary and one to the east of the Project Boundary – and eight sites within the main bed along two (east-west) transects that commence near the western side of the Project Boundary. The monitoring site to the east of the Project Boundary (PB-K10) was established as a potential reference site, as it provides for a measure of environmental disturbance as a result of easterly swell that may at times wrap around Kurnell Point and impact on *P. australis* within the eastern sections of the Project Boundary. Additional reference sites can be adopted from sites within the main bed to the west. This may include most of those western sites, with the two most easterly sites (PB-K01 and PB-K05) along these transects being possible exclusions.

7. Recommendations

7.1 Performance indicators

Data collected across the two years of Baseline surveys indicate that the spatial extent of *Halophila* and *Zostera* seagrasses can be highly variable and susceptible to substantial weather-event-induced declines within both Project Boundaries, while *P. australis* areal extent is much more stable with minimal decline, although some reductions in shoot density and small-scale edge effects around smaller patches have been evident. Furthermore, the significance of disturbances that have at times occurred across the Baseline period may have reduced the health and resilience of these seagrass assemblages (e.g., reductions in growth, reproductive potential, health and density) to well below average. Thus, there is the possibility of further declines as a result of similar or more extreme events that may occur into the post-baseline monitoring periods. In light of this, it must be acknowledged that the lower extreme of natural variability still remains unknown, and as such performance indicators may need to be adjusted to be reflective of results of those future surveys.

The performance measures will also need to consider any major environmental events, such as extremely destructive weather events, that may occur from now onwards, which have the inherent potential to impact on seagrass assemblages within the Survey Areas. For extreme events in particular this may require additional surveys in an attempt to capture any changes in seagrass extent and assemblages and separate their influence from any potential impacts attributable to the proposal.

7.1.1 Seagrass areal extent

The Seagrass Monitoring Program requires an acceptable rate of change in seagrass areal extent within the Project Boundary (excluding Construction Footprint and Buffer) to be established. This rate of change should also consider wider scale changes detected in the Survey Area, which are expected to be independent of future construction and operational activities within the Project Boundary.

The following performance indicators for seagrass areal extent are proposed. These have been chosen to allow for natural variability and the reduced precision when mapping large areas in GIS.

Any decrease in *Halophila* and *Zostera* extent within the Project Boundary (excluding the Buffer Area and Construction Footprint) shall not exceed 20% of:

- The areal extent measured in the Baseline 4 survey.
- Decline resulting from natural variability. To be estimated for the same period of time based on change in areal extent within the Survey Area (excluding Project Boundary).

Any decrease in *P. australis* areal extent within the Project Boundary (excluding the Buffer Area and Construction Footprint) shall not be greater than 10% of:

- The areal extent measured in the Baseline 4 survey.
- Decline resulting from natural variability. To be estimated for the same period of time based on change in areal extent within the Study Area (excluding Project Boundary)

7.1.2 *Halophila* and *Zostera* beds

The performance indicator for *Halophila* and *Zostera* beds shall be based on seagrass percent cover. Any decrease since the Baseline 4 survey at the potential impact sites shall not exceed 20%.

The BACI framework should also be suited to apply appropriate multivariate and univariate statistical procedures to detect more subtle changes that may potentially be attributable to the project and, additionally or alternatively, determine the contribution of natural variability and other independent stressors.

7.1.3 *Posidonia* beds

The performance indicator for seagrass shall be based on *P. australis* density. Any decrease since the Baseline 4 survey at the potential impact locations shall not exceed 10%. The potential impact locations should include the monitoring sites within the Project Boundary, and at Kurnell the most eastern sites along the two transects.

The BACI framework should also be suited to apply appropriate multivariate and univariate statistical procedures to detect more subtle changes that may potentially be attributable to the project. At Kurnell, additional statistical analysis to detect any changes in the relationship of *P. australis* density in the main bed with distance along the transects from the Construction Footprint should be investigated.

At Kurnell the potential impact site PB-K09 is mapped to encroach into the Buffer Area, any transplanting of areas of this bed that occur within the Buffer Area will need to be considered in future analysis of this site.

7.2 Modifications to the monitoring program

Consideration should be given to establish an additional *P. australis* bed monitoring site between the eastern perimeter of the Buffer Area and the monitoring site PB-K10.

7.3 Other

The period between the completion of the final Baseline survey (Baseline 4) and the first during construction survey should not exceed 15 months.

A decision will need to be made to either retain or transplant the area of the *P. australis* bed at monitoring site PB-K09 at Kurnell, which occurs within the Buffer Area. It is recommended that transplanting is avoided within 10 metres of the monitoring site to minimise edge effects.

During construction, detailed mapping of positions of all seabed works, anchors and moorings supported by real-time tracking of construction vessels and barges should be incorporated into the CEMP and considered when considering if any impacts can be attributed to the project.

8. Conclusions

In conclusion the baseline period of the Seagrass Monitoring Program has included four surveys completed over approximately two years. This has provided a measure of baseline variability in seagrass extent, coverage, composition and density within the Survey Areas at La Perouse and Kurnell, providing a robust BACI framework to investigate changes that may occur during and after the completion of construction.

The Baseline Surveys have found that the *Halophila* and *Zostera* seagrass beds that dominate the Survey Areas are highly variable in spatial and temporal extent, all the while having declined substantially over the last two years. In comparison, *P. australis* areal extent and condition remained relatively stable, although declines in shoot density were evident in some areas. The large-scale changes and reductions in seagrass extent in the Survey Area across the Baseline Surveys is attributed to environmental disturbances as a result of extreme weather events that occurred along the Australian East Coast over the last two years.

As of the completion of the Baseline 4 survey, seagrass within the Construction Footprint and Buffer Area at La Perouse was found to have an areal extent of 51 m^2 (all *Halophila* and *Zostera*), while at Kurnell the areal extent was 3,826 m^2, which included 258 m^2 of *P. australis* seagrass (Endangered Population). This 258 m^2 consists of typically low to moderate densities of *P. australis*. Furthermore, the *P. australis* shoot densities outside the established monitoring bed and patches were as low as 1-2 plants per m^2 and interspersed amongst other seagrasses that may dominate the seagrass community.

Performance measures have been derived based on the variability that has detected through Baseline Surveys. The performance measures will require regular review and interpretation with consideration of the statistical analysis, qualitative information sources, and major weather events with potential for environmental disturbances. These considerations will be essential to allow for any changes potentially attributable to the project to be accurately separated from those that represent natural variability and other disturbances that may act as stressors within the Survey Areas.

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10. Plates

Plate 1: Survey equipment and methodologies a) Towed camera used to map seagrasses, b) Drop camera used to collect photoquadrats, c) CPCe digital photoquadrat analysis screen, d) DoD rod installed within the main *P. australis* seagrass bed at Kurnell, e) dive survey, f) 0.25 m^2 quadrat.

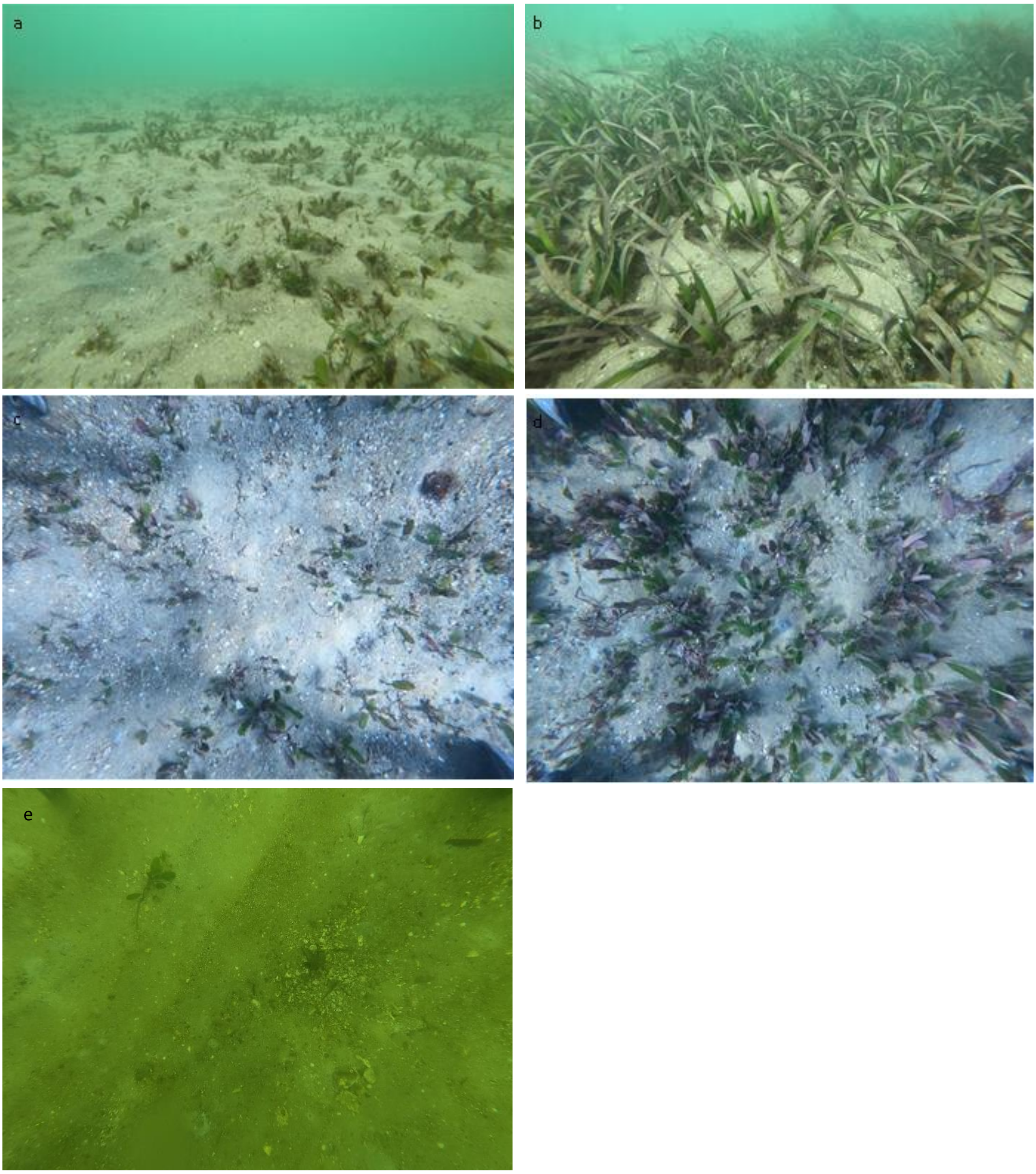


Plate 2: Seagrasses in the Project Area at La Perouse, a) Low density *Halophila* dominated seagrass within *Zostera / Halophila* beds, b) *Posidonia australis*, c) low density *Halophila*, d) medium density *Halophila*, e) reduced *Halophila* density in summer 2022 (HZ-LP02), previously *Zostera / Halophila* in winter 2021 (Niche 2021a).

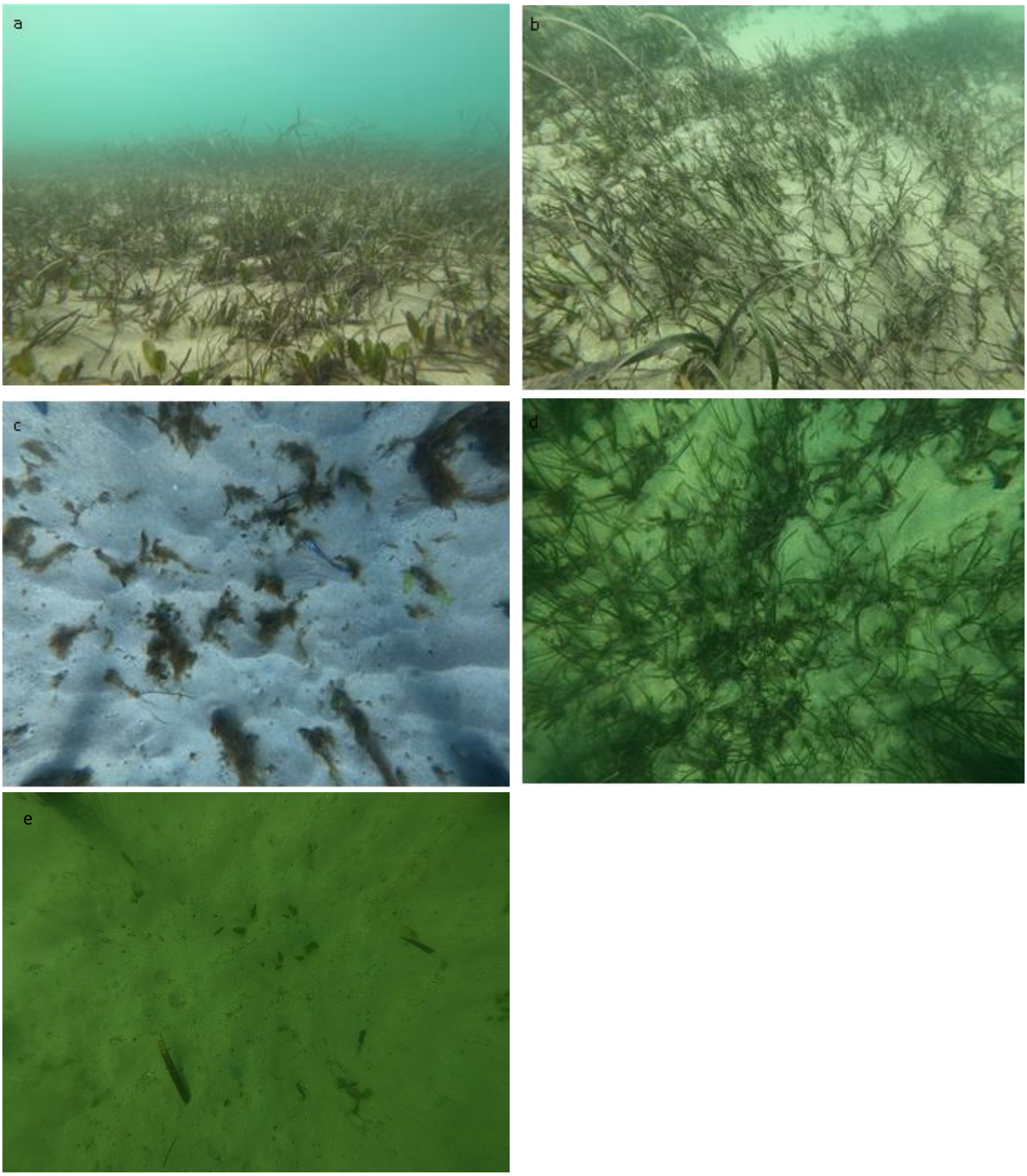
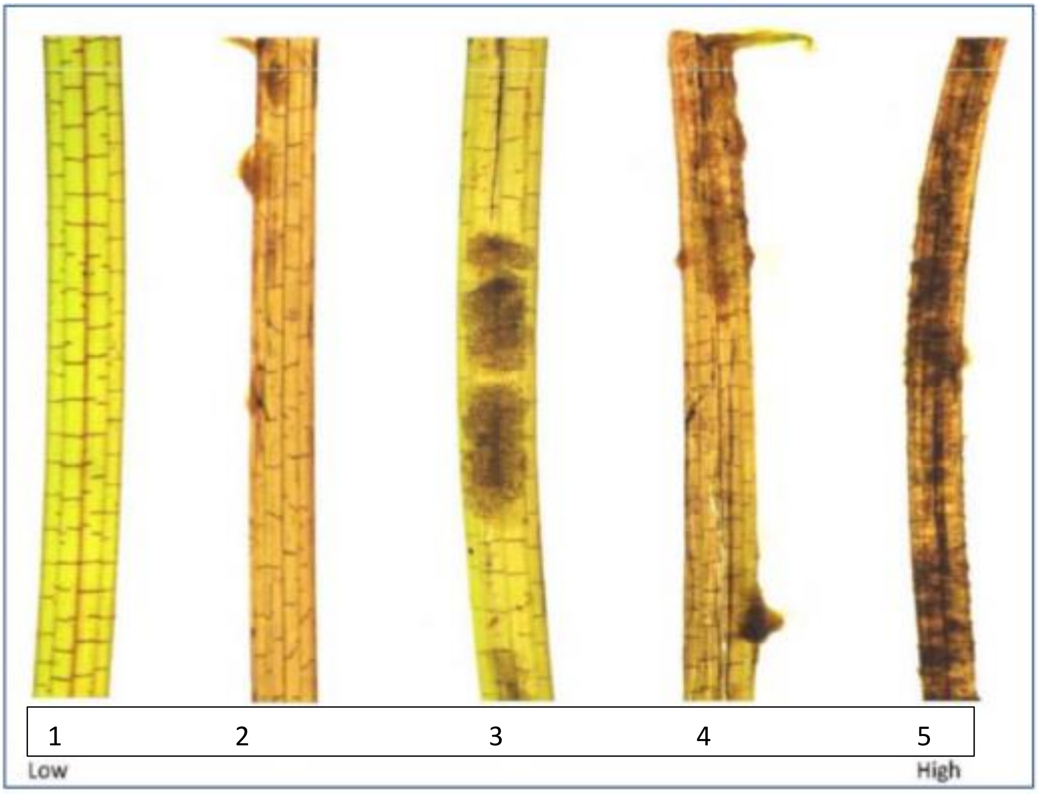


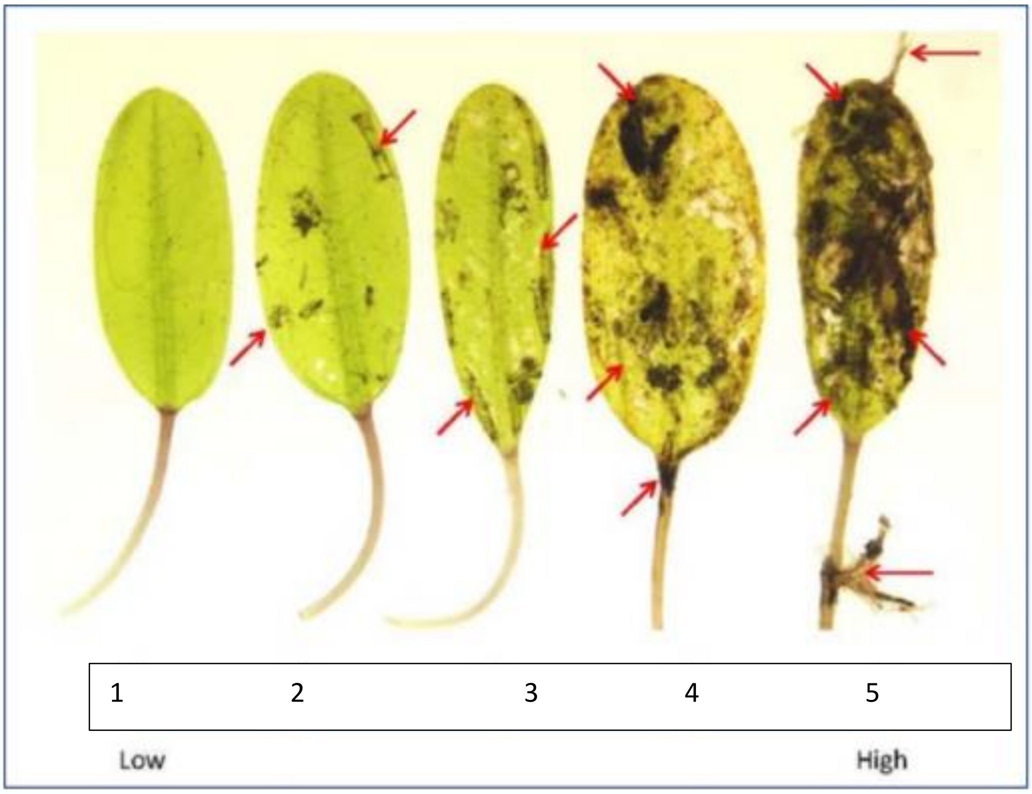
Plate 3: Seagrasses in the Project Area at Kurnell, a) Medium density *Zostera* dominated seagrass within *Zostera* / *Halophila* beds with *P. australis* in the background, b) Medium density *Zostera* dominated seagrass within *Zostera* / *Halophila* beds adjoining a low density patch of *P. australis*, c) low density *Halophila* with heavy epiphytic fouling and d) Medium density *Zostera* dominated seagrass within *Zostera / Halophila* bed in shallow areas close to the proposal footprint, e) reduced *Halophila* density in summer 2022 (HZ-K07).

