Centre for Tropical Water and Aquatic Ecosystem Research

Annual and Post Flood Seagrass Monitoring in Hervey Bay and the Great Sandy Marine Park - 2025

March 2026 | Report No. 26/16

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The report may be cited as

Rasheed M.A., van de Wetering C. and Smith T. 2026. Annual and Post Flood Seagrass Monitoring in Hervey Bay and the Great Sandy Marine Park - 2025. JCU Centre for Tropical Water & Aquatic Ecosystem Research, Publication 26/16, Cairns. 54 pp.

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This work was conducted by James Cook University, TropWATER and commissioned by the Queensland Department of the Environment, Tourism, Science and Innovation.

Acknowledgments:

This project was funded by the Queensland Government through the Department of the Environment, Tourism, Science and Innovation (DETSI) Healthy Waters Program. We wish to thank the many TropWATER, DETSI and Queensland Parks and Wildlife Service staff that helped put this project and report together.

1 KEY FINDINGS

- Seagrass meadows across Hervey Bay and the Great Sandy Strait have substantially recovered from flood related losses and are now at their best condition since post flood monitoring began in 2022.
- Overall trends based on all 12 sampling areas (across both Hervey Bay and Great Sandy Strait) are shown in Fig 1. below, with more detailed information on individual areas in the main report.
- Total seagrass extent within annual monitoring areas has increased by ~92% since 2022 and is now comparable to the historical pre-flood extent.
- Seagrass biomass has reached its highest level in the post-flood monitoring period, and percent cover remained similar to 2024, at around 16% across all blocks and sites.
- There was a marked increase in extent and density in intertidal seagrass areas within the Great Sandy Strait region between 2024 and 2025.
- Deeper subtidal seagrasses in Hervey Bay, having largely recovered in 2024, remained relatively stable, exhibiting natural variability typical of *Halophila*-dominated meadows.
- Seagrass in the intertidal/shallow subtidal areas in southern Hervey Bay between Burrum Heads and Point Vernon, while much improved, remained below historically recorded maximum extent.
- A lack of pre-flood seagrass monitoring, for the majority of seagrass areas in the years prior to the 2022 floods, substantially hampered the ability to assess the extent of recovery, with previous comparable data more than 20 years old.
- This annual monitoring program provides a scaled representative assessment of seagrasses in the region that will avoid similar problems in the future. Its continuation provides baselines, an ability to detect change, and the foundations to develop ecosystem health reporting and management.
- Improved seagrass condition has largely restored foraging habitat for dugongs and green turtles, and has likely seen the return of other seagrass related services such as fish nursery habitat, although population responses of associated fauna were not measured as part of this program.

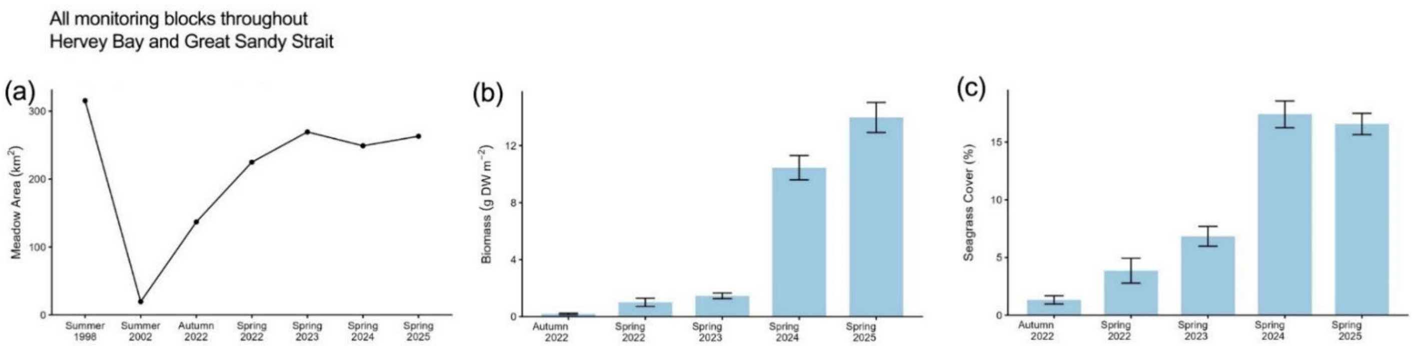

Figure 1: Overall Seagrass trends across all 12 monitoring blocks combined: (a) area in each survey including 1998; (b) Mean (± SE) seagrass biomass and; (c) percent seagrass cover (bottom) in Autumn 2022, Spring 2022, 2023, 2024 and 2025.