Appendix 1: Monitoring site locations

Site	Location	Status	Easting (GDA94 MGA56)	Northing (GDA94 MGA56)
***Halophila / Zostera* monitoring (drop camera)**				
HZ-LP01	La Perouse	Potential impact	336429.98	6237907.4
HZ-LP02	La Perouse	Potential impact	336516.36	6237871.92
HZ-LP03	La Perouse	Reference	336438.35	6238037.7
HZ-LP04	La Perouse	Reference	336317.97	6238009.92
HZ-K05	Kurnell	Potential impact	335274.25	6236137.09
HZ-K06	Kurnell	Potential impact	335344.73	6236180.62
HZ-K07	Kurnell	Reference	335437.75	6236230.96
HZ-K08	Kurnell	Reference	335164.51	6236149.72
HZ-K09	Kurnell	Potential impact	335310.06	6236050.64
HZ-K10	Kurnell	Potential impact	335383.27	6236105.94
***Posidonia* bed monitoring (ADAS scientific divers)**				
PB-K01	Kurnell	Potential impact	335263.13	6236095.86
PB-K02	Kurnell	Potential impact	335234.62	6236085.28
PB-K03	Kurnell	Potential impact, possible reference	335189.91	6236071.11
PB-K04	Kurnell	Potential impact, possible reference	335127.2	6236041.22
PB-K05	Kurnell	Potential impact	335315.43	6236006.55
PB-K06	Kurnell	Potential impact	335287.92	6235986.41
PB-K07	Kurnell	Potential impact, possible reference	335250.49	6235967.27
PB-K08	Kurnell	Potential impact, possible reference	335173.89	6235927.58
PB-K09	Kurnell	Potential impact	335326.24	6236087.61
PB-K10	Kurnell	Potential impact, possible reference	335417.71	6236193.76
PB-LP11	La Perouse	Potential impact	336545.65	6237861.53
PB-LP12	La Perouse	Reference	336578.02	6238082.55
***Posidonia* patch monitoring (ADAS scientific divers)**				
PP-LP01	La Perouse	Potential impact	336506.15	6237863.79
PP-LP02	La Perouse	Potential impact	336533.9	6237847.83
PP-K03	Kurnell	Potential impact	335367.57	6236122.05
PP-K04	Kurnell	Potential impact	335346.18	6236109.77
PP-K07	Kurnell	Potential impact	335340.22	6236069.58
PP-K08	Kurnell	Potential impact	335355.6	6236062.17
PP-K09	Kurnell	Potential impact	335366.1	6236071.99
PP-K11	Kurnell	Potential impact	335370.57	6236060.62

Appendix 2: Epiphyte loading scale





Appendix 3: Baseline monitoring master dataset

The baseline monitoring master dataset has been provided as an electronic appendix with this report, titled: *7476_Kamay_Baseline_Masterdata_20230201*

Appendix 4: Seagrass mapping, *Zostera* and *Halophila* monitoring results

Baseline 1 – Baseline 4: seagrass mapping results

Area	Baseline 1 (winter 2021)			Baseline 2 (summer 2022)			Baseline 3 (winter 2022)			Baseline 4 (summer 2022/23)		
	Kurnell (m²)	La Perouse (m²)	Total (m²)	Kurnell (m²)	La Perouse (m²)	Total (m²)	Kurnell (m²)	La Perouse (m²)	Total (m²)	Kurnell (m²)	La Perouse (m²)	Total (m²)
Survey Area												
Posidonia	34407	51	34459	36119	112	36231	13902	213	14115	6743	165	6908
Posidonia / Halophila	401	404	805	275	150	425	3074	0	3074	192	0	192
Posidonia / Zostera	17	94	111	0	0	0	3655	41	3696	176	0	176
Posidonia Mixed				601	168	770	14214	0	14214	28264	246	28511
Zostera				0	0	0	210	366	576	538	117	655
Zostera / Halophila	36418	12203	48621	20328	1025	21353	10237	867	11104	11992	10684	22676
Halophila	999	17277	18276	15630	21335	36965	12513	9010	21523	224	174	398
Rock / Rubble / Reef	12887	3594	16480	13616	4503	18120	25323	12187	37510	22789	12238	35027
Sand or silt	-	-	-	-	-	-	52838	49757	102594	64923	64636	129560
Project Boundary												
Posidonia	2791	0	2791	3555	0	3555	19	137	156	456	9	464
Posidonia / Halophila	804	170	975	838	3	841	3175	0	3175	0	0	0
Posidonia / Zostera	0	0	0	0	0	0	85	0	85	30	0	30
Posidonia Mixed	635	0	635	484	132	616	1083	0	1083	3492	151	3643
Zostera	0	0	0	0	0	0	247	135	382	26	462	488
Zostera / Halophila	22630	6367	28997	2249	7053	9302	7728	295	8023	12151	8294	20445
Halophila	1733	20868	22601	19242	17868	37110	5880	9073	14952	1618	316	1934
Rock / Rubble / Reef	5174	7778	12952	5336	8871	14207	5959	9463	15421	6337	9489	15826
Sand or silt	-	-	-	-	-	-	22140	42777	64917	22199	42810	65009
Buffer Area - temporary construction footprint (15 m buffer)												
Posidonia	70	0	70	106	0	106	6	0	6	42	0	42
Posidonia / Halophila	22	0	22	23	0	23	65	0	65	0	0	0
Posidonia / Zostera	0	0	0	0	0	0	49	0	49	0	0	0
Posidonia Mixed	136	0	136	91	0	91	143	0	143	209	0	209
Zostera	146	0	146	0	0	0	22	0	22	72	0	72
Zostera / Halophila	3745	51	3796	7	0	7	1691	0	1691	2595	51	2645
Halophila	84	3474	3558	4358	2505	6863	1884	78	1962	168	0	168
Rock / Rubble / Reef	817	670	1487	773	680	1453	1696	1626	3322	1667	1626	3293
Sand or silt	-	-	-	-	-	-	1636	3736	5372	2421	3762	6184
Construction footprint - permanent												
Posidonia	4	0	4	0	0	0	0	0	0	0	0	0
Posidonia / Halophila	16	0	16	14	0	14	5	0	5	0	0	0
Posidonia / Zostera	0	0	0	0	0	0	0	0	0	0	0	0
Posidonia Mixed	0	0	0	0	0	0	0	0	0	7	0	7
Zostera	52	0	52	0	0	0	18	0	18	19	0	19
Zostera / Halophila	866	0	866	42	0	42	365	0	365	677	0	677
Halophila	57	991	1048	985	673	1658	435	0	435	37	0	37
Rock / Rubble / Reef	103	114	217	103	114	218	229	519	747	229	518	747
Sand or silt	-	-	-	-	-	-	274	1035	1309	374	1035	1409

**Niche (2022a) presented seagrass within the Project Boundary inclusive of seagrass totals within the Construction Footprint and Buffer Area. The totals presented in this table are for each discreet individual area (i.e. not inclusive of other areas).*

Baseline 1 – Baseline 4: drop camera survey results - seagrass species

Survey	Baseline 1						Baseline 2						Baseline 3						Baseline 4					
Species	*Halophila (HS)*		*Zostera (ZC)*		*Posidonia (PA)*		*Halophila (HS)*		*Zostera (ZC)*		*Posidonia (PA)*		*Halophila (HS)*		*Zostera (ZC)*		*Posidonia (PA)*		*Halophila (HS)*		*Zostera (ZC)*		*Posidonia (PA)*	
	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
HZ-LP01	15.6	1.4	0.7	0.4	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0
HZ-LP02	10.7	1.4	3.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.0	0.0
HZ-LP03	20.2	2.2	0.8	0.6	0.0	0.0	3.8	0.8	0.0	0.0	0.0	0.0	1.4	0.6	0.1	0.1	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0
HZ-LP04	24.0	2.0	0.0	0.0	0.0	0.0	6.8	1.3	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0
HZ-K05	1.5	0.5	0.1	0.1	0.0	0.0	1.5	0.4	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	4.4	0.8	0.1	0.1	0.0	0.0
HZ-K06	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HZ-K07	0.7	0.3	0.8	0.5	0.0	0.0	0.9	0.4	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HZ-K08	1.0	0.4	1.7	0.6	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	1.4	0.5	2.7	1.5	0.0	0.0
HZ-K09	3.8	1.1	38.9	2.8	0.0	0.0	21.1	1.5	0.3	0.2	0.0	0.0	0.6	0.3	2.9	1.1	0.0	0.0	6.7	1.1	7.1	1.1	0.0	0.0
HZ-K10	2.3	0.6	21.2	2.5	0.0	0.0	12.6	1.7	0.6	0.3	0.0	0.0	0.9	0.5	2.0	0.7	0.0	0.0	6.6	1.5	19.0	1.9	0.0	0.0

Baseline 1 – Baseline 4: drop camera survey results – macroalgae, seagrass substrate

Survey	Baseline 1						Baseline 2						Baseline 3						Baseline 4					
Species	MACROALGAE (MA)		SEAGRASS (S)		SUBSTRATE (SU)		MACROALGAE (MA)		SEAGRASS (S)		SUBSTRATE (SU)		MACROALGAE (MA)		SEAGRASS (S)		SUBSTRATE (SU)		MACROALGAE (MA)		SEAGRASS (S)		SUBSTRATE (SU)	
	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
HZ-LP01	0.0	0.0	16.3	1.5	83.7	1.5	0.0	0.0	0.5	0.2	99.2	0.3	0.1	0.1	0.0	0.0	99.6	0.3	0.0	0.0	0.2	0.2	99.8	0.2
HZ-LP02	0.0	0.0	14.4	1.4	83.6	1.5	0.0	0.0	0.0	0.0	96.0	3.3	0.4	0.3	0.1	0.1	99.3	0.3	20.9	4.9	0.3	0.2	76.2	4.8
HZ-LP03	0.3	0.2	21.0	2.3	78.6	2.4	0.8	0.4	3.8	0.8	95.4	0.8	0.1	0.1	1.6	0.6	98.0	0.6	1.7	0.8	0.7	0.3	97.6	0.9
HZ-LP04	0.0	0.0	24.0	2.0	75.5	1.9	0.0	0.0	6.8	1.3	92.7	1.3	0.3	0.2	0.1	0.1	99.1	0.4	0.0	0.0	0.3	0.2	99.7	0.2
HZ-K05	0.0	0.0	1.6	0.6	95.0	1.4	0.0	0.0	1.5	0.4	98.4	0.4	0.6	0.3	0.2	0.2	97.8	0.5	0.0	0.0	4.5	0.9	81.5	3.2
HZ-K06	0.5	0.3	0.3	0.2	95.3	0.9	0.2	0.2	0.2	0.2	99.5	0.2	0.6	0.3	0.2	0.2	97.8	0.5	0.0	0.0	0.0	0.0	98.9	0.6
HZ-K07	0.0	0.0	1.5	0.6	96.8	0.8	0.7	0.3	0.9	0.4	98.4	0.5	0.3	0.2	0.1	0.1	99.6	0.2	0.1	0.1	0.0	0.0	98.7	0.5
HZ-K08	0.1	0.1	2.7	0.8	92.6	1.6	0.0	0.0	1.1	0.3	98.9	0.3	3.1	0.7	0.2	0.2	96.4	0.7	0.0	0.0	4.1	1.6	88.9	3.7
HZ-K09	0.2	0.2	42.7	2.7	57.0	2.7	0.0	0.0	21.5	1.5	78.4	1.5	2.2	0.5	3.5	1.1	93.8	1.5	0.0	0.0	13.8	1.0	59.4	2.9
HZ-K10	0.0	0.0	23.5	2.8	76.2	2.8	0.0	0.0	13.2	1.6	86.8	1.6	0.7	0.3	2.9	0.7	96.3	0.9	0.0	0.0	25.5	2.0	46.4	3.7

Baseline 1 – Baseline 4: drop camera survey results - epiphytic, algae turfing algae, sand silt

Survey	Baseline 1						Baseline 2						Baseline 3						Baseline 4					
Site	Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)	
	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
HZ-LP-01	0.0	0.0	0.0	0.0	67.8	2.2	N.D.	-	0.3	0.3	52.0	5.0	0.0	0.0	0.3	0.3	85.4	2.8	0.0	0.0	0.0	0.0	82.3	3.8
HZ-LP-02	2.1	0.6	0.0	0.0	83.0	1.5	N.D.	-	4.0	3.3	82.1	4.6	0.0	0.0	0.1	0.1	93.3	1.3	2.6	1.0	0.0	0.0	62.1	5.2
HZ-LP-03	0.0	0.0	0.1	0.1	75.5	2.7	N.D.	-	0.0	0.0	91.4	1.0	0.0	0.0	0.3	0.2	92.7	1.2	0.1	0.1	0.0	0.0	94.3	1.2
HZ-LP-04	0.1	0.1	0.3	0.2	46.9	3.0	N.D.	-	0.0	0.0	74.3	3.2	0.0	0.0	0.4	0.3	82.8	3.6	0.0	0.0	0.0	0.0	97.6	0.8
HZ-K-05	2.0	0.6	1.3	0.6	94.9	1.4	N.D.	-	0.1	0.1	98.4	0.4	0.0	0.0	1.3	0.3	90.2	2.1	13.9	2.4	0.1	0.1	81.5	3.2
HZ-K-06	3.6	0.8	0.3	0.2	95.1	0.9	N.D.	-	0.0	0.0	99.5	0.2	0.0	0.0	1.3	0.3	90.2	2.1	1.1	0.6	0.0	0.0	98.9	0.6

Survey	Baseline 1						Baseline 2						Baseline 3						Baseline 4					
Site	Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)		Epiphytic algae (EA) (%)		Turfing algae (TA) (%)		Sediment (SS) (%)	
	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
HZ-K-07	1.8	0.5	0.0	0.0	96.6	0.8	N.D.	-	0.0	0.0	98.4	0.5	0.0	0.0	0.0	0.0	99.3	0.3	1.2	0.5	0.0	0.0	98.7	0.5
HZ-K-08	2.3	0.8	2.3	1.1	92.4	1.6	N.D.	-	0.0	0.0	98.9	0.3	0.0	0.0	0.2	0.2	95.9	0.8	7.0	2.5	0.0	0.0	88.9	3.7
HZ-K-09	0.1	0.1	0.0	0.0	57.0	2.7	N.D.	-	0.1	0.1	78.4	1.5	0.5	0.3	0.1	0.1	90.7	2.0	26.8	2.5	0.0	0.0	59.4	2.9
HZ-K-10	0.3	0.2	0.0	0.0	76.2	2.8	N.D.	-	0.0	0.0	86.8	1.6	0.1	0.1	0.0	0.0	92.4	1.6	28.1	2.6	0.0	0.0	46.4	3.7

Note: N.D. not recorded

Appendix 5: Summary *Posidonia* bed and patch monitoring data

Baseline 1 – Baseline 4: Average shoot density results (0.25 m²)

Seagrass	Baseline 1 (winter 2021)						Baseline 2 (summer 2022)						Baseline 3 (winter 2022)						Baseline 4 (summer 2022/23)					
	Halophila		*Zostera*		*Posidonia*		*Halophila*		*Zostera*		*Posidonia*		*Halophila*		*Zostera*		*Posidonia*		*Halophila*		*Zostera*		*Posidonia*	
	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error
PB-K01	15.2	2.9	15.8	3.7	15.8	1.7	124.8	18.0	0.8	0.8	16.8	2.7	45.2	13.4	2.2	1.3	10.8	1.3	18.2	5.7	1.8	1.2	8.2	1.4
PB-K02	35.2	5.4	109.6	8.4	13.2	2.5	335.2	32.9	0.0	0.0	16.2	1.4	20.2	4.0	0.8	0.8	12.4	2.0	24.6	7.8	27.6	24.7	10.2	1.8
PB-K03	19.2	2.9	24.8	2.0	39.6	7.5	113.6	9.0	78.4	20.4	19.6	3.6	19.8	4.9	33.6	9.2	17.2	2.3	24.4	7.1	34.2	12.0	13.0	2.3
PB-K04	43.2	13.2	68.8	13.8	15.0	1.3	145.6	22.7	76.0	13.1	21.2	0.9	10.2	1.7	24.0	4.3	13.6	0.9	27.6	8.2	56.4	23.4	13.2	1.7
PB-K05	56.0	15.7	42.4	11.4	37.4	1.7	217.6	29.7	137.6	35.5	21.0	2.4	1.2	1.2	23.4	6.0	9.8	2.1	1.8	1.1	238.8	33.2	11.8	1.0
PB-K06	24.8	11.2	19.2	4.3	30.8	4.6	112.8	12.2	62.4	12.4	26.0	4.5	1.8	1.0	0.4	0.4	25.2	1.7	1.8	0.9	43.8	13.9	15.4	1.6
PB-K07	2.4	1.6	12.0	3.8	7.8	0.7	139.2	18.9	33.6	14.4	50.4	2.6	2.6	1.5	0.0	0.0	35.6	4.3	6.2	3.3	16.8	11.6	22.6	2.8
PB-K08	12.0	4.0	37.6	10.4	8.8	1.1	58.4	27.4	20.8	11.0	46.8	1.7	0.8	0.6	11.6	5.0	36.2	3.8	47.4	28.4	64.0	36.5	35.2	6.3
PB-K09	19.2	7.1	62.4	8.4	11.2	0.4	164.8	32.1	0.8	0.8	14.8	1.0	14.8	2.2	6.4	3.4	10.6	0.7	17.0	8.9	41.2	24.1	6.4	0.9
PB-K10	34.4	3.7	24.0	4.4	20.8	2.6	108.8	13.9	2.4	1.6	12.2	2.1	1.0	0.6	0.0	0.0	11.4	0.5	0.0	0.0	1.2	1.2	5.4	2.0
PB-LP11	44.0	7.0	4.8	2.9	22.0	1.8	96.0	4.0	0.0	0.0	29.8	3.0	0.0	0.0	0.0	0.0	11.0	0.8	0.0	0.0	3.6	3.1	7.0	0.6
PB-LP12	5.6	5.6	4.0	4.0	29.0	1.9	28.8	17.7	6.4	3.9	33.2	8.1	0.0	0.0	0.0	0.0	21.4	2.8	0.0	0.0	0.4	0.4	14.6	1.4
PP-K03	32.8	2.7	32.8	9.0	17.4	1.6	428.0	69.4	4.8	3.2	12.4	1.3	8.6	3.0	2.6	1.6	7.4	1.0	5.0	2.4	121.6	14.2	8.2	0.9
PP-K04	83.2	9.7	62.4	7.0	13.0	1.8	230.4	12.8	4.0	2.2	11.2	2.5	1.4	1.4	0.2	0.2	14.0	0.4	2.8	2.1	27.4	11.1	10.6	1.1
PP-K07	155.0	35.3	146.0	29.6	6.5	1.3	310.4	86.1	5.6	3.0	16.4	3.9	2.2	1.4	15.0	7.4	9.8	2.6	3.2	1.8	134.4	18.7	8.0	0.9
PP-K08	50.7	21.9	104.0	18.9	13.0	0.6	199.2	34.9	10.4	3.0	14.2	1.5	6.4	4.5	71.0	22.5	5.8	1.6	9.0	6.8	97.4	17.0	6.0	0.5
PP-K09	24.0	10.3	71.0	10.0	13.0	1.9	144.8	55.1	41.6	17.7	15.0	1.5	6.8	2.1	13.0	3.4	11.0	2.2	8.0	4.6	117.3	15.4	10.3	2.9
PP-K11	42.0	13.1	76.0	12.5	17.3	2.7	152.0	45.3	24.8	9.4	16.2	4.6	15.8	4.4	53.6	7.7	17.4	1.8	0.2	0.2	180.2	54.5	9.8	2.2
PP-LP01	140.0	26.6	4.0	4.0	12.0	1.7	152.0	36.7	0.0	0.0	13.0	2.0	0.0	0.0	0.0	0.0	7.8	1.5	0.8	0.8	0.0	0.0	4.8	1.4
PP-LP02	97.3	15.4	13.3	13.3	15.3	1.5	128.0	6.9	0.0	0.0	24.7	1.9	0.0	0.0	0.0	0.0	12.0	0.8	3.8	2.6	24.2	17.2	12.0	3.6

Baseline 1 – Baseline 4: Average leaf length (0.25 m²)

Survey	Baseline 1 (winter 2021)				Baseline 2 (summer 2022)				Baseline 3 (winter 2022)				Baseline 4 (summer 2022/23)			
Species	*Zostera*		*Posidonia*		*Zostera*		*Posidonia*		*Zostera*		*Posidonia*		*Zostera*		*Posidonia*	
	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error	Average	Standard error
PB-K01	5.3	0.8	25.3	2.5	16.0	0.0	34.2	1.1	2.3	0.2	5.3	1.6	12.2	0.3	34.3	1.5
PB-K02	8.7	1.2	33.6	2.4	-	-	28.5	1.9	2.4	0.2	8.5	-	16.9	4.8	33.3	1.8
PB-K03	30.6	1.4	11.7	1.3	11.3	4.8	31.0	1.1	2.2	0.1	10.9	1.1	13.5	0.9	43.1	3.0
PB-K04	29.1	5.9	16.9	4.5	13.6	3.4	31.7	1.9	1.5	0.1	9.7	0.7	9.3	0.8	30.6	2.1
PB-K05	5.5	0.4	38.4	2.0	9.1	0.8	32.5	0.4	2.2	-	8.0	1.0	3.3	0.2	28.3	1.9
PB-K06	9.2	2.4	31.3	2.7	7.5	1.1	33.2	1.3	2.5	0.2	5.0	-	7.2	0.6	25.3	1.7
PB-K07	10.5	0.7	30.5	0.9	10.4	1.9	30.7	1.5	1.3	0.1	-	-	6.1	0.7	29.6	1.4
PB-K08	10.4	0.6	30.8	1.9	16.1	3.0	32.3	1.2	1.5	0.3	5.0	0.6	6.8	0.4	24.3	1.7
PB-K09	15.2	1.8	38.6	2.6	14.0	-	36.3	1.3	2.2	0.1	7.3	0.9	7.7	2.3	36.3	3.1
PB-K10	4.2	0.8	27.0	2.8	14.7	4.8	31.9	1.4	1.9	0.4	-	-	4.3	-	25.5	3.9
PB-LP11	4.4	0.3	38.6	0.8		-	46.2	1.2	-	-	-	-	5.8	0.0	24.7	2.1
PB-LP12	4.6	-	34.6	2.5	12.2	1.9	42.4	3.3	-	-	-	-	8.0	-	39.0	3.5
PP-K03	6.2	1.1	36.9	3.0	7.9	1.2	27.8	1.1	8.8	0.0	25.6	1.2	7.9	1.1	32.6	1.3
PP-K04	8.7	1.0	27.7	1.6	12.2	2.4	37.5	2.4	12.3	-	21.5	1.1	9.1	0.4	25.8	1.5
PP-K07	9.9	0.8	34.8	2.8	7.7	1.5	31.5	1.4	7.9	1.5	21.4	1.3	8.4	0.7	28.1	1.0
PP-K08	11.9	1.9	37.0	1.8	8.1	0.7	36.2	1.3	6.6	0.6	22.9	1.6	8.2	2.2	23.5	6.3
PP-K09	11.7	0.3	37.1	1.5	6.6	1.2	33.1	1.9	7.9	1.2	24.4	2.2	10.6	0.3	38.4	0.2
PP-K11	10.1	0.9	58.5	2.7	20.5	11.0	40.6	2.0	7.3	0.6	32.2	2.7	3.3	0.5	30.5	2.4
PP-LP01	13.9	-	32.7	3.3		-	35.8	0.9		-	21.5	1.5	-	-	31.0	1.9
PP-LP02	2.1	-	27.2	2.2		-	39.0	1.6		-	21.7	1.6	5.2	0.4	29.2	2.4

Baseline 1 - Baseline 4: Average epiphytic cover (0.25 m²)

Survey	Baseline 1 (winter 2021)						Baseline 2 (summer 2022)						Baseline 3 (winter 2022)						Baseline 4 (summer 2022/23)					
Species	Halophila		*Zostera*		*Posidonia*		Halophila		*Zostera*		*Posidonia*		Halophila		*Zostera*		*Posidonia*		Halophila		*Zostera*		*Posidonia*	
	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error	Average Epiphyte Scale	Standard error
PB-K01	2.2	0.2	2.7	0.2	2.0	0.1	2.8	0.3	4.0	0.0	4.1	0.1	2.1	0.1	2.0	0.4	3.6	0.3	2.4	0.4	1.0	0.0	3.1	0.2
PB-K02	2.6	0.2	1.7	0.2	3.0	0.4	2.2	0.1	-	-	3.3	0.1	2.4	0.1	3.0	-	3.4	0.2	2.0	0.3	1.8	0.1	3.3	0.0
PB-K03	2.5	0.4	3.3	0.3	2.0	0.2	2.7	0.2	3.0	0.4	4.3	0.1	2.0	0.2	1.9	0.1	3.5	0.1	2.8	0.2	1.4	0.2	4.5	0.3
PB-K04	3.0	0.0	3.0	0.0	3.3	0.2	2.3	0.3	2.5	0.2	3.8	0.1	1.8	0.2	1.9	0.2	3.6	0.2	2.1	0.3	1.8	0.2	3.0	0.1
PB-K05	2.6	0.4	1.3	0.0	3.0	0.1	2.7	0.3	2.6	0.1	3.9	0.1	1.0	-	1.6	0.3	3.6	0.1	1.6	0.1	1.3	0.1	2.8	0.2
PB-K06	3.1	0.3	1.5	0.1	3.7	0.2	3.2	0.2	2.6	0.3	4.4	0.1	1.7	0.3	1.0	-	3.4	0.2	2.0	0.2	2.3	0.2	3.5	0.2
PB-K07	4.0	0.3	1.7	0.0	3.6	0.1	2.8	0.4	2.1	0.1	4.2	0.2	2.3	0.1	-	-	3.7	0.2	2.7	0.2	2.3	0.1	2.9	0.3
PB-K08	3.6	0.3	1.9	0.1	3.8	0.2	2.5	0.2	3.6	0.5	4.4	0.1	1.2	0.1	1.6	0.1	3.5	0.1	1.4	0.1	1.2	0.1	2.5	0.2
PB-K09	2.5	0.5	2.1	0.1	3.8	0.1	2.6	0.2	2.7	-	4.1	0.3	3.0	0.2	2.6	0.4	3.5	0.1	3.1	0.4	2.3	0.3	3.4	0.3
PB-K10	3.9	0.2	2.9	0.4	3.8	0.2	2.6	0.2	2.1	0.1	4.4	0.4	2.3	0.2	-	-	3.7	0.2	-	-	1.0	-	2.3	0.2
PB-LP11	2.3	0.1	1.7	0.3	2.2	0.2	3.3	0.3		-	3.0	0.1	-	-	-	-	3.0	0.2	-	-	1.9	0.3	3.1	0.3
PB-LP12	2.9	-	2.8	-	3.9	0.2	1.9	0.4	1.7	0.3	2.9	0.1	-	-	-	-	4.6	0.2	-	-	2.0	-	3.3	0.3
PP-K03	4.1	0.3	3.8	0.3	4.2	0.3	2.3	0.2	2.2	0.2	3.7	0.2	2.9	0.1	1.7	-	2.7	0.3	1.8	0.3	1.9	0.1	2.9	0.1
PP-K04	3.4	0.2	2.7	0.5	4.1	0.2	3.0	0.3	3.7	0.3	4.2	0.2	2.3	-	1.0	-	2.7	0.2	2.1	0.1	1.8	0.2	3.1	0.1
PP-K07	2.1	0.2	1.9	0.1	2.2	0.0	2.3	0.3	1.7	0.2	3.5	0.1	2.7	-	2.3	0.2	3.8	0.3	2.1	0.1	2.1	0.1	3.0	0.2
PP-K08	3.0	0.5	2.3	0.1	4.1	0.1	2.8	0.3	1.8	0.7	3.9	0.2	2.3	0.4	2.4	0.2	3.6	0.2	2.4	0.5	2.1	0.2	2.7	0.3
PP-K09	3.7	0.2	2.7	0.2	4.0	0.2	2.3	0.1	2.9	0.2	3.7	0.1	2.1	0.4	2.6	0.2	3.7	0.4	2.1	0.1	1.9	0.3	2.8	0.2
PP-K11	2.6	0.3	2.6	0.3	3.0	0.2	2.1	0.2	2.6	0.4	4.2	0.1	1.8	0.1	2.3	0.2	4.3	0.3	1.0	-	1.2	0.1	2.0	0.3
PP-LP01	1.7	0.3	2.0	-	2.3	0.1	3.1	0.6		-	3.5	0.3		-		-	3.0	0.1	2.2	-	-	-	3.0	0.3
PP-LP02	1.8	0.3	1.0	-	1.9	0.2	3.4	0.1		-	3.0	0.4		-		-	4.2	0.1	2.0	0.0	1.8	0.2	3.5	0.1

Baseline 1 - Baseline 4: Average percentage of *P. australis* sheath visible (0.25 m^2)

Survey	Baseline 1 (winter 2021)	Baseline 2 (summer 2022)	Baseline 3 (winter 2022)	Baseline 4 (summer 2022/23)
PB-K01	46.0	34.0	0.0	0.0
PB-K02	42.7	12.0	25.1	4.0
PB-K03	42.0	28.0	0.0	0.0
PB-K04	0.0	12.0	26.0	0.0
PB-K05	68.0	18.0	14.0	2.0
PB-K06	44.0	34.0	12.0	42.0
PB-K07	40.7	30.0	0.0	52.0
PB-K08	47.0	88.0	30.0	20.0
PB-K09	4.0	24.2	0.0	36.2
PB-K10	55.0	6.1	0.0	0.0
PB-LP11	6.0	50.0	14.9	0.0
PB-LP12	50.0	28.0	0.0	-
PP-K03	46.0	10.0	0.0	28.1
PP-K04	-	25.3	4.0	14.0
PP-K07	14.6	32.0	0.0	45.0
PP-K08	0.0	63.6	0.0	69.5
PP-K09	67.5	72.0	0.0	-
PP-K11	25.0	26.0	0.0	2.5
PP-LP01	30.7	75.2	2.5	0.0
PP-LP02	3.3	40.0	-	100.0

Appendix 6: Statistical analysis results

Halophila / *Zostera* seagrasses: La Perouse

Univariate PERMANOVA for Total Seagrass Cover

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	28667	9555.8	65.534	**0.0002**	9960
Si	3	1414	471.34	3.2325	0.0699	9953
SuxSi	9	1312.3	145.82	4.7504	**0.0001**	9927
Res	464	14243	30.695			
Total	479	45636				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'LP01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	10.607	0.0001	4868	**0.0001**
1, 3	11.03	0.0001	1891	**0.0001**
1, 4	10.82	0.0001	1973	**0.0001**
2, 3	2.1112	0.1135	6	0.041
2, 4	0.88104	0.387	10	0.3817
3, 4	1.4392	0.4908	2	0.1553

Within level 'LP02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	10.087	0.0001	2618	**0.0001**
1, 3	9.9785	0.0001	2935	**0.0001**
1, 4	9.7099	0.0001	3655	**0.0001**
2, 3	1	1	1	0.3201
2, 4	1.3605	0.488	2	0.1762
3, 4	0.82605	0.7444	3	0.4145

Within level 'LP03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	6.9595	**0.0001**	7766	0.0001
1, 3	8.0355	**0.0001**	4273	0.0001
1, 4	8.6188	**0.0001**	4318	0.0001

Groups	t	P(perm)	Unique perms	P(MC)
2, 3	2.227	0.0253	80	**0.0291**
2, 4	3.6846	0.0007	74	**0.0007**
3, 4	1.3061	0.2713	10	0.1934

Within level 'LP04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	7.3915	**0.0001**	8585	0.0001
1, 3	12.193	**0.0001**	2647	0.0001
1, 4	12.045	**0.0001**	2701	0.0001
2, 3	5.3467	**0.0001**	469	0.0001
2, 4	5.1345	**0.0001**	489	0.0001
3, 4	1.0269	0.6118	3	0.3044

Term 'SuxSi' for pairs of levels of factor 'Site'

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	0.92628	0.352	4333	0.3562
LP01, LP03	1.7145	0.0943	5070	0.0897
LP01, LP04	3.1757	**0.0025**	4441	0.003
LP02, LP03	2.4239	0.0184	5954	0.0211
LP02, LP04	3.9985	0.0003	5745	0.0004
LP03, LP04	0.99737	3.15E-01	6007	0.3307

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	2.1112	0.1109	6	**0.0381**
LP01, LP03	4.0471	**0.0001**	152	0.0003
LP01, LP04	5.0185	**0.0001**	876	0.0001
LP02, LP03	4.767	0.0001	68	**0.0001**
LP02, LP04	5.4562	**0.0001**	469	0.0001
LP03, LP04	2.0536	**4.33E-02**	548	0.0427

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	1	1	1	0.3183

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP03	2.5357	0.0096	8	**0.0141**
LP01, LP04	1	1	1	0.3159
LP02, LP03	2.3169	0.0288	8	**0.0222**
LP02, LP04	7.80E-09	1	2	1
LP03, LP04	2.3169	2.81E-02	8	**0.0253**

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	0.38368	1	3	0.7052
LP01, LP03	1.3359	0.3286	5	0.1837
LP01, LP04	0.46009	1	3	0.6406
LP02, LP03	0.86978	0.5729	5	0.3873
LP02, LP04	1.04E-08	1	4	1
LP03, LP04	0.95697	0.541	5	0.3426

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	9.26E-01	0.352	4333	0.3562
LP01, LP03	1.7145	0.0943	5070	0.0897
LP01, LP04	3.18E+00	**0.0025**	4441	0.003
LP02, LP03	2.4239	**0.0184**	5954	0.0211
LP02, LP04	4	**0.0003**	5745	0.0004
LP03, LP04	0.99737	0.315	6007	0.3307