2 EXECUTIVE SUMMARY

Flooding of the Mary River and associated flood plumes in 2022 caused substantial declines in seagrass meadows and associated impacts to dugongs and green sea turtles in Hervey Bay and the Great Sandy Strait. In response, the Queensland Department of the Environment, Tourism, Science and Innovation (DETSI) partnered with James Cook University (JCU) to undertake a series of post-flood seagrass assessments across Hervey Bay and the Great Sandy Strait between 2022 and 2024 and develop a longer-term monitoring strategy to assess seagrass recovery and a basis for ongoing monitoring within the Great Sandy Marine Park (GSMP).

The long-term monitoring strategy is based on annual assessment of 12 representative monitoring areas spanning intertidal, shallow subtidal and deep-water habitats across key management zones within the marine park, ideally with periodic broadscale surveys of the entire GSMP (every 5 years) to align with regional dugong aerial surveys. This report details the findings of the second of these annual scale surveys conducted between October and November 2025.

By 2024 substantial gains in seagrass biomass and percent cover were recorded across much of the GSMP. The 2025 monitoring found seagrass meadows across the GSMP continued their recovery and are now in their best overall condition since post-flood monitoring began. Seagrass was recorded in all monitoring areas, with a total mapped area within the 12 monitoring blocks 92% greater than Spring 2022 and approaching the same extent recorded in historical surveys in 1998. Above-ground biomass reached its highest level across the monitoring period (average across all blocks 13.97 ± 1.05 g DW m^{-2}). There were differences in recovery between regions within the GSMP. Intertidal meadows in southern Hervey Bay between Burrum Heads and Point Vernon, while improving, still remained below their historical maximum extent. Assessing whether this represented a recovery from 2022 floods was hampered by a lack of recent pre-flood seagrass mapping, with the available pre-flood seagrass extent more than 20 years old.

The relatively rapid seagrass recovery between 2022 and 2025 was likely facilitated by a combination of a return of favourable benthic light conditions and the availability of seagrass propagules (both as adult plants and a sediment seed-bank) to facilitate recolonisation. Benthic light measured as part of this program across 2024 and 2025 showed light above (i.e. better than) thresholds to support growth of intertidal and shallow sub-tidal species for much of the year (e.g. *Halodule uninervis*, *Zostera muelleri*). In deeper areas within Hervey Bay, light was lower and more variable, corresponding with greater condition variability for these deeper *Halophila* dominated meadows.

The improved seagrass condition in 2025 is encouraging for the region's seagrass dependent dugongs and green sea turtles, and other species (e.g. fish and prawns) dependent on seagrass. The substantial seagrass recovery suggests that foraging resources for these species have largely been restored, although updated data are required to confirm corresponding megafauna population responses.

Continued annual monitoring is essential to establish reliable baselines and detect change to inform management decisions in the future. We recommend continuation of the seagrass monitoring approach adopted in 2024 and 2025 on an annual basis into the future, ideally with large scale surveys of the entire region every 5 years to synchronise with dugong aerial surveys. This will ensure the difficulties of assessing impact and recovery from the 2022 floods due to lack of pre-impact data are avoided in the future. The annual monitoring approach also supports development of reporting of ecosystem health and report cards but requires regular and consistent monitoring. The 5 years of data collected under this post flood program provides an ideal basis for this and is consistent with the existing regional report card seagrass methodology.

CONTENTS

3 INTRODUCTION

3.1 STUDY AREA

The Great Sandy Marine Park on the eastern subtropical coast of Australia, extends from Baffle Creek in the north to Double Island Point in the south. It encompasses the Bundaberg Coast, Hervey Bay, Great Sandy Strait, Tin Can Inlet and the waters seaward to three nautical miles off the east coast of K'gari (Figure 2). The marine environments are among the most biodiverse in Australia and in 2009 contributed to the recognition by UNESCO of the globally significant Great Sandy Biosphere (Ribbe 2014). The region also hosts the east coast's largest dugong population south of Torres Strait and six of the world's seven species of endangered and vulnerable marine turtles. Of these, loggerhead, green and flat-back turtles regularly nest along the region's foreshores.