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	2.11E+00	0.1109	6	0.0381
LP01, LP03	4.0471	0.0001	152	**0.0003**
LP01, LP04	5.02E+00	0.0001	876	**0.0001**
LP02, LP03	4.767	**0.0001**	68	0.0001
LP02, LP04	5.4562	0.0001	469	**0.0001**
LP03, LP04	2.0536	0.0433	548	**0.0427**

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	1	1	1	0.3183

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP03	2.5357	**0.0096**	8	0.0141
LP01, LP04	1	1	1	0.3159
LP02, LP03	2.3169	**0.0288**	8	0.0222
LP02, LP04	7.80E-09	1	2	1
LP03, LP04	2.3169	**0.0281**	8	0.0253

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
LP01, LP02	0.38368	1	3	0.7052
LP01, LP03	1.3359	0.3286	5	0.1837
LP01, LP04	0.46009	1	3	0.6406
LP02, LP03	0.86978	0.5729	5	0.3873
LP02, LP04	1.04E-08	1	4	1
LP03, LP04	0.95697	0.5414	5	0.3426

Multivariate PERMANOVA

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Se	1	12396	12396	0.52964	1	3
Si	3	26619	8872.9	2.3097	0.0604	9951
Su(Se)	2	46811	23406	95.638	**0.0001**	9960
SexSi	3	20033	6677.6	1.7383	0.1577	9957
Su(Se)xSi	6	23049	3841.6	15.697	**0.0001**	9948
Res	464	1.14E+05	244.73			
Total	479	2.42E+05				

Halophila / Zostera seagrasses: Kurnell

Univariate PERMANOVA for Total Seagrass Cover

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	10876	3625.3	2.2305	0.1097	9960
Si	5	48163	9632.7	5.9267	**0.0037**	9945
SuxSi	15	24380	1625.3	39.85	**0.0001**	9923
Res	696	28387	40.786			
Total	719	1.12E+05				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.16234	0.8911	1252	0.8722
1, 3	2.2387	**0.005**	47	0.0261
1, 4	2.6995	0.0069	828	**0.0108**
2, 3	2.9557	0.0051	107	**0.0045**
2, 4	3.0843	0.003	1074	**0.0039**
3, 4	4.716	0.0001	176	**0.0002**

Within level 'K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.18775	0.7436	8	0.8565
1, 3	0.16976	0.7432	8	0.8609
1, 4	1.4389	0.4842	2	0.152
2, 3	1.83E-02	1	6	0.9869
2, 4	1.439	0.4862	2	0.1535
3, 4	1.4383	0.4962	2	0.1625

Within level 'K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.78366	0.4708	345	0.4299
1, 3	2.2617	**0.0102**	22	0.0266
1, 4	2.4892	**0.0091**	11	0.0149
2, 3	1.92E+00	**0.0654**	20	0.0593
2, 4	2.2736	**0.0232**	16	0.0266
3, 4	1	1	1	0.3192

Within level 'K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	1.8337	0.0659	2364	**0.0722**
1, 3	3.0195	0.0006	115	**0.0048**
1, 4	0.77745	0.4862	414	0.4381
2, 3	2.32E+00	**0.0133**	216	0.0234
2, 4	1.8069	0.053	1546	**0.0717**
3, 4	2.3677	**0.0025**	19	0.0227

Within level 'K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	6.8352	0.0001	9817	**0.0001**
1, 3	13.3	0.0001	9842	**0.0001**
1, 4	9.8878	0.0001	9843	**0.0001**
2, 3	9.72E+00	0.0001	3728	**0.0001**
2, 4	4.2438	0.0002	2965	**0.0001**
3, 4	6.7546	**0.0001**	95	0.0001

Within level 'K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.1609	0.0021	9812	**0.0029**
1, 3	7.0836	0.0001	9816	**0.0001**
1, 4	0.58915	0.5585	9815	0.5495
2, 3	5.70E+00	0.0001	909	**0.0001**
2, 4	4.7313	0.0001	1694	**0.0001**
3, 4	10.507	0.0001	528	**0.0001**

Term 'SuxSi' for pairs of levels of factor 'Site'

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
K05, K06	2.1421	**0.0272**	26	0.0352
K05, K07	0.16599	0.8839	38	0.8677
K05, K08	1.082	0.2978	122	0.279
K05, K09	14.695	0.0001	9818	**0.0001**
K05, K10	7.62E+00	0.0001	9747	**0.0001**
K06, K07	1.9325	8.48E-02	18	0.0541
K06, K08	2.9325	**0.0017**	56	0.0042
K06, K09	15.494	0.0001	9815	**0.0001**
K06, K10	8.2441	0.0001	9642	**0.0001**
K07, K08	1.2245	0.2155	74	0.2225
K07, K09	14.75	0.0001	9823	**0.0001**
K07, K10	7.6675	0.0001	9750	**0.0001**
K08, K09	14.048	0.0001	9831	**0.0001**
K08, K10	7.1149	0.0001	9747	**0.0001**
K09, K10	4.9017	0.0001	9803	**0.0001**

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
K05, K06	2.9729	0.0052	103	**0.0044**
K05, K07	1.0333	0.2896	215	0.3104
K05, K08	0.76893	0.4414	1742	0.4429
K05, K09	13.039	0.0001	5573	**0.0001**
K05, K10	6.91E+00	0.0001	3317	**0.0001**
K06, K07	1.5924	1.46E-01	30	0.1151
K06, K08	2.3077	0.0162	216	**0.0245**
K06, K09	14.279	0.0001	3832	**0.0001**
K06, K10	7.8407	0.0001	893	**0.0001**
K07, K08	0.34309	0.751	1007	0.7356
K07, K09	13.411	0.0001	4406	**0.0001**
K07, K10	7.2475	0.0001	1722	**0.0001**
K08, K09	13.421	0.0001	8707	**0.0001**
K08, K10	7.1969	0.0001	7896	**0.0001**
K09, K10	3.7364	0.0003	5063	**0.0007**

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
K05, K06	8.40E-09	1	5	1
K05, K07	0.61109	0.7459	3	0.5447
K05, K08	3.57E-02	1	4	0.9728
K05, K09	2.8686	**0.0009**	83	0.0048
K05, K10	3.50E+00	**0.0003**	68	0.0008
K06, K07	0.61109	7.46E-01	3	0.5427
K06, K08	3.57E-02	1	4	0.9732
K06, K09	2.8686	**0.0005**	81	0.0072
K06, K10	3.4981	**0.0002**	65	0.0013
K07, K08	0.5841	1	2	0.5645
K07, K09	2.99	**0.0004**	42	0.0053
K07, K10	3.6967	**0.0002**	36	0.0006
K08, K09	2.8777	**0.0002**	41	0.0067
K08, K10	3.5139	**0.0001**	35	0.0016
K09, K10	0.42011	0.6822	124	0.6846

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
K05, K06	5.05E+00	**0.0001**	90	0.0001
K05, K07	5.0486	**0.0001**	91	0.0001
K05, K08	2.15E-01	0.8393	170	0.8273

Groups	t	P(perm)	Unique perms	P(MC)
K05, K09	6.7408	0.0001	201	**0.0001**
K05, K10	9.51E+00	0.0001	1089	**0.0001**
K06, K07	Denominator is 0			
K06, K08	2.51E+00	**0.0004**	19	0.0149
K06, K09	13.187	**0.0001**	36	0.0001
K06, K10	12.632	0.0001	216	**0.0001**
K07, K08	2.5141	**0.0004**	19	0.0155
K07, K09	13.187	**0.0001**	36	0.0001
K07, K10	12.632	0.0001	214	**0.0001**
K08, K09	4.9816	**0.0001**	37	0.0001
K08, K10	8.2381	**0.0001**	211	0.0001
K09, K10	5.1642	**0.0001**	155	0.0001

Multivariate PERMANOVA

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Se	1	11961	11961	0.58363	0.7997	9938
Si	5	68571	13714	3.4455	0.0131	9937
Su(Se)	2	45612	22806	5.7295	0.0008	9958
SexSi	5	22545	4509	1.1328	0.3587	9930
Su(Se)xSi	10	3.98E+04	3980.4	28.895	**0.0001**	9906
Res	696	95876	137.75			
Total	719	2.84E+05				

PAIR-WISE TESTS

Term 'Su(Se)xSi' for pairs of levels of factor 'Survey'

Within level 'Winter' of factor 'Season'

Within level 'K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	3.118	0.0003	9962	**0.0002**

Within level 'Winter' of factor 'Season'

Within level 'K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	2.7177	0.0021	9964	**0.0019**

Within level 'Winter' of factor 'Season'

Within level 'K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	3.1976	0.0001	8270	**0.0001**

Within level 'Winter' of factor 'Season'

Within level 'K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	4.2462	0.0001	9967	**0.0001**

Within level 'Winter' of factor 'Season'

Within level 'K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	9.1521	0.0001	9951	**0.0001**

Within level 'Winter' of factor 'Season'

Within level 'K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	5.8046	0.0001	9946	**0.0001**

Within level 'Summer' of factor 'Season'

Within level 'K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	6.3152	0.0001	9946	**0.0001**

Within level 'Summer' of factor 'Season'

Within level 'K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	2.368	0.0039	120	**0.0104**

Within level 'Summer' of factor 'Season'

Within level 'K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	2.832	0.0006	3980	**0.0009**

Within level 'Summer' of factor 'Season'

Within level 'K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	3.1114	0.0005	9738	**0.0019**

Within level 'Summer' of factor 'Season'

Within level 'K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	11.976	0.0001	9950	**0.0001**

Within level 'Summer' of factor 'Season'

Within level 'K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	13.049	0.0001	9957	**0.0001**

Posidonia Bed: La Perouse

Univariate PERMANOVA for Shoot Count

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	2575.8	858.6	41.478	**0.0092**	797
Si	1	504.1	504.1	24.353	**0.0257**	794
SuxSi	3	62.1	20.7	0.36078	0.7805	9941
Res	32	1836	57.375			
Total	39	4978				

PAIR-WISE TESTS

Term 'Su'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.3333	0.1655	6	0.1846
1, 3	5.4706	0.1676	6	0.1083
1, 4	49	0.1731	6	0.0136
2, 3	4.3714	0.1698	6	0.1404
2, 4	9.8571	0.1632	6	0.0631
3, 4	3.8571	0.3328	6	0.1612

Univariate PERMANOVA for Leaf Length

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	2464.1	821.36	4.3032	0.1581	839
Si	1	87.32	87.32	0.45748	0.5462	835
SuxSi	3	572.61	190.87	7.7315	**0.0005**	9954
Res	32	790	24.688			
Total	39	3914				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'PB-LP11' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	5.3797	**0.0082**	77	0.0015
1, 3	11.662	**0.007**	84	0.0001
1, 4	6.1426	**0.0076**	97	0.0002
2, 3	14.516	**0.0101**	95	0.0001
2, 4	8.8927	0.0076	112	**0.0001**
3, 4	1.8446	0.1016	78	0.1004

Within level 'PB-LP12' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	1.9052	**0.0765**	81	0.0957
1, 3	3.236	**0.0075**	77	0.0128
1, 4	1.0185	0.3805	63	0.3448
2, 3	4.779	0.0074	102	**0.0013**
2, 4	0.71919	0.5026	67	0.4929

Groups	t	P(perm)	Unique perms	P(MC)
3, 4	3.6009	**0.0069**	70	0.0073

Univariate PERMANOVA for Epiphytes

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Se	1	1.1804	1.1804	0.81763	0.6685	3
Si	1	6.7827	6.7827	30.87	**0.0001**	9654
Su(Se)	2	2.8874	1.4437	6.5708	**0.0038**	9952
SexSi	1	6.0284	6.0284	27.437	**0.0002**	9649
Pooled	34	7.4703	0.21972			
Total	39	24.349				

PAIR-WISE TESTS

Term 'SexSi' for pairs of levels of factor 'Season'

Within level 'PB-LP11' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
Winter, Summer	1.0816	0.3346	3	0.4017

Within level 'PB-LP12' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
Winter, Summer	2.9806	0.331	3	0.1031

Term 'SexSi' for pairs of levels of factor 'Site'

Within level 'Winter' of factor 'Season'

Groups	t	P(perm)	Unique perms	P(MC)
PB-LP11, PB-LP12	7.9836	0.0001	2417	**0.0001**

Within level 'Summer' of factor 'Season'

Groups	t	P(perm)	Unique perms	P(MC)
PB-LP11, PB-LP12	0.2158	0.8337	2140	0.828

Multivariate PERMANOVA for Composition

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	19679	6559.5	4.0162	0.092	840
Si	1	2802.2	2802.2	1.7157	0.2729	839
SuxSi	3	4899.7	1633.2	5.1896	**0.0007**	9959
Res	32	10071	314.72			
Total	39	37451				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'PB-LP11' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.0663	0.0076	126	**0.0064**
1, 3	9.7221	**0.0086**	66	0.0001
1, 4	5.1704	**0.0084**	91	0.0003
2, 3	25.947	**0.009**	66	0.0001
2, 4	6.8194	**0.0087**	91	0.0001
3, 4	1.8798	**0.0252**	30	0.0841

Within level 'PB-LP12' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.94415	0.3381	126	0.4374
1, 3	1.4466	**0.0228**	56	0.144
1, 4	2.2659	0.0088	126	**0.0114**
2, 3	1.9359	**0.0093**	91	0.0639
2, 4	2.1833	0.0099	126	**0.0288**
3, 4	1.6577	0.081	91	0.1006

Posidonia Bed: Kurnell

Univariate PERMANOVA for Shoot Count

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	2762	920.65	1.9809	0.1373	9958
Si	9	9991.6	1110.2	2.3886	**0.0361**	9939
SuxSi	27	12549	464.78	12.964	**0.0001**	9895
Res	160	5736	35.85			
Total	199	31038				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'PB-K01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.31189	0.7859	14	0.7655
1, 3	2.3113	**0.0408**	14	0.0506
1, 4	3.372	**0.0145**	19	0.0097
2, 3	2.0135	0.1196	19	0.0774
2, 4	2.8231	**0.0298**	24	0.0226
3, 4	1.3553	0.2242	13	0.2113

Within level 'PB-K02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	1.0363	0.3644	17	0.3262
1, 3	0.25049	0.8755	18	0.8079
1, 4	0.96926	0.3816	19	0.3674
2, 3	1.5644	0.1806	16	0.164
2, 4	2.6112	**0.0394**	18	0.0318
3, 4	0.82565	0.4878	15	0.4305

Within level 'PB-K03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.3953	**0.0325**	52	0.0432
1, 3	2.8517	**0.0161**	49	0.0223
1, 4	3.3793	**0.0141**	56	0.0102
2, 3	0.55799	0.6242	24	0.5922
2, 4	1.5238	0.1711	27	0.1646

Groups	t	P(perm)	Unique perms	P(MC)
3, 4	1.2816	0.267	18	0.242

Within level 'PB-K04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.9691	**0.0167**	16	0.0047
1, 3	0.875	0.4681	10	0.4007
1, 4	0.85424	0.4764	13	0.4165
2, 3	6.0083	**0.0076**	19	0.0001
2, 4	4.2885	**0.0146**	20	0.0031
3, 4	0.21082	0.9214	11	0.8417

Within level 'PB-K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	5.5729	**0.0077**	32	0.0004
1, 3	10.078	**0.0067**	45	0.0001
1, 4	12.963	**0.0076**	29	0.0001
2, 3	3.5	**0.0231**	30	0.0074
2, 4	3.5703	**0.0072**	23	0.0063
3, 4	0.85436	0.4246	13	0.4186

Within level 'PB-K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.74564	0.492	35	0.4738
1, 3	1.1412	0.3207	29	0.294
1, 4	3.1567	**0.0229**	36	0.0138
2, 3	0.16739	0.8982	26	0.8737
2, 4	2.2317	**0.0761**	32	0.0549
3, 4	4.2976	**0.0136**	24	0.0029

Within level 'PB-K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	15.66	**0.0076**	42	0.0001
1, 3	6.361	**0.0076**	48	0.0002
1, 4	5.0468	**0.0073**	32	0.0006
2, 3	2.9354	**0.0292**	37	0.0199
2, 4	7.1971	**0.0091**	46	0.0001

Groups	t	P(perm)	Unique perms	P(MC)
3, 4	2.5196	**0.0457**	35	0.0331

Within level 'PB-K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	19.292	**0.0073**	39	0.0001
1, 3	6.9641	**0.0071**	39	0.0001
1, 4	4.119	**0.009**	51	0.0029
2, 3	2.5648	**0.0471**	31	0.0321
2, 4	1.7756	0.1464	39	0.1146
3, 4	0.13573	0.8803	38	0.8993

Within level 'PB-K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.4641	**0.0217**	10	0.0095
1, 3	0.71714	0.7023	5	0.4894
1, 4	4.8	**0.007**	12	0.0014
2, 3	3.4293	**0.0233**	11	0.008
2, 4	6.261	**0.0079**	19	0.0002
3, 4	3.5246	**0.0252**	11	0.0068

Within level 'PB-K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.5954	**0.0477**	25	0.0279
1, 3	3.5785	**0.0213**	20	0.0072
1, 4	4.6861	**0.0093**	32	0.002
2, 3	0.373	0.7901	12	0.7234
2, 4	2.3324	**0.0767**	19	0.0463
3, 4	2.8539	**0.0293**	17	0.0218

Term 'SuxSi' for pairs of levels of factor 'Site'

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.84893	0.4518	17	0.422
PB-K01, PB-K03	3.0854	0.0151	53	**0.0141**
PB-K01, PB-K04	0.36745	0.7763	13	0.7284