Hervey Bay extends from the relatively narrow opening of the Great Sandy Strait in the south at Urangan and is bound by the Queensland coast on the western side north to Bundaberg and by K'gari (Fraser Island) on the eastern side with an opening of about 80 km width in the north (Figure 2). The average depth of the bay is approximately 20 m (Ribbe 2014). There are four main river catchments that influence the marine waters of Hervey Bay; the Mary, Burrum, Elliott and Burnett (Figure 2). These rivers discharge turbid flood waters during major flood events that establish a frontal structure along the western region of the bay with a recovery time of approximately 2 months (Ribbe 2014). Hervey Bay contains one of the largest expanses of deep-water (> 10 m) seagrasses on the east coast of Queensland (Rasheed et al. 2025; Lee Long et al. 1993), which support large numbers of dugongs (Preen and Marsh 1995, Sheppard et al. 2006, Sheppard et al. 2007) and green turtles (Hazel and Gyuris 2006), along with a range of other species (e.g. fish and prawns) which use and rely on seagrass habitats.

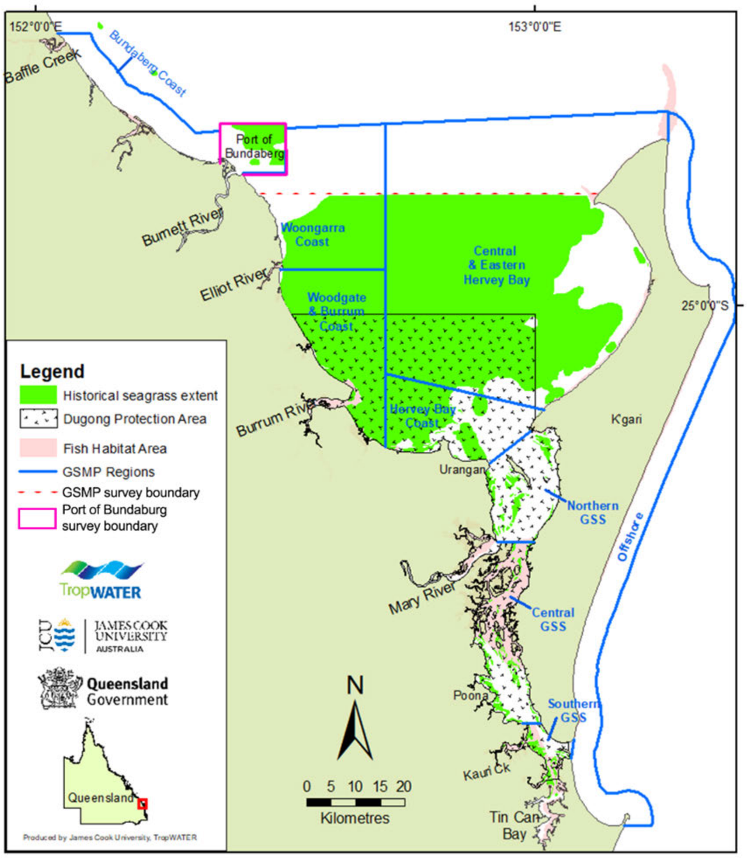

Figure 2. Map of the Great Sandy Marine Park.

The Great Sandy Strait is a sand passage estuary that encompasses an area of around 930 km^2 between the mainland and K'gari, from Urangan in the north to Tin Can Inlet in the south (Figure 2). The Mary River flows into the northern section of the Great Sandy Strait and the smaller catchments of Boonooroo Creek, Kauri Creek and Tin Can Estuary flow into the southern section (Figure 2). The Great Sandy Strait is the largest area of tidal swamps within the Southeast Queensland bioregion, consisting of intertidal sand and mud flats, extensive seagrass beds, mangroves, salt flats and saltmarshes. The region supports a wide range of migratory and other birds, fish, crustaceans, dugong, turtle and dolphins and in 1999 was listed as a Wetland of International Importance under the Ramsar agreement (RAMSAR 1999).

3.2 Seagrasses of the Great Sandy Marine Park

Historically, seagrass meadows in Hervey Bay and the Great Sandy Strait are extensive, covering up to ~2,350 km^2 (Rasheed et al 2025; Smith et al 2025). In Hervey Bay seagrass areas are dominated by deep-water communities of the colonising species *Halophila spinulosa*, *Halophila ovalis* and *Halophila decipiens* (Figure 3). Intertidal meadows also occur predominately on sand banks between Urangan and Burrum Heads and generally contain low-biomass assemblages of *Zostera muelleri* (syn. *Zostera capricorni*), *Halodule uninervis* and *H. ovalis* (Rasheed et al. 2025). Seagrasses in the Great Sandy Strait were first mapped in 1973 with six species including extensive dense meadows of *Cymodocea serrulata* on the western shore to the west of the Tin Can Bay and *Z. muelleri*, *H. uninervis* and *H. ovalis* dominating meadows along intertidal mudflats (Dredge 1977). A series of broad-scale seagrass mapping surveys in the 1990s and early 2000s using aerial photography, aerial and dive surveys combined with long-term monitoring transects found dynamic meadows that at their peak included dense *Z. muelleri* with *H. ovalis* meadows on the mud/sand banks throughout the region (Campbell and McKenzie 2003).

3.3 Recent monitoring, impacts and recovery of GSMP seagrasses

In early 2022 two significant flood events in January and February-March dispersed suspended sediments from the Mary River and other catchments into Hervey Bay and Great Sandy Strait (Bryant et al. 2024). The first event was driven by a rain depression brought by the remnants of tropical cyclone Seth with discharge in the Mary River at Home Park peaking at 663,655 ML day^{-1} on 9th January 2022. The second flood event saw discharge in the Mary River at Home Park peak at 657,944 ML day^{-1} on 28th February 2022. The plume was largely constrained to the mainland coast and Great Sandy Strait during January and extended further offshore into the southern and western regions of Hervey Bay during March (Lewis et al. 2022).

Concerns about the impact of the floods to seagrasses, dugongs and turtles led to JCU in collaboration with DETSI implementing a program to map and monitor the post-flood seagrass distribution in Hervey Bay and Great Sandy Strait in May 2022 (York et al. 2022, Bryant et al. 2023), October/November 2022 (Bryant et al. 2023) and again between August and November 2023 (Bryant et al. 2024). These surveys were the first time bay-wide seagrass distribution had been assessed in more than 20 years. In Hervey Bay, seagrass distribution three months after the flood (744 km^2) was less than a third of that found during historical (1998) surveys (2,307 km^2), and where seagrass existed, density was extremely low (York et al. 2022). In October 2022, nine months after the flood, seagrass distribution had increased significantly (1343 km^2), and by November 2023 total seagrass distribution in Hervey Bay (1700 ± 404 km^2) had increased to be almost 75% of the 1998 distribution. Average seagrass biomass and percent cover had increased significantly at subtidal and deep-water meadows, but the majority of intertidal seagrass remained low in density (around 1 to 2%). In the Great Sandy Strait, the total area of intertidal seagrass mapped from August to November 2023 (53 km^2) had more than tripled since the first post-flood survey in May 2022 (12 km^2) and was very similar to the total area of seagrass mapped in December 1998 (53 km^2). However, little sub-tidal seagrass remained, and seagrass biomass and cover remained well below historical levels for the majority of areas (Bryant et al. 2024).

Following the three large scale post flood assessments a longer-term monitoring strategy based on annual surveys of representative seagrass areas across the GSMP combined with benthic light (PAR) and benthic temperature monitoring was designed by JCU in collaboration with DETSI as a means of maintaining seagrass assessments at a scale to inform management without the necessity for remapping all seagrasses within the region each year (Bryant et al. 2024; Rasheed et al. 2025). The suggested design of this program also incorporates periodic re-surveying of the entire GSMP area approximately every 5 years ideally coinciding with scheduled dugong and green turtle assessments (Rasheed et al 2025). This report presents findings from the second of the annual scale assessments in the Great Sandy Marine Park conducted from October to November in 2025.