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K05	8.8182	**0.007**	35	0.0001
PB-K01, PB-K06	3.0379	**0.0262**	34	0.0159
PB-K01, PB-K07	4.2281	**0.0067**	20	0.003
PB-K01, PB-K08	3.4238	**0.0167**	17	0.0098
PB-K01, PB-K09	2.5796	**0.0241**	12	0.0322
PB-K01, PB-K10	1.6071	0.1731	17	0.1526
PB-K02, PB-K03	3.3314	**0.0099**	56	0.0092
PB-K02, PB-K04	0.63481	0.5815	17	0.5394
PB-K02, PB-K05	7.9355	**0.0081**	42	0.0002
PB-K02, PB-K06	3.3453	**0.0228**	42	0.0111
PB-K02, PB-K07	2.0587	0.1195	18	0.0727
PB-K02, PB-K08	1.6088	0.1775	18	0.1447
PB-K02, PB-K09	0.78567	0.4884	15	0.4579
PB-K02, PB-K10	2.1095	**0.0723**	26	0.0699
PB-K03, PB-K04	3.2257	**0.0081**	50	0.0119
PB-K03, PB-K05	0.2854	0.7981	34	0.7777
PB-K03, PB-K06	0.99768	0.3485	41	0.3506
PB-K03, PB-K07	4.212	**0.0087**	54	0.004
PB-K03, PB-K08	4.0583	**0.0078**	57	0.0037
PB-K03, PB-K09	3.7749	**0.0092**	42	0.0045
PB-K03, PB-K10	2.3667	**0.0403**	36	0.0457
PB-K04, PB-K05	10.377	**0.009**	39	0.0001
PB-K04, PB-K06	3.2917	**0.0237**	37	0.0097
PB-K04, PB-K07	4.8107	**0.0088**	18	0.0013
PB-K04, PB-K08	3.679	**0.0164**	17	0.0061
PB-K04, PB-K09	2.8014	**0.0398**	11	0.0234
PB-K04, PB-K10	2.0084	**0.0936**	20	0.0821
PB-K05, PB-K06	1.3389	0.2644	27	0.2162
PB-K05, PB-K07	15.822	**0.0087**	35	0.0001
PB-K05, PB-K08	14.125	**0.0082**	39	0.0001
PB-K05, PB-K09	14.881	**0.0068**	27	0.0001
PB-K05, PB-K10	5.3576	**0.0102**	30	0.0015
PB-K06, PB-K07	4.917	**0.0077**	44	0.0011
PB-K06, PB-K08	4.6401	**0.0081**	45	0.0018
PB-K06, PB-K09	4.229	**0.0094**	37	0.0028
PB-K06, PB-K10	1.8905	0.1024	32	0.0923
PB-K07, PB-K08	0.77152	**0.587**	8	0.4602
PB-K07, PB-K09	4.1231	**0.0154**	9	0.0028
PB-K07, PB-K10	4.8516	**0.0073**	28	0.0013
PB-K08, PB-K09	2.1213	0.1134	9	0.0675
PB-K08, PB-K10	4.3022	**0.0149**	27	0.0022
PB-K09, PB-K10	3.6869	**0.0248**	18	0.0063

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.19696	0.9301	15	0.8512
PB-K01, PB-K03	0.61842	0.5333	25	0.5551
PB-K01, PB-K04	1.5576	0.1593	16	0.1625
PB-K01, PB-K05	1.1676	0.3117	21	0.2765
PB-K01, PB-K06	1.7595	0.1252	32	0.1164
PB-K01, PB-K07	8.9481	**0.0087**	47	0.0001
PB-K01, PB-K08	9.4963	**0.0076**	47	0.0001
PB-K01, PB-K09	0.69928	0.5488	15	0.5109
PB-K01, PB-K10	1.3518	0.2353	21	0.2093
PB-K02, PB-K03	0.86923	0.4482	23	0.4083
PB-K02, PB-K04	2.9988	**0.0224**	14	0.0172
PB-K02, PB-K05	1.7253	0.1394	20	0.1225
PB-K02, PB-K06	2.0828	0.1003	32	0.0736
PB-K02, PB-K07	11.464	**0.0094**	49	0.0001
PB-K02, PB-K08	13.996	**0.0084**	42	0.0001
PB-K02, PB-K09	0.811	0.4878	11	0.4349
PB-K02, PB-K10	1.5836	0.1678	18	0.1473
PB-K03, PB-K04	0.42762	0.8703	18	0.682
PB-K03, PB-K05	0.32152	0.8077	22	0.7541
PB-K03, PB-K06	1.1081	0.3335	31	0.3022
PB-K03, PB-K07	6.8665	**0.0068**	49	0.0002
PB-K03, PB-K08	6.8	**0.0065**	48	0.0001
PB-K03, PB-K09	1.2738	0.2597	23	0.242
PB-K03, PB-K10	1.7639	0.1329	28	0.1099
PB-K04, PB-K05	7.88E-02	1	15	0.9375
PB-K04, PB-K06	1.0515	0.3634	27	0.3184
PB-K04, PB-K07	10.592	**0.0075**	45	0.0002
PB-K04, PB-K08	13.723	**0.0077**	37	0.0001
PB-K04, PB-K09	4.9377	**0.0102**	16	0.0007
PB-K04, PB-K10	3.9931	**0.0096**	23	0.0044
PB-K05, PB-K06	0.98437	0.3651	29	0.3536
PB-K05, PB-K07	8.2957	**0.0073**	48	0.0001
PB-K05, PB-K08	8.8807	**0.0081**	46	0.0001
PB-K05, PB-K09	2.4061	0.0815	18	0.0483
PB-K05, PB-K10	2.7773	**0.0486**	25	0.0248
PB-K06, PB-K07	4.6993	**0.0089**	44	0.0015
PB-K06, PB-K08	4.3523	**0.0073**	42	0.0029
PB-K06, PB-K09	2.4417	0.0628	30	0.0408
PB-K06, PB-K10	2.7914	**0.0328**	38	0.0229
PB-K07, PB-K08	1.1619	0.3222	18	0.2842
PB-K07, PB-K09	12.747	**0.0076**	39	0.0001
PB-K07, PB-K10	11.414	**0.0075**	51	0.0001
PB-K08, PB-K09	16.681	**0.0074**	34	0.0001
PB-K08, PB-K10	13.003	**0.0079**	50	0.0001

Groups	t	P(perm)	Unique perms	P(MC)
PB-K09, PB-K10	1.1315	0.3408	14	0.2972

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.68224	0.5773	14	0.5186
PB-K01, PB-K03	2.44	**0.0244**	12	0.0419
PB-K01, PB-K04	1.7709	0.1435	10	0.1127
PB-K01, PB-K05	0.40226	0.788	15	0.7084
PB-K01, PB-K06	6.8806	**0.0075**	29	0.0002
PB-K01, PB-K07	5.5179	**0.0077**	42	0.0008
PB-K01, PB-K08	6.354	**0.0084**	33	0.0005
PB-K01, PB-K09	0.13484	1	8	0.8947
PB-K01, PB-K10	0.43529	0.8692	7	0.6731
PB-K02, PB-K03	1.5912	0.1669	19	0.1506
PB-K02, PB-K04	0.55234	0.6449	13	0.593
PB-K02, PB-K05	0.89709	0.419	17	0.3965
PB-K02, PB-K06	4.9824	**0.0082**	30	0.0009
PB-K02, PB-K07	4.8997	**0.007**	47	0.0014
PB-K02, PB-K08	5.5788	**0.0082**	44	0.001
PB-K02, PB-K09	0.85617	0.5333	12	0.4215
PB-K02, PB-K10	0.49266	0.7544	11	0.635
PB-K03, PB-K04	1.4576	0.173	14	0.19
PB-K03, PB-K05	2.3663	0.0559	21	0.0443
PB-K03, PB-K06	2.832	**0.0404**	22	0.0238
PB-K03, PB-K07	3.7716	**0.0187**	39	0.005
PB-K03, PB-K08	4.2939	**0.0087**	39	0.003
PB-K03, PB-K09	2.7405	**0.0081**	17	0.026
PB-K03, PB-K10	2.4731	**0.0158**	15	0.0386
PB-K04, PB-K05	1.64E+00	0.1628	15	0.1453
PB-K04, PB-K06	6.1137	**0.0076**	26	0.0007
PB-K04, PB-K07	4.9923	**0.0076**	43	0.002
PB-K04, PB-K08	5.7968	**0.0075**	32	0.0006
PB-K04, PB-K09	2.5175	**0.0457**	8	0.0375
PB-K04, PB-K10	2.0788	0.0876	7	0.0703
PB-K05, PB-K06	5.7076	**0.0082**	33	0.0003
PB-K05, PB-K07	5.368	**0.0084**	49	0.0008
PB-K05, PB-K08	6.0758	**0.0082**	48	0.0005
PB-K05, PB-K09	0.35425	0.8199	14	0.7329
PB-K05, PB-K10	0.7303	0.5726	13	0.4858
PB-K06, PB-K07	2.2534	0.0641	32	0.058
PB-K06, PB-K08	2.6616	**0.0077**	28	0.0284
PB-K06, PB-K09	8.037	**0.0089**	30	0.0001
PB-K06, PB-K10	7.9674	**0.0081**	29	0.0002

Groups	t	P(perm)	Unique perms	P(MC)
PB-K07, PB-K08	0.10461	0.9661	30	0.9233
PB-K07, PB-K09	5.7174	**0.0086**	46	0.0004
PB-K07, PB-K10	5.5783	**0.0073**	46	0.0007
PB-K08, PB-K09	6.632	**0.0088**	31	0.0001
PB-K08, PB-K10	6.4905	**0.0094**	28	0.0001
PB-K09, PB-K10	0.88345	0.5428	6	0.4071

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.87039	0.4588	14	0.4092
PB-K01, PB-K03	1.7481	0.1357	18	0.1162
PB-K01, PB-K04	2.2869	0.0792	15	0.053
PB-K01, PB-K05	2.0854	0.1013	13	0.0685
PB-K01, PB-K06	3.3941	**0.0166**	19	0.0075
PB-K01, PB-K07	4.5311	**0.0084**	33	0.0027
PB-K01, PB-K08	4.1672	**0.0085**	54	0.0037
PB-K01, PB-K09	1.057	0.3811	11	0.3209
PB-K01, PB-K10	1.1245	0.3137	16	0.2915
PB-K02, PB-K03	0.94711	0.421	17	0.3657
PB-K02, PB-K04	1.2268	0.3118	13	0.2516
PB-K02, PB-K05	0.78259	0.5208	12	0.4579
PB-K02, PB-K06	2.178	0.0714	16	0.063
PB-K02, PB-K07	3.6888	**0.0157**	27	0.0069
PB-K02, PB-K08	3.8045	**0.0096**	48	0.0053
PB-K02, PB-K09	1.8767	0.1266	14	0.0986
PB-K02, PB-K10	1.7645	0.1357	19	0.1153
PB-K03, PB-K04	6.97E-02	1	15	0.9485
PB-K03, PB-K05	0.47287	0.7403	14	0.6462
PB-K03, PB-K06	0.85066	0.4612	17	0.4216
PB-K03, PB-K07	2.607	**0.0449**	27	0.0316
PB-K03, PB-K08	3.2933	**0.0249**	46	0.0137
PB-K03, PB-K09	2.6171	**0.021**	17	0.0292
PB-K03, PB-K10	2.4453	0.056	22	0.0392
PB-K04, PB-K05	7.30E-01	0.5802	10	0.4896
PB-K04, PB-K06	0.96476	0.3985	14	0.3628
PB-K04, PB-K07	2.8603	**0.0358**	26	0.0211
PB-K04, PB-K08	3.3675	**0.0083**	46	0.0087
PB-K04, PB-K09	3.5839	**0.008**	18	0.0076
PB-K04, PB-K10	2.9694	**0.0214**	20	0.0177
PB-K05, PB-K06	1.9524	0.1124	11	0.0881
PB-K05, PB-K07	3.6	**0.0071**	25	0.007
PB-K05, PB-K08	3.6598	**0.0083**	38	0.0062
PB-K05, PB-K09	4.0249	**0.0224**	13	0.0032

Groups	t	P(perm)	Unique perms	P(MC)
PB-K05, PB-K10	2.834	**0.0321**	19	0.0217
PB-K06, PB-K07	2.2199	0.0673	24	0.0577
PB-K06, PB-K08	3.0408	**0.0239**	42	0.0179
PB-K06, PB-K09	4.9394	**0.0066**	20	0.0015
PB-K06, PB-K10	3.8866	**0.0077**	26	0.0041
PB-K07, PB-K08	1.8187	0.127	40	0.1086
PB-K07, PB-K09	5.4242	**0.0077**	33	0.0005
PB-K07, PB-K10	4.9203	**0.0075**	36	0.0016
PB-K08, PB-K09	4.5088	**0.0066**	49	0.0028
PB-K08, PB-K10	4.4874	**0.0099**	53	0.0023
PB-K09, PB-K10	0.44632	0.7229	14	0.669

Univariate PERMANOVA for Leaf Length

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Se	1	2134.5	2134.5	3.1672	0.0711	9954
Si	9	963.65	107.07	0.65591	0.7356	9939
Su(Se)	2	1119.8	559.9	3.4299	0.0603	9958
SexSi	9	1490.4	165.6	1.0144	0.4607	9948
Su(Se)xSi	18	2938.3	163.24	7.7628	**0.0001**	9919
Res	160	3364.6	21.029			
Total	199	12011				

PAIR-WISE TESTS

Term 'Su(Se)xSi' for pairs of levels of factor 'Survey'

Within level 'Winter' of factor 'Season'

Within level 'PB-K01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	1.2373	0.2592	58	0.2466

Within level 'Winter' of factor 'Season'

Within level 'PB-K02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	4.3594	0.0077	115	**0.0021**

Within level 'Winter' of factor 'Season'

Within level 'PB-K03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	6.1864	**0.0065**	83	0.0008

Within level 'Winter' of factor 'Season'

Within level 'PB-K04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	0.94461	0.3915	122	0.373

Within level 'Winter' of factor 'Season'

Within level 'PB-K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	5.1561	0.0092	103	**0.0007**

Within level 'Winter' of factor 'Season'

Within level 'PB-K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	1.263	0.2377	53	0.2469

Within level 'Winter' of factor 'Season'

Within level 'PB-K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	8.1897	0.0083	126	**0.0001**

Within level 'Winter' of factor 'Season'

Within level 'PB-K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	6.4022	0.0087	116	**0.0002**

Within level 'Winter' of factor 'Season'

Within level 'PB-K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	5.2819	0.0095	126	**0.0006**

Within level 'Winter' of factor 'Season'

Within level 'PB-K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 3	2.0222	**0.0789**	76	0.0789

Within level 'Summer' of factor 'Season'

Within level 'PB-K01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	4.49E-02	0.9853	113	0.9653

Within level 'Summer' of factor 'Season'

Within level 'PB-K02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	1.78E+00	0.1018	100	0.1149

Within level 'Summer' of factor 'Season'

Within level 'PB-K03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	3.85E+00	0.0086	126	**0.0044**

Within level 'Summer' of factor 'Season'

Within level 'PB-K04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	3.81E-01	0.7761	72	0.7126

Within level 'Summer' of factor 'Season'

Within level 'PB-K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	2.19E+00	0.082	76	0.0649

Within level 'Summer' of factor 'Season'

Within level 'PB-K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	3.62E+00	0.0176	94	**0.0071**

Within level 'Summer' of factor 'Season'

Within level 'PB-K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	5.62E-01	0.6106	77	0.5871

Within level 'Summer' of factor 'Season'

Within level 'PB-K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	3.74E+00	0.0142	87	**0.0051**

Within level 'Summer' of factor 'Season'

Within level 'PB-K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	6.45E-04	1	126	1

Within level 'Summer' of factor 'Season'

Within level 'PB-K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
2, 4	1.54E+00	0.2183	84	0.1585

Univariate PERMANOVA for Epiphytes

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	28.047	9.3491	6.9604	**0.0012**	9970
Si	9	6.0262	0.66957	0.4984	0.8616	9938
SuxSi	27	36.29	1.3441	6.6921	**0.0001**	9896
Res	159	31.935	0.20085			
Total	198	103.18				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'PB-K01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	9.8822	**0.0075**	46	0.0001
1, 3	4.9446	**0.0056**	31	0.0013
1, 4	4.8055	**0.0164**	40	0.0014
2, 3	1.5201	0.1798	30	0.1674
2, 4	4.646	**0.0078**	60	0.0017
3, 4	1.6288	0.1756	31	0.1418

Within level 'PB-K02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.57764	0.6152	24	0.5759
1, 3	0.92434	0.3987	40	0.3953
1, 4	0.7706	0.3538	27	0.4662
2, 3	0.72599	0.5025	22	0.4902
2, 4	0.52233	0.7435	13	0.6162
3, 4	0.50372	0.6985	14	0.6291

Within level 'PB-K03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	9.029	**0.0088**	56	0.0001
1, 3	6.0501	**0.0063**	33	0.0003
1, 4	6.8458	**0.0073**	56	0.0002
2, 3	3.9399	**0.0077**	28	0.0043
2, 4	0.66551	0.5868	36	0.5316
3, 4	3.0318	**0.0151**	38	0.0191

Within level 'PB-K04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.1281	0.0841	17	0.0669
1, 3	1.066	0.3274	17	0.3116
1, 4	1.0733	0.4238	12	0.3189
2, 3	0.98533	0.4603	12	0.3621
2, 4	6.7552	**0.0081**	16	0.0002
3, 4	2.846	0.0384	15	0.0256

Within level 'PB-K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	5.875	**0.0086**	21	0.0002
1, 3	4.1541	**0.0172**	27	0.0033
1, 4	0.70186	0.5589	17	0.4968
2, 3	2.8411	**0.0609**	14	0.0221
2, 4	4.5204	**0.008**	26	0.0019
3, 4	3.4466	**0.015**	37	0.0065

Within level 'PB-K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.9115	**0.0069**	11	0.0219
1, 3	0.8939	0.4833	14	0.3883
1, 4	0.6	0.6017	13	0.5683
2, 3	5.4233	**0.0089**	20	0.0004
2, 4	4.6349	**0.0076**	21	0.002
3, 4	0.32824	0.7932	15	0.7501

Within level 'PB-K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.7332	**0.0318**	47	0.0273
1, 3	0.44217	0.6723	47	0.665
1, 4	1.9771	0.1014	62	0.0817
2, 3	1.6464	0.1676	18	0.1339
2, 4	3.6919	**0.0165**	30	0.0058
3, 4	2.014	0.0857	24	0.0758

Within level 'PB-K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.9245	**0.0086**	38	0.004
1, 3	1.2525	0.2398	34	0.2376
1, 4	4.6359	**0.0073**	79	0.0014
2, 3	7.6613	**0.0065**	20	0.0001
2, 4	8.581	**0.0076**	34	0.0003
3, 4	4.2568	**0.0088**	22	0.0026

Within level 'PB-K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.95929	0.4033	20	0.369
1, 3	1.7903	0.133	20	0.1129
1, 4	1.1472	0.2745	80	0.2898
2, 3	1.9524	0.1142	32	0.0866
2, 4	1.6084	0.1527	100	0.1463
3, 4	0.29931	0.8231	68	0.7728

Within level 'PB-K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	1.3216	0.2303	44	0.2179
1, 3	0.52615	0.6597	16	0.6026
1, 4	5.5922	**0.0074**	49	0.0007
2, 3	1.5695	0.1708	46	0.1561
2, 4	4.6468	**0.0068**	78	0.002
3, 4	4.4872	**0.0087**	53	0.002

Term 'SuxSi' for pairs of levels of factor 'Site'

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	2.1172	**0.0654**	29	0.0694
PB-K01, PB-K03	0.30194	0.7524	14	0.7684
PB-K01, PB-K04	4.7063	**0.0075**	25	0.0014
PB-K01, PB-K05	4.4785	**0.0178**	20	0.0026
PB-K01, PB-K06	5.7931	**0.0071**	18	0.0003
PB-K01, PB-K07	7.6715	**0.0074**	64	0.0003
PB-K01, PB-K08	8.044	**0.0074**	64	0.0002
PB-K01, PB-K09	9.1706	**0.0083**	34	0.0001

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K10	8.2993	**0.0091**	33	0.0002
PB-K02, PB-K03	2.1472	0.0669	28	0.0655
PB-K02, PB-K04	0.54026	0.6338	27	0.5985
PB-K02, PB-K05	8.80E-02	0.977	24	0.9345
PB-K02, PB-K06	1.34	0.2066	23	0.2175
PB-K02, PB-K07	1.2402	0.2594	72	0.2491
PB-K02, PB-K08	1.6404	0.1558	86	0.1349
PB-K02, PB-K09	1.7424	0.1511	29	0.1163
PB-K02, PB-K10	1.7877	0.143	30	0.1091
PB-K03, PB-K04	4.1914	**0.0095**	28	0.0029
PB-K03, PB-K05	3.7477	**0.0341**	13	0.0051
PB-K03, PB-K06	5.1922	**0.0157**	19	0.0018
PB-K03, PB-K07	6.1236	**0.0074**	81	0.0002
PB-K03, PB-K08	6.5732	**0.0083**	81	0.0004
PB-K03, PB-K09	7.1386	**0.0088**	37	0.0002
PB-K03, PB-K10	6.7918	**0.0075**	36	0.0001
PB-K04, PB-K05	1.1488	0.3372	16	0.2786
PB-K04, PB-K06	1.2392	0.2562	17	0.2435
PB-K04, PB-K07	1.1733	0.2713	34	0.2772
PB-K04, PB-K08	1.8399	0.1142	43	0.1002
PB-K04, PB-K09	2.0884	0.0893	19	0.0711
PB-K04, PB-K10	2.087	0.0893	20	0.0709
PB-K05, PB-K06	2.4873	0.0701	17	0.0369
PB-K05, PB-K07	2.9894	**0.0235**	54	0.0156
PB-K05, PB-K08	3.6786	**0.0155**	54	0.0059
PB-K05, PB-K09	4.263	**0.0081**	21	0.0031
PB-K05, PB-K10	3.9669	**0.0102**	22	0.003
PB-K06, PB-K07	0.36331	0.771	27	0.7228
PB-K06, PB-K08	0.31769	0.7581	28	0.7594
PB-K06, PB-K09	0.44414	0.8382	11	0.6687
PB-K06, PB-K10	0.55537	0.6868	12	0.5919
PB-K07, PB-K08	0.92005	0.3993	51	0.3765
PB-K07, PB-K09	1.1941	0.2926	32	0.2652
PB-K07, PB-K10	1.2404	0.2917	36	0.2493
PB-K08, PB-K09	0.14436	0.9236	34	0.8865
PB-K08, PB-K10	0.30793	0.7948	38	0.7652
PB-K09, PB-K10	0.19803	0.9301	12	0.847

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	4.0456	**0.0176**	37	0.0048
PB-K01, PB-K03	1.1389	0.317	25	0.2981
PB-K01, PB-K04	1.712	0.1216	18	0.1196
PB-K01, PB-K05	0.97683	0.3953	15	0.3547

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K06	2.068	0.0851	14	0.0745
PB-K01, PB-K07	0.4702	0.6741	20	0.6495
PB-K01, PB-K08	2.2971	0.079	14	0.0493
PB-K01, PB-K09	8.00E-02	0.9493	30	0.938
PB-K01, PB-K10	0.76966	0.5008	40	0.4536
PB-K02, PB-K03	5.5245	**0.0069**	35	0.0009
PB-K02, PB-K04	3.089	0.0216	14	0.0165
PB-K02, PB-K05	4.35E+00	**0.008**	17	0.0033
PB-K02, PB-K06	7.2684	**0.008**	23	0.0001
PB-K02, PB-K07	4.1426	**0.0089**	22	0.0038
PB-K02, PB-K08	7.8207	**0.007**	23	0.0002
PB-K02, PB-K09	2.5931	0.055	25	0.03
PB-K02, PB-K10	2.7263	**0.0419**	52	0.0257
PB-K03, PB-K04	3.2699	**0.0076**	19	0.0125
PB-K03, PB-K05	2.6369	0.0822	11	0.0316
PB-K03, PB-K06	0.83441	0.417	17	0.4267
PB-K03, PB-K07	0.53047	0.6271	21	0.6116
PB-K03, PB-K08	1.0258	0.3416	15	0.3301
PB-K03, PB-K09	0.61619	0.6154	29	0.548
PB-K03, PB-K10	0.24104	0.7867	62	0.8053
PB-K04, PB-K05	1.2472	0.351	7	0.2446
PB-K04, PB-K06	5.1241	**0.0068**	14	0.0012
PB-K04, PB-K07	2.0466	0.1082	13	0.0734
PB-K04, PB-K08	5.7886	**0.0084**	15	0.0003
PB-K04, PB-K09	1.0608	0.351	16	0.3227
PB-K04, PB-K10	1.5418	0.2043	38	0.1581
PB-K05, PB-K06	4.7673	**0.0072**	11	0.0012
PB-K05, PB-K07	1.4184	0.2427	11	0.1927
PB-K05, PB-K08	5.6737	**0.006**	12	0.0009
PB-K05, PB-K09	0.61237	0.5946	15	0.5548
PB-K05, PB-K10	1.2064	0.3053	33	0.2618
PB-K06, PB-K07	1.2545	0.276	12	0.2469
PB-K06, PB-K08	0.18732	1	7	0.8624
PB-K06, PB-K09	1.0702	0.3938	16	0.3098
PB-K06, PB-K10	7.33E-02	0.9079	23	0.9406
PB-K07, PB-K08	1.41	0.2514	12	0.1998
PB-K07, PB-K09	0.23905	0.8782	19	0.8156
PB-K07, PB-K10	0.50024	0.6552	40	0.6284
PB-K08, PB-K09	1.154	0.3553	15	0.2819
PB-K08, PB-K10	0.12503	0.8759	28	0.9036
PB-K09, PB-K10	0.60582	0.5874	44	0.5588

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.37726	0.7629	32	0.7212
PB-K01, PB-K03	0.12978	0.9544	19	0.9019
PB-K01, PB-K04	6.06E-02	1	18	0.9547
PB-K01, PB-K05	0.19057	0.8953	30	0.8511
PB-K01, PB-K06	0.55977	0.7113	18	0.5916
PB-K01, PB-K07	0.27545	0.8284	21	0.7902
PB-K01, PB-K08	0.20484	0.7937	13	0.8361
PB-K01, PB-K09	3.50E-01	0.7516	31	0.741
PB-K01, PB-K10	0.28653	0.8241	20	0.7846
PB-K02, PB-K03	0.36028	0.7674	23	0.7326
PB-K02, PB-K04	0.39794	0.7073	25	0.6966
PB-K02, PB-K05	8.13E-01	0.4863	34	0.4404
PB-K02, PB-K06	0.16982	0.8757	23	0.866
PB-K02, PB-K07	0.72385	0.5252	29	0.4877
PB-K02, PB-K08	0.30473	0.8639	15	0.769
PB-K02, PB-K09	0.11366	0.941	38	0.9182
PB-K02, PB-K10	0.76141	0.5055	29	0.4611
PB-K03, PB-K04	8.84E-02	1	12	0.933
PB-K03, PB-K05	0.61707	0.6373	17	0.556
PB-K03, PB-K06	0.65561	0.5831	11	0.5287
PB-K03, PB-K07	0.51465	0.647	16	0.6163
PB-K03, PB-K08	0.11952	1	10	0.9039
PB-K03, PB-K09	0.36209	0.7491	20	0.7252
PB-K03, PB-K10	0.5534	0.6392	15	0.593
PB-K04, PB-K05	0.3844	0.798	18	0.7046
PB-K04, PB-K06	0.65539	0.5879	15	0.5302
PB-K04, PB-K07	0.40452	0.7419	17	0.6938
PB-K04, PB-K08	0.19518	0.9484	12	0.8523
PB-K04, PB-K09	0.39535	0.7323	21	0.7077
PB-K04, PB-K10	0.42967	0.7268	16	0.6745
PB-K05, PB-K06	1.3149	0.2654	14	0.2245
PB-K05, PB-K07	0.1864	0.8682	26	0.8557
PB-K05, PB-K08	0.96086	0.4283	14	0.3568
PB-K05, PB-K09	1.1752	0.3178	29	0.2699
PB-K05, PB-K10	0.20414	0.8599	24	0.8392
PB-K06, PB-K07	0.97543	0.4236	15	0.356
PB-K06, PB-K08	0.62897	0.6051	9	0.5404
PB-K06, PB-K09	0.3721	0.8037	23	0.7155
PB-K06, PB-K10	1.04E+00	0.4009	11	0.3219
PB-K07, PB-K08	0.62854	0.6306	13	0.5413
PB-K07, PB-K09	0.78028	0.4751	30	0.4584
PB-K07, PB-K10	1.05E-08	1	19	1
PB-K08, PB-K09	0.29656	0.8052	16	0.7686
PB-K08, PB-K10	0.68349	0.5587	14	0.5175

Groups	t	P(perm)	Unique perms	P(MC)
PB-K09, PB-K10	0.84379	0.4225	27	0.4211

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	1.6573	0.1336	23	0.1399
PB-K01, PB-K03	4.4044	**0.0075**	71	0.0036
PB-K01, PB-K04	2.52E-01	0.8356	17	0.8093
PB-K01, PB-K05	1.0412	0.2983	33	0.3234
PB-K01, PB-K06	1.7491	0.1474	30	0.1152
PB-K01, PB-K07	0.37854	0.7129	32	0.7165
PB-K01, PB-K08	1.999	0.0877	31	0.0772
PB-K01, PB-K09	8.24E-01	0.5585	66	0.4353
PB-K01, PB-K10	2.7858	**0.0383**	50	0.0229
PB-K02, PB-K03	4.1994	**0.0078**	36	0.0039
PB-K02, PB-K04	4.2207	**0.0062**	15	0.0017
PB-K02, PB-K05	2.31E+00	0.0543	27	0.0509
PB-K02, PB-K06	0.7895	0.4911	18	0.456
PB-K02, PB-K07	1.376	0.1691	20	0.2071
PB-K02, PB-K08	3.7106	**0.0085**	32	0.0072
PB-K02, PB-K09	0.10299	0.9921	41	0.9224
PB-K02, PB-K10	4.5938	**0.008**	34	0.0019
PB-K03, PB-K04	5.29E+00	**0.007**	34	0.0006
PB-K03, PB-K05	4.4606	**0.01**	53	0.0033
PB-K03, PB-K06	2.9619	**0.0167**	37	0.0225
PB-K03, PB-K07	3.6848	**0.0164**	52	0.0074
PB-K03, PB-K08	5.4243	**0.0088**	38	0.0014
PB-K03, PB-K09	2.3759	0.0637	91	0.0454
PB-K03, PB-K10	5.953	**0.0079**	56	0.0009
PB-K04, PB-K05	1.0359	0.3692	14	0.3269
PB-K04, PB-K06	2.4312	0.0637	14	0.0452
PB-K04, PB-K07	0.27768	0.8277	16	0.7925
PB-K04, PB-K08	2.2141	**0.0398**	14	0.0591
PB-K04, PB-K09	1.0193	0.4479	31	0.3342
PB-K04, PB-K10	3.1354	**0.0228**	25	0.0158
PB-K05, PB-K06	2.3738	0.0591	23	0.0464
PB-K05, PB-K07	0.48245	0.6816	19	0.6443
PB-K05, PB-K08	0.68483	0.5493	20	0.5225
PB-K05, PB-K09	1.4627	0.1927	83	0.1817
PB-K05, PB-K10	1.356	0.1828	36	0.2125
PB-K06, PB-K07	1.6136	0.1542	22	0.1438
PB-K06, PB-K08	3.4097	**0.0155**	25	0.0084
PB-K06, PB-K09	0.29247	0.8056	62	0.7774
PB-K06, PB-K10	4.13E+00	**0.0088**	48	0.0032

Groups	t	P(perm)	Unique perms	P(MC)
PB-K07, PB-K08	1.1396	0.3136	21	0.2864
PB-K07, PB-K09	0.97505	0.3652	68	0.3582
PB-K07, PB-K10	1.75E+00	0.1007	38	0.1185
PB-K08, PB-K09	2.0907	**0.0397**	64	0.0711
PB-K08, PB-K10	0.73926	0.4662	31	0.4743
PB-K09, PB-K10	2.6253	**0.0249**	91	0.0315

Multivariate PERMANOVA for Composition

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	58411	19470	11.664	**0.0001**	9941
Si	9	49257	5473	3.2787	**0.0002**	9911
SuxSi	27	45070	1669.2	5.4706	**0.0001**	9844
Res	160	48821	305.13			
Total	199	2.02E+05				

PAIR-WISE TESTS

Term 'SuxSi' for pairs of levels of factor 'Survey'

Within level 'PB-K01' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	6.2633	0.0081	126	**0.0001**
1, 3	2.9412	0.0091	126	**0.0069**
1, 4	2.3229	0.0085	126	**0.0162**
2, 3	2.6003	0.0236	126	**0.013**
2, 4	3.5732	0.0079	126	**0.0006**
3, 4	1.3155	2.06E-01	126	0.2054

Within level 'PB-K02' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	15.411	0.0081	126	**0.0001**
1, 3	7.2307	0.0081	126	**0.0002**
1, 4	2.1866	0.046	126	**0.0386**
2, 3	8.306	0.0095	126	**0.0001**
2, 4	3.7364	0.0079	125	**0.001**
3, 4	0.90936	4.91E-01	126	0.4414

Within level 'PB-K03' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	5.6231	0.0083	126	**0.0002**
1, 3	1.7881	0.0405	126	0.0569
1, 4	1.6647	0.0171	126	0.0955
2, 3	3.7521	0.008	126	**0.0005**
2, 4	2.4695	0.0081	126	**0.0078**
3, 4	0.54904	0.695	126	0.6847

Within level 'PB-K04' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.822	0.0079	126	**0.0043**
1, 3	3.6046	0.0073	126	**0.0017**
1, 4	1.0312	0.3892	126	0.3391
2, 3	7.5189	0.008	126	**0.0001**
2, 4	2.3374	0.0096	126	**0.0272**
3, 4	0.98176	3.69E-01	126	0.3583

Within level 'PB-K05' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.9279	0.0092	126	**0.0018**
1, 3	3.4403	0.0076	126	**0.0015**
1, 4	6.4343	0.0075	126	**0.0001**
2, 3	5.2591	0.0073	126	**0.0003**
2, 4	6.517	0.0082	126	**0.0001**
3, 4	3.9702	7.10E-03	126	**0.0004**

Within level 'PB-K06' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.8044	0.0072	126	**0.0014**
1, 3	4.4138	0.0093	126	**0.0009**
1, 4	2.5212	0.0083	126	**0.0065**
2, 3	8.2857	0.0076	126	**0.0001**
2, 4	4.2053	0.008	126	**0.0004**
3, 4	4.0512	8.20E-03	126	**0.0004**

Within level 'PB-K07' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	4.5765	0.007	126	**0.0007**
1, 3	3.6492	0.0082	126	**0.0011**
1, 4	1.7763	0.0654	126	0.0662
2, 3	6.9295	0.0078	126	**0.0001**
2, 4	3.2028	0.0084	126	**0.0016**
3, 4	1.645	8.59E-02	126	0.1061

Within level 'PB-K08' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.0158	0.0244	126	**0.0402**
1, 3	2.3871	0.0389	126	**0.0229**
1, 4	1.4769	0.1355	126	0.1455
2, 3	1.7346	0.1012	126	0.0839
2, 4	0.42766	0.7717	126	0.7917
3, 4	1.4901	1.55E-01	126	0.1506

Within level 'PB-K09' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	8.1863	0.0066	126	**0.0001**
1, 3	3.8598	0.0089	126	**0.0011**
1, 4	1.195	0.2152	126	0.2759
2, 3	4.9651	0.007	126	**0.0001**
2, 4	3.98	0.0081	126	**0.0009**
3, 4	1.7598	9.02E-02	126	0.0898

Within level 'PB-K10' of factor 'Site'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	5.5385	0.0083	126	**0.0001**
1, 3	9.5981	0.0098	126	**0.0001**
1, 4	4.3052	**0.0072**	91	0.0005
2, 3	8.309	0.0076	126	**0.0001**
2, 4	4.3387	**0.0078**	91	0.0007
3, 4	1.9077	**0.0227**	66	0.0536

Term 'SuxSi' for pairs of levels of factor 'Site'

Within level '1' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	5.5478	0.0066	126	**0.0004**
PB-K01, PB-K03	2.6637	0.0082	126	**0.0117**
PB-K01, PB-K04	3.434	0.0077	126	**0.0026**
PB-K01, PB-K05	3.3297	0.0149	126	**0.0041**
PB-K01, PB-K06	1.5305	0.1035	126	0.1172
PB-K01, PB-K07	2.1599	1.60E-02	126	**0.038**
PB-K01, PB-K08	1.0725	0.3504	126	0.3231
PB-K01, PB-K09	3.3986	0.0076	126	**0.0019**
PB-K01, PB-K10	2.5648	0.0075	126	**0.0124**
PB-K02, PB-K03	6.2705	0.0093	126	**0.0001**
PB-K02, PB-K04	1.7142	0.0324	126	0.0749
PB-K02, PB-K05	3.4642	0.0081	126	**0.0017**
PB-K02, PB-K06	4.4303	0.0093	126	**0.0005**
PB-K02, PB-K07	3.9805	0.0069	126	**0.0011**
PB-K02, PB-K08	1.8939	0.0078	126	0.0698
PB-K02, PB-K09	2.6654	0.0083	126	**0.0079**
PB-K02, PB-K10	5.1886	0.009	126	**0.0003**
PB-K03, PB-K04	3.5651	0.0086	126	**0.0014**
PB-K03, PB-K05	1.8396	0.0764	126	0.0661
PB-K03, PB-K06	0.75967	0.6807	126	0.6215
PB-K03, PB-K07	3.0882	0.0108	126	**0.0041**
PB-K03, PB-K08	1.6015	0.0079	126	0.1193
PB-K03, PB-K09	4.1246	0.0082	126	**0.0009**
PB-K03, PB-K10	2.4588	0.0173	126	**0.0106**
PB-K04, PB-K05	2.0564	0.0156	1.26E+02	**0.0345**
PB-K04, PB-K06	2.917	0.0072	126	**0.0074**
PB-K04, PB-K07	3.4361	0.0093	126	**0.0016**
PB-K04, PB-K08	1.4649	0.0152	126	0.1647
PB-K04, PB-K09	1.4783	0.1188	126	0.1374
PB-K04, PB-K10	2.6096	0.017	126	**0.0064**
PB-K05, PB-K06	1.5658	0.146	126	0.1211
PB-K05, PB-K07	3.4933	0.0075	1.26E+02	**0.0006**
PB-K05, PB-K08	1.8413	0.0087	126	0.0666
PB-K05, PB-K09	3.0131	0.0094	126	**0.0024**
PB-K05, PB-K10	1.9409	0.0384	126	**0.0414**
PB-K06, PB-K07	2.6281	0.0066	126	**0.0079**
PB-K06, PB-K08	1.508	0.0391	126	0.1379
PB-K06, PB-K09	3.2455	0.0081	126	**0.0028**
PB-K06, PB-K10	1.5881	0.1166	126	0.1133
PB-K07, PB-K08	1.1487	0.3203	126	0.2811
PB-K07, PB-K09	2.9307	0.0078	126	**0.0046**
PB-K07, PB-K10	3.0969	0.0092	126	**0.0038**
PB-K08, PB-K09	1.0195	0.4136	125	0.3411
PB-K08, PB-K10	1.5687	0.01	125	0.1292
PB-K09, PB-K10	3.8973	0.0076	126	**0.0021**

Within level '2' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	3.7713	0.0082	126	**0.0013**
PB-K01, PB-K03	4.0183	0.0079	126	**0.0007**
PB-K01, PB-K04	4.2314	0.0082	126	**0.0002**
PB-K01, PB-K05	5.0386	0.0075	126	**0.0002**
PB-K01, PB-K06	4.1396	0.0077	126	**0.0002**
PB-K01, PB-K07	3.1644	1.39E-02	126	**0.0032**
PB-K01, PB-K08	2.8425	0.0089	126	**0.0147**
PB-K01, PB-K09	0.7617	0.4708	126	0.4873
PB-K01, PB-K10	0.68177	0.5521	126	0.5985
PB-K02, PB-K03	7.773	0.0083	126	**0.0001**
PB-K02, PB-K04	7.7748	0.008	126	**0.0001**
PB-K02, PB-K05	6.016	0.0081	126	**0.0002**
PB-K02, PB-K06	8.4688	0.0071	126	**0.0001**
PB-K02, PB-K07	5.7279	0.0053	126	**0.0002**
PB-K02, PB-K08	3.8325	0.0082	126	**0.0022**
PB-K02, PB-K09	2.8437	0.0258	126	**0.0127**
PB-K02, PB-K10	4.6313	0.0073	126	**0.0001**
PB-K03, PB-K04	0.4097	0.8997	126	0.8651
PB-K03, PB-K05	2.0022	0.0279	126	**0.0307**
PB-K03, PB-K06	0.52861	0.8066	126	0.7573
PB-K03, PB-K07	2.5376	0.0243	126	**0.0168**
PB-K03, PB-K08	2.4475	0.0071	126	**0.0333**
PB-K03, PB-K09	4.3296	0.0068	126	**0.0003**
PB-K03, PB-K10	3.9734	0.0106	126	**0.0011**
PB-K04, PB-K05	1.7127	0.0868	1.26E+02	0.0849
PB-K04, PB-K06	0.88336	0.5108	126	0.4924
PB-K04, PB-K07	2.6271	0.0133	126	**0.0131**
PB-K04, PB-K08	2.4708	0.0081	126	**0.0279**
PB-K04, PB-K09	4.3371	0.0079	126	**0.0003**
PB-K04, PB-K10	4.4349	0.0078	126	**0.0003**
PB-K05, PB-K06	2.4617	0.0148	126	**0.0123**
PB-K05, PB-K07	3.3799	0.0078	1.26E+02	**0.004**
PB-K05, PB-K08	2.9038	0.0085	126	**0.0083**
PB-K05, PB-K09	4.7158	0.0075	126	**0.0003**
PB-K05, PB-K10	5.2695	0.0079	126	**0.0003**
PB-K06, PB-K07	2.3458	0.0162	126	**0.0309**
PB-K06, PB-K08	2.1282	0.0085	126	0.0564
PB-K06, PB-K09	4.4417	0.0078	126	**0.0002**
PB-K06, PB-K10	4.0623	0.0073	126	**0.0014**
PB-K07, PB-K08	1.4586	0.1745	126	0.1769
PB-K07, PB-K09	3.3347	0.008	126	**0.002**
PB-K07, PB-K10	3.4652	0.0085	126	**0.0025**
PB-K08, PB-K09	3.0834	0.0086	126	**0.0095**
PB-K08, PB-K10	2.9457	0.0072	126	**0.0144**

Groups	t	P(perm)	Unique perms	P(MC)
PB-K09, PB-K10	1.2442	0.2706	126	0.2415

Within level '3' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	1.6148	0.0878	126	0.1095
PB-K01, PB-K03	3.2182	0.0085	126	**0.0044**
PB-K01, PB-K04	4.0632	0.0071	126	**0.0015**
PB-K01, PB-K05	4.3794	0.0071	126	**0.0013**
PB-K01, PB-K06	4.8993	0.0084	126	**0.0005**
PB-K01, PB-K07	5.2883	8.30E-03	126	**0.0002**
PB-K01, PB-K08	4.9203	0.0085	126	**0.0003**
PB-K01, PB-K09	1.815	0.024	126	0.0628
PB-K01, PB-K10	5.3568	0.0085	126	**0.0002**
PB-K02, PB-K03	3.8383	0.0085	126	**0.0012**
PB-K02, PB-K04	4.7394	0.0095	126	**0.0003**
PB-K02, PB-K05	4.9046	0.0074	126	**0.0005**
PB-K02, PB-K06	4.5087	0.0083	126	**0.001**
PB-K02, PB-K07	4.8811	0.0081	126	**0.0005**
PB-K02, PB-K08	5.1685	0.0077	126	**0.0002**
PB-K02, PB-K09	1.2443	0.2593	126	0.2304
PB-K02, PB-K10	4.9495	0.0084	126	**0.0005**
PB-K03, PB-K04	1.2685	0.2433	126	0.2253
PB-K03, PB-K05	2.2084	0.0399	126	**0.0314**
PB-K03, PB-K06	5.4397	0.0097	126	**0.0001**
PB-K03, PB-K07	6.0201	0.007	126	**0.0001**
PB-K03, PB-K08	3.702	0.008	126	**0.0023**
PB-K03, PB-K09	2.5686	0.0173	126	**0.0121**
PB-K03, PB-K10	7.1359	0.008	126	**0.0001**
PB-K04, PB-K05	1.583	0.1399	1.26E+02	0.1406
PB-K04, PB-K06	6.1323	0.0071	126	**0.0001**
PB-K04, PB-K07	6.9963	0.0086	126	**0.0001**
PB-K04, PB-K08	3.9429	0.0087	126	**0.0024**
PB-K04, PB-K09	2.5449	0.0169	126	**0.0163**
PB-K04, PB-K10	7.7279	0.0076	126	**0.0001**
PB-K05, PB-K06	4.2865	0.0082	126	**0.0012**
PB-K05, PB-K07	4.8796	0.0076	1.26E+02	**0.0006**
PB-K05, PB-K08	2.499	0.0325	126	**0.0218**
PB-K05, PB-K09	3.3685	0.0236	126	**0.008**
PB-K05, PB-K10	4.3229	0.0104	126	**0.0005**
PB-K06, PB-K07	1.1576	0.2881	126	0.286
PB-K06, PB-K08	2.3406	0.023	126	**0.0221**
PB-K06, PB-K09	4.2581	0.007	126	**0.0012**
PB-K06, PB-K10	3.0171	0.0058	126	**0.005**

Groups	t	P(perm)	Unique perms	P(MC)
PB-K07, PB-K08	2.2929	0.0426	126	**0.0204**
PB-K07, PB-K09	4.737	0.0066	126	**0.0006**
PB-K07, PB-K10	3.7714	0.0086	126	**0.0025**
PB-K08, PB-K09	4.1148	0.0073	126	**0.002**
PB-K08, PB-K10	4.5666	0.0091	126	**0.0008**
PB-K09, PB-K10	4.4906	0.0084	126	**0.0007**

Within level '4' of factor 'Survey'

Groups	t	P(perm)	Unique perms	P(MC)
PB-K01, PB-K02	0.53871	0.8467	126	0.7809
PB-K01, PB-K03	1.9686	0.04	126	**0.0397**
PB-K01, PB-K04	2.3013	0.0251	126	**0.0167**
PB-K01, PB-K05	6.6505	0.008	126	**0.0001**
PB-K01, PB-K06	3.7571	0.0096	126	**0.0007**
PB-K01, PB-K07	2.1005	2.47E-02	126	**0.0262**
PB-K01, PB-K08	2.199	0.0137	126	**0.0186**
PB-K01, PB-K09	1.9046	0.0319	126	0.0553
PB-K01, PB-K10	2.8919	0.0083	91	**0.004**
PB-K02, PB-K03	0.82768	0.4523	126	0.4898
PB-K02, PB-K04	1.1184	0.3183	126	0.3175
PB-K02, PB-K05	4.2345	0.0083	126	**0.0014**
PB-K02, PB-K06	2.6426	0.0253	126	**0.0112**
PB-K02, PB-K07	1.7344	0.0755	126	**0.0771**
PB-K02, PB-K08	1.4383	0.1321	126	0.1411
PB-K02, PB-K09	1.2878	0.2004	126	0.2225
PB-K02, PB-K10	2.9031	0.0082	91	**0.0027**
PB-K03, PB-K04	0.45749	0.9335	126	0.841
PB-K03, PB-K05	4.3931	0.0077	126	**0.0011**
PB-K03, PB-K06	2.2127	0.0088	126	**0.027**
PB-K03, PB-K07	1.9375	0.0686	126	0.064
PB-K03, PB-K08	1.4086	0.1572	126	0.1677
PB-K03, PB-K09	0.90196	0.4693	126	0.4266
PB-K03, PB-K10	3.5274	0.0086	91	**0.0006**
PB-K04, PB-K05	2.8943	0.0085	1.26E+02	**0.0043**
PB-K04, PB-K06	1.2746	0.2207	126	0.2297
PB-K04, PB-K07	1.805	0.0881	126	0.0749
PB-K04, PB-K08	1.2833	0.2071	126	0.215
PB-K04, PB-K09	0.55846	0.7961	126	0.7456
PB-K04, PB-K10	3.2331	0.0084	91	**0.0017**
PB-K05, PB-K06	3.6589	0.009	126	**0.0017**
PB-K05, PB-K07	3.8704	0.0082	1.26E+02	**0.0021**
PB-K05, PB-K08	2.7876	0.011	126	**0.0099**
PB-K05, PB-K09	3.4774	0.0087	126	**0.0049**

Groups	t	P(perm)	Unique perms	P(MC)
PB-K05, PB-K10	4.5639	0.0079	91	**0.0001**
PB-K06, PB-K07	1.709	0.0771	126	0.0909
PB-K06, PB-K08	1.6946	0.0812	126	0.0785
PB-K06, PB-K09	1.8078	0.0772	126	0.0716
PB-K06, PB-K10	3.2287	0.0082	91	**0.0024**
PB-K07, PB-K08	1.1122	0.2968	126	0.3006
PB-K07, PB-K09	2.0446	0.0484	126	0.038
PB-K07, PB-K10	2.4639	0.009	91	**0.0095**
PB-K08, PB-K09	1.6501	0.0638	126	0.0879
PB-K08, PB-K10	2.8591	0.0068	91	**0.0038**
PB-K09, PB-K10	3.0615	0.0052	91	**0.0023**

Posidonia patches: La Perouse

Univariate PERMANOVA for Shoot Count: LP01

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	153.43	51.143	5.5894	**0.0223**	982
Res	10	91.5	9.15			
Total	13	244.93				

PAIR-WISE TESTS

Term 'Su'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.37796	1	3	0.7232
1, 3	1.86	0.1341	17	0.1219
1, 4	3.3251	0.0552	21	0.0188
2, 3	2.1576	0.1409	12	0.0784
2, 4	3.5326	**0.0336**	20	0.0169
3, 4	1.4771	0.2034	11	0.1881

Univariate PERMANOVA for Shoot Count: LP02

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	370.67	123.56	4.7319	**0.0198**	1998
Res	12	313.33	26.111			
Total	15	684				

PAIR-WISE TESTS

Term 'Su'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	3.9598	0.0948	9	0.015
1, 3	2.1651	0.0727	15	0.0727
1, 4	0.66975	0.622	25	0.5264
2, 3	7.2158	**0.0192**	30	0.0005
2, 4	2.5093	0.0717	34	0.044
3, 4	Negative			

Posidonia patches: Kurnell

Univariate PERMANOVA for Shoot Count: PP-K03

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	316.15	105.38	13.776	**0.0006**	613
Res	16	122.4	7.65			
Total	19	438.55				

PAIR-WISE TESTS

Term 'Su'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	2.4056	0.0771	14	0.043
1, 3	5.2559	**0.0086**	24	0.0009
1, 4	5.0644	**0.0063**	23	0.0012
2, 3	2.9775	**0.0289**	15	0.0206
2, 4	2.6563	**0.0485**	13	0.0293
3, 4	0.59628	0.6641	9	0.5599

Univariate PERMANOVA for Shoot Count: PP-K03

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	37.2	12.4	0.91009	0.4565	336
Res	16	218	13.625			
Total	19	255.2				

Univariate PERMANOVA for Shoot Count: PP-K07

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	271.42	90.474	2.8571	0.0585	2043
Res	15	475	31.667			
Total	18	746.42				

Univariate PERMANOVA for Shoot Count: PP-K08

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	276.68	92.226	12.463	**0.0008**	1009
Res	14	103.6	7.4			
Total	17	380.28				

Term 'Su'

Groups	t	P(perm)	Unique perms	P(MC)
1, 2	0.57617	0.5977	16	0.5867
1, 3	3.3883	**0.0377**	15	0.0164
1, 4	8.301	**0.0168**	19	0.0002
2, 3	3.8421	**0.0167**	22	0.0057
2, 4	5.0468	**0.008**	19	0.0012
3, 4	0.12082	1	9	0.907

Univariate PERMANOVA for Shoot Count: PP-K09

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	55.083	18.361	1.1091	0.3847	1720
Res	12	198.67	16.556			
Total	15	253.75				

Univariate PERMANOVA for Shoot Count: PP-K11

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Su	3	191.4	63.799	1.4422	0.27	2325
Res	15	663.55	44.237			
Total	18	854.95				

Outer Transect - shoot count

All surveys

Regression Statistics	
Multiple R	0.1926
R Square	0.0371
Adjusted R Square	0.0246
Standard Error	8.7393
Observations	79.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	226.6348	226.6348	2.9674	0.0890
Residual	77.0000	5880.9095	76.3754		
Total	78.0000	6107.5443			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	11.8297	2.5722	4.5990	**0.0000**	6.7077	16.9516	6.7077	16.9516
75	0.0296	0.0172	1.7226	0.0890	-0.0046	0.0638	-0.0046	0.0638

Baseline 1

Regression Statistics	
Multiple R	0.1170
R Square	0.0137
Adjusted R Square	-0.0443
Standard Error	14.6487
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	50.6061	50.6061	0.2358	0.6334
Residual	17.0000	3647.9202	214.5835		
Total	18.0000	3698.5263			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	16.8689	8.8450	1.9072	0.0735	-1.7924	35.5301	-1.7924	35.5301
80	0.0248	0.0510	0.4856	0.6334	-0.0828	0.1323	-0.0828	0.1323

Baseline 2

Regression Statistics	
Multiple R	0.2788
R Square	0.0777
Adjusted R Square	0.0235
Standard Error	4.7217
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	31.9463	31.9463	1.4329	0.2477
Residual	17.0000	379.0011	22.2942		
Total	18.0000	410.9474			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	15.8958	2.8510	5.5755	**0.0000**	9.8807	21.9108	9.8807	21.9108
80	0.0197	0.0164	1.1971	0.2477	-0.0150	0.0543	-0.0150	0.0543

Baseline 3

Regression Statistics	
Multiple R	0.3827
R Square	0.1465
Adjusted R Square	0.0962
Standard Error	3.8987
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	44.3363	44.3363	2.9169	0.1059
Residual	17.0000	258.4005	15.2000		
Total	18.0000	302.7368			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	7.8073	2.3541	3.3165	**0.0041**	2.8407	12.7740	2.8407	12.7740
80	0.0232	0.0136	1.7079	0.1059	-0.0055	0.0518	-0.0055	0.0518

Baseline 4

Regression Statistics	
Multiple R	0.3827
R Square	0.1465
Adjusted R Square	0.0962
Standard Error	3.8987
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	44.3363	44.3363	2.9169	0.1059
Residual	17.0000	258.4005	15.2000		
Total	18.0000	302.7368			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	7.8073	2.3541	3.3165	**0.0041**	2.8407	12.7740	2.8407	12.7740
80	0.0232	0.0136	1.7079	0.1059	-0.0055	0.0518	-0.0055	0.0518

Outer Transect – leaf length

All surveys

Regression Statistics	
Multiple R	0.1801
R Square	0.0324
Adjusted R Square	0.0199
Standard Error	8.8035
Observations	79.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	200.1276	200.1276	2.5823	0.1122
Residual	77.0000	5967.5656	77.5009		
Total	78.0000	6167.6932			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	31.5099	2.5466	12.3732	**0.0000**	26.4389	36.5809	26.4389	36.5809
80	-0.0239	0.0149	-1.6069	0.1122	-0.0536	0.0057	-0.0536	0.0057

Baseline 1

Regression Statistics	
Multiple R	0.5482
R Square	0.3006
Adjusted R Square	0.2594
Standard Error	9.1672
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	613.9661	613.9661	7.3058	0.0151
Residual	17.0000	1428.6530	84.0384		
Total	18.0000	2042.6191			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	35.8536	5.5353	6.4773	**0.0000**	24.1752	47.5319	24.1752	47.5319
80	-0.0862	0.0319	-2.7029	0.0151	-0.1535	-0.0189	-0.1535	-0.0189

Baseline 2

Regression Statistics	
Multiple R	0.0661
R Square	0.0044
Adjusted R Square	-0.0542
Standard Error	3.9628
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	1.1715	1.1715	0.0746	0.7880

Residual	17.0000	266.9614	15.7036		
Total	18.0000	268.1330			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept		31.9133	2.3928	13.3375	**0.0000**	26.8650	36.9616	26.8650	36.9616
	80	-0.0038	0.0138	-0.2731	0.7880	-0.0329	0.0253	-0.0329	0.0253

Baseline 3

Regression Statistics	
Multiple R	0.1168
R Square	0.0136
Adjusted R Square	-0.0444
Standard Error	4.4793
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	4.7202	4.7202	0.2353	0.6338
Residual	17.0000	341.0900	20.0641		
Total	18.0000	345.8102			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept		20.7269	2.7046	7.6635	**0.0000**	15.0206	26.4332	15.0206	26.4332
	80	0.0076	0.0156	0.4850	0.6338	-0.0253	0.0404	-0.0253	0.0404

Baseline 4

Regression Statistics	
Multiple R	0.1011

R Square	0.0102
Adjusted R Square	-0.0480
Standard Error	6.8729
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	8.2900	8.2900	0.1755	0.6805
Residual	17.0000	803.0160	47.2362		
Total	18.0000	811.3060			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	36.8314	4.1499	8.8753	**0.0000**	28.0759	45.5869	28.0759	45.5869
80	-0.0100	0.0239	-0.4189	0.6805	-0.0605	0.0404	-0.0605	0.0404

Inner Transect - shoot count

All surveys

Regression Statistics	
Multiple R	0.262353
R Square	0.068829
Adjusted R Square	0.056736
Standard Error	14.12778
Observations	79

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1136.011	1136.011	5.691607	0.019504
Residual	77	15368.75	199.5941		

Total	78	16504.76

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	18.46698	3.611095	5.113957	**2.25E-06**	11.27637	25.65759	11.27637	25.65759
80	0.046721	0.019584	2.385709	**0.019504**	0.007725	0.085717	0.007725	0.085717

Baseline 1

Regression Statistics	
Multiple R	0.792396
R Square	0.627892
Adjusted R Square	0.606003
Standard Error	9.104223
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2377.66	2377.66	28.68561	5.24E-05
Residual	17	1409.077	82.88687		
Total	18	3786.737			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	44.44675	4.930447	9.014751	**6.92E-08**	34.04442	54.84908	34.04442	54.84908
80	-0.14756	0.027551	-5.35589	**5.24E-05**	-0.20569	-0.08943	-0.20569	-0.08943

Baseline 2

Regression Statistics	
Multiple R	0.739086
R Square	0.546249

Adjusted R Square	0.519558
Standard Error	10.15914
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2112.2	2112.2	20.46546	0.0003
Residual	17	1754.537	103.208		
Total	18	3866.737			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	13.98072	5.501741	2.541145	**0.021091**	2.373061	25.58838	2.373061	25.58838
80	0.13908	0.030744	4.523877	**0.0003**	0.074217	0.203943	0.074217	0.203943

Baseline 3

Regression Statistics	
Multiple R	0.67968
R Square	0.461965
Adjusted R Square	0.430315
Standard Error	9.51857
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1322.483	1322.483	14.59643	0.001368
Residual	17	1540.254	90.60318		
Total	18	2862.737			

		Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept		9.633917	5.154839	1.868907	0.078965	-1.24184	20.50968	-1.24184	20.50968
	80	0.110051	0.028805	3.820527	**0.001368**	0.049277	0.170824	0.049277	0.170824

Baseline 4

Regression Statistics	
Multiple R	0.660394
R Square	0.436121
Adjusted R Square	0.402951
Standard Error	9.174605
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1106.737	1106.737	13.1483	0.002087
Residual	17	1430.947	84.17337		
Total	18	2537.684			

		Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept		5.945616	4.836898	1.229221	0.235732	-4.25935	16.15058	-4.25935	16.15058
	80	0.083343	0.022984	3.626059	**0.002087**	0.03485	0.131835	0.03485	0.131835

Inner Transect – leaf length

All surveys

Regression Statistics	
Multiple R	0.193185

R Square	0.037321
Adjusted R Square	0.024818
Standard Error	5.771299
Observations	79

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	99.42717	99.42717	2.985093	0.088043
Residual	77	2564.708	33.3079		
Total	78	2664.135			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	30.59355	1.475158	20.73916	**2.99E-33**	27.65614	33.53097	27.65614	33.53097
80	-0.01382	0.008	-1.72774	0.088043	-0.02975	0.002108	-0.02975	0.002108

Baseline 1

Regression Statistics	
Multiple R	0.330882
R Square	0.109483
Adjusted R Square	0.0571
Standard Error	4.627191
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	44.74951	44.74951	2.090034	0.166446
Residual	17	363.9853	21.4109		
Total	18	408.7348			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	35.46575	2.505883	14.15299	**7.76E-11**	30.1788	40.7527	30.1788	40.7527
80	-0.02024	0.014003	-1.4457	0.166446	-0.04979	0.0093	-0.04979	0.0093

Baseline 2

Regression Statistics	
Multiple R	0.102886
R Square	0.010585
Adjusted R Square	-0.04762
Standard Error	2.75813
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1.383603	1.383603	0.181879	0.675115
Residual	17	129.3238	7.60728		
Total	18	130.7074			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	32.7244	1.493682	21.90855	**6.71E-14**	29.57301	35.87579	29.57301	35.87579
80	-0.00356	0.008347	-0.42647	0.675115	-0.02117	0.01405	-0.02117	0.01405

Baseline 3

Regression Statistics	
Multiple R	0.591043
R Square	0.349332
Adjusted R Square	0.311058

Standard Error	4.013251
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	147.0012	147.0012	9.127007	0.0077
Residual	17	273.8051	16.10618		
Total	18	420.8063			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	28.08988	2.1734	12.92439	**3.21E-10**	23.50441	32.67536	23.50441	32.67536
80	-0.03669	0.012145	-3.02109	**0.0077**	-0.06231	-0.01107	-0.06231	-0.01107

Baseline 4

Regression Statistics	
Multiple R	0.096969
R Square	0.009403
Adjusted R Square	-0.04887
Standard Error	4.041336
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.635529	2.635529	0.161368	0.692905
Residual	17	277.6508	16.3324		
Total	18	280.2863			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	25.77151	2.130613	12.09582	**8.91E-10**	21.27631	30.26671	21.27631	30.26671
80	0.004067	0.010124	0.401707	0.692905	-0.01729	0.025428	-0.01729	0.025428

Outer Transect - shoot count

All surveys

Regression Statistics	
Multiple R	0.1926
R Square	0.0371
Adjusted R Square	0.0246
Standard Error	8.7393
Observations	79.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	226.6348	226.6348	2.9674	0.0890
Residual	77.0000	5880.9095	76.3754		
Total	78.0000	6107.5443			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	11.8297	2.5722	4.5990	**0.0000**	6.7077	16.9516	6.7077	16.9516
75	0.0296	0.0172	1.7226	0.0890	-0.0046	0.0638	-0.0046	0.0638

Baseline 1

Regression Statistics	
Multiple R	0.1170
R Square	0.0137
Adjusted R Square	-0.0443
Standard Error	14.6487

Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	50.6061	50.6061	0.2358	0.6334
Residual	17.0000	3647.9202	214.5835		
Total	18.0000	3698.5263			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	16.8689	8.8450	1.9072	0.0735	-1.7924	35.5301	-1.7924	35.5301
80	0.0248	0.0510	0.4856	0.6334	-0.0828	0.1323	-0.0828	0.1323

Baseline 2

Regression Statistics	
Multiple R	0.2788
R Square	0.0777
Adjusted R Square	0.0235
Standard Error	4.7217
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	31.9463	31.9463	1.4329	0.2477
Residual	17.0000	379.0011	22.2942		
Total	18.0000	410.9474			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%

Intercept	15.8958	2.8510	5.5755	**0.0000**	9.8807	21.9108	9.8807	21.9108
80	0.0197	0.0164	1.1971	0.2477	-0.0150	0.0543	-0.0150	0.0543

Baseline 3

Regression Statistics	
Multiple R	0.3827
R Square	0.1465
Adjusted R Square	0.0962
Standard Error	3.8987
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	44.3363	44.3363	2.9169	0.1059
Residual	17.0000	258.4005	15.2000		
Total	18.0000	302.7368			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	7.8073	2.3541	3.3165	**0.0041**	2.8407	12.7740	2.8407	12.7740
80	0.0232	0.0136	1.7079	0.1059	-0.0055	0.0518	-0.0055	0.0518

Baseline 4

Regression Statistics	
Multiple R	0.3827
R Square	0.1465
Adjusted R Square	0.0962
Standard Error	3.8987
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	44.3363	44.3363	2.9169	0.1059
Residual	17.0000	258.4005	15.2000		
Total	18.0000	302.7368			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	7.8073	2.3541	3.3165	**0.0041**	2.8407	12.7740	2.8407	12.7740
80	0.0232	0.0136	1.7079	0.1059	-0.0055	0.0518	-0.0055	0.0518

Outer Transect – leaf length

All surveys

Regression Statistics	
Multiple R	0.1801
R Square	0.0324
Adjusted R Square	0.0199
Standard Error	8.8035
Observations	79.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	200.1276	200.1276	2.5823	0.1122
Residual	77.0000	5967.5656	77.5009		
Total	78.0000	6167.6932			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	31.5099	2.5466	12.3732	**0.0000**	26.4389	36.5809	26.4389	36.5809

80	-0.0239	0.0149	-1.6069	0.1122	-0.0536	0.0057	-0.0536	0.0057

Baseline 1

Regression Statistics	
Multiple R	0.5482
R Square	0.3006
Adjusted R Square	0.2594
Standard Error	9.1672
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	613.9661	613.9661	7.3058	0.0151
Residual	17.0000	1428.6530	84.0384		
Total	18.0000	2042.6191			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	35.8536	5.5353	6.4773	**0.0000**	24.1752	47.5319	24.1752	47.5319
80	-0.0862	0.0319	-2.7029	0.0151	-0.1535	-0.0189	-0.1535	-0.0189

Baseline 2

Regression Statistics	
Multiple R	0.0661
R Square	0.0044
Adjusted R Square	-0.0542
Standard Error	3.9628
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	1.1715	1.1715	0.0746	0.7880
Residual	17.0000	266.9614	15.7036		
Total	18.0000	268.1330			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	31.9133	2.3928	13.3375	**0.0000**	26.8650	36.9616	26.8650	36.9616
80	-0.0038	0.0138	-0.2731	0.7880	-0.0329	0.0253	-0.0329	0.0253

Baseline 3

Regression Statistics	
Multiple R	0.1168
R Square	0.0136
Adjusted R Square	-0.0444
Standard Error	4.4793
Observations	19.0000

ANOVA

	df	SS	MS	F	Significance F
Regression	1.0000	4.7202	4.7202	0.2353	0.6338
Residual	17.0000	341.0900	20.0641		
Total	18.0000	345.8102			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	20.7269	2.7046	7.6635	**0.0000**	15.0206	26.4332	15.0206	26.4332
80	0.0076	0.0156	0.4850	0.6338	-0.0253	0.0404	-0.0253	0.0404

Baseline 4

Regression Statistics	
Multiple R	0.1011
R Square	0.0102
Adjusted R Square	-0.0480
Standard Error	6.8729
Observations	19.0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.0000	8.2900	8.2900	0.1755	0.6805
Residual	17.0000	803.0160	47.2362		
Total	18.0000	811.3060			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	36.8314	4.1499	8.8753	**0.0000**	28.0759	45.5869	28.0759	45.5869
80	-0.0100	0.0239	-0.4189	0.6805	-0.0605	0.0404	-0.0605	0.0404

Outer Transect - shoot count

All surveys

Regression Statistics	
Multiple R	0.262353
R Square	0.068829
Adjusted R Square	0.056736
Standard Error	14.12778
Observations	79

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1136.011	1136.011	5.691607	0.019504
Residual	77	15368.75	199.5941		
Total	78	16504.76			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	18.46698	3.611095	5.113957	**2.25E-06**	11.27637	25.65759	11.27637	25.65759
80	0.046721	0.019584	2.385709	**0.019504**	0.007725	0.085717	0.007725	0.085717

Baseline 1

Regression Statistics	
Multiple R	0.792396
R Square	0.627892
Adjusted R Square	0.606003
Standard Error	9.104223
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2377.66	2377.66	28.68561	5.24E-05
Residual	17	1409.077	82.88687		
Total	18	3786.737			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	44.44675	4.930447	9.014751	**6.92E-08**	34.04442	54.84908	34.04442	54.84908
80	-0.14756	0.027551	-5.35589	**5.24E-05**	-0.20569	-0.08943	-0.20569	-0.08943

Baseline 2

Regression Statistics	
Multiple R	0.739086
R Square	0.546249
Adjusted R Square	0.519558
Standard Error	10.15914
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2112.2	2112.2	20.46546	0.0003
Residual	17	1754.537	103.208		
Total	18	3866.737			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	13.98072	5.501741	2.541145	**0.021091**	2.373061	25.58838	2.373061	25.58838
80	0.13908	0.030744	4.523877	**0.0003**	0.074217	0.203943	0.074217	0.203943

Baseline 3

Regression Statistics	
Multiple R	0.67968
R Square	0.461965
Adjusted R Square	0.430315
Standard Error	9.51857
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1322.483	1322.483	14.59643	0.001368

Residual	17	1540.254	90.60318		
Total	18	2862.737			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	9.633917	5.154839	1.868907	0.078965	-1.24184	20.50968	-1.24184	20.50968
80	0.110051	0.028805	3.820527	**0.001368**	0.049277	0.170824	0.049277	0.170824

Baseline 4

Regression Statistics	
Multiple R	0.660394
R Square	0.436121
Adjusted R Square	0.402951
Standard Error	9.174605
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1106.737	1106.737	13.1483	0.002087
Residual	17	1430.947	84.17337		
Total	18	2537.684			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	5.945616	4.836898	1.229221	0.235732	-4.25935	16.15058	-4.25935	16.15058
80	0.083343	0.022984	3.626059	**0.002087**	0.03485	0.131835	0.03485	0.131835

Outer Transect – leaf length

All surveys

Regression Statistics	
Multiple R	0.193185
R Square	0.037321
Adjusted R Square	0.024818
Standard Error	5.771299
Observations	79

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	99.42717	99.42717	2.985093	0.088043
Residual	77	2564.708	33.3079		
Total	78	2664.135			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	30.59355	1.475158	20.73916	**2.99E-33**	27.65614	33.53097	27.65614	33.53097
80	-0.01382	0.008	-1.72774	0.088043	-0.02975	0.002108	-0.02975	0.002108

Baseline 1

Regression Statistics	
Multiple R	0.330882
R Square	0.109483
Adjusted R Square	0.0571
Standard Error	4.627191
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	44.74951	44.74951	2.090034	0.166446
Residual	17	363.9853	21.4109		

Total	18	408.7348			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	35.46575	2.505883	14.15299	**7.76E-11**	30.1788	40.7527	30.1788	40.7527
80	-0.02024	0.014003	-1.4457	0.166446	-0.04979	0.0093	-0.04979	0.0093

Baseline 2

Regression Statistics	
Multiple R	0.102886
R Square	0.010585
Adjusted R Square	-0.04762
Standard Error	2.75813
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.383603	1.383603	0.181879	0.675115
Residual	17	129.3238	7.60728		
Total	18	130.7074			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	32.7244	1.493682	21.90855	**6.71E-14**	29.57301	35.87579	29.57301	35.87579
80	-0.00356	0.008347	-0.42647	0.675115	-0.02117	0.01405	-0.02117	0.01405

Baseline 3

Regression Statistics

Multiple R	0.591043
R Square	0.349332
Adjusted R Square	0.311058
Standard Error	4.013251
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	147.0012	147.0012	9.127007	0.0077
Residual	17	273.8051	16.10618		
Total	18	420.8063			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	28.08988	2.1734	12.92439	**3.21E-10**	23.50441	32.67536	23.50441	32.67536
80	-0.03669	0.012145	-3.02109	0.0077	-0.06231	-0.01107	-0.06231	-0.01107

Baseline 4

Regression Statistics	
Multiple R	0.096969
R Square	0.009403
Adjusted R Square	-0.04887
Standard Error	4.041336
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.635529	2.635529	0.161368	0.692905
Residual	17	277.6508	16.3324		
Total	18	280.2863			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	25.77151	2.130613	12.09582	**8.91E-10**	21.27631	30.26671	21.27631	30.26671
80	0.004067	0.010124	0.401707	0.692905	-0.01729	0.025428	-0.01729	0.025428

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Terrestrial
Freshwater
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Wildlife Schools and training

Heritage management
Aboriginal heritage
Historical heritage
Conservation management
Community consultation
Archaeological, built and landscape values

Environmental management and approvals
Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

Environmental offsetting
Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)