	***Zostera muelleri ssp capricorni*** • Narrow and wide leaf blades • 5 longitudinal veins and cross veins which form a mesh across the leaf blade • Rounded leaf tip • Leaf grows straight from the rhizome i.e. no shoots
	***Halodule uninervis*** • Narrow leaf blades 0.25-5mm wide • Trident leaf tip ending in three points • 1 central longitudinal vein which does not usually split into two at the tip • Usually pale ivory rhizome, with clean black leaf scars along the stem • Dugong preferred food
	***Halophila spinulosa*** • Fern like • Leaves arranged in opposite pairs • Erect shoot up to 15cm long • Found at subtidal depths
	***Halophila ovalis*** • Small oval shaped leaves (0.5 - 2cm long) • 8 or more cross-veins on leaf • No hairs on leaf surface • Dugong preferred food
	***Halophila decipiens*** • Small oval leaf blade (1-2.5cm long) • 6-8 cross veins • Leaf hairs on both sides • Found at subtidal depths
	***Cymodocea serrulata*** • Flat, strap-like leaves 5-9mm wide • Serrated leaf tip • Robust strong rhizome • 13-17 longitudinal veins • Leaves 6-15cm long
	***Syringodium isoetifolium*** • Cylindrical in cross section (spaghetti like) • Leaf tip tapers to a point • Leaves 7-30cm long • Found on shallow subtidal reef flats and sand banks

Figure 3: Seagrass species found in the Great Sandy Marine Park. *C. serrulata* and *S. isoetifolium* have not been observed in the region since 1998 and 2002 respectively (McKenzie and Campbell 2003).

4 METHODS

4.1 SAMPLING APPROACH

Our study area was bound in the north by a line connecting Bargara on the mainland to just north of Rooney Point on K'gari, and encompassed the area between the mainland and K'gari to the southern extent of the Great Sandy Strait including Tin Can Bay (Figure 4). A line between Urangan on the mainland and Moon Point on K'gari defined waters belonging to Hervey Bay (to the north) and Great Sandy Strait (to the south). The initial three post flood surveys covered the entirety of Hervey Bay and the intertidal regions of the Great Sandy Strait and in 2023 also included subtidal waters in the Great Sandy Strait (see York et al 2022; Bryant et al. 2023; 2024).

Within this broader area, 12 sampling "blocks" were selected for regular long-term monitoring (Figure 4) (Smith et al 2025). The most recent 2025 survey is the second long-term monitoring survey utilising survey blocks to represent the main seagrass species and community types and to track their response to future disturbances (Figure 4). In both the Hervey Bay and the Great Sandy Strait, blocks were chosen in areas where the general seagrass extent was consistent over previous surveys (since May 2022), in proximity to light loggers to monitor links between benthic light and seagrass growth, and in areas that were newly classified Marine National Park zones (MNPZ), Go slow area for turtles and dugongs (GSA), and within Conservation Park Zones (CPZ) (Figure 4). An additional block was selected outside of the Marine National Park Zone as a representative for deep-water seagrass in the General use zone (GUZ) for the 2024 survey. This block has since been discontinued from the program. In the Great Sandy Strait, an additional block was chosen in proximity to the Mary River mouth to track the effects of river flow on seagrasses, as well as an additional block in an area that has been noted as having high dugong activity. Subtidal blocks contained 16 sites, strategically spaced at intervals in a grid pattern to ensure statistical robustness. Sites within intertidal blocks were distributed across the banks in a stratified manner, with a higher density of sites near seagrass meadow boundaries and areas of species composition change. Within meadow boundaries, sites were allocated randomly at sufficient intensity to account for spatial variability in seagrass characteristics. An additional block surveyed in 2024 to the north of the Hervey Bay survey extent is not included in this report, as it was not surveyed in other years, or historical extents or the current survey.

The adopted sampling blocks encompassed seagrass meadows and areas that were representative of the different seagrass community types and ensured a spread of assessments across the major regions of the GSMP including coastal meadows in Hervey Bay, deep offshore meadows and large sections of seagrass within the Great Sandy Strait from south of the Urangan marina, across to K'Gari and south to Tin Can Bay (Figure 4).

For seagrass change comparisons between survey years, analysis was constrained to the same 12 survey block regions as the long-term monitoring strategy, when the sampling had surveyed broader areas (autumn 2022 and Spring 2022 & 2023).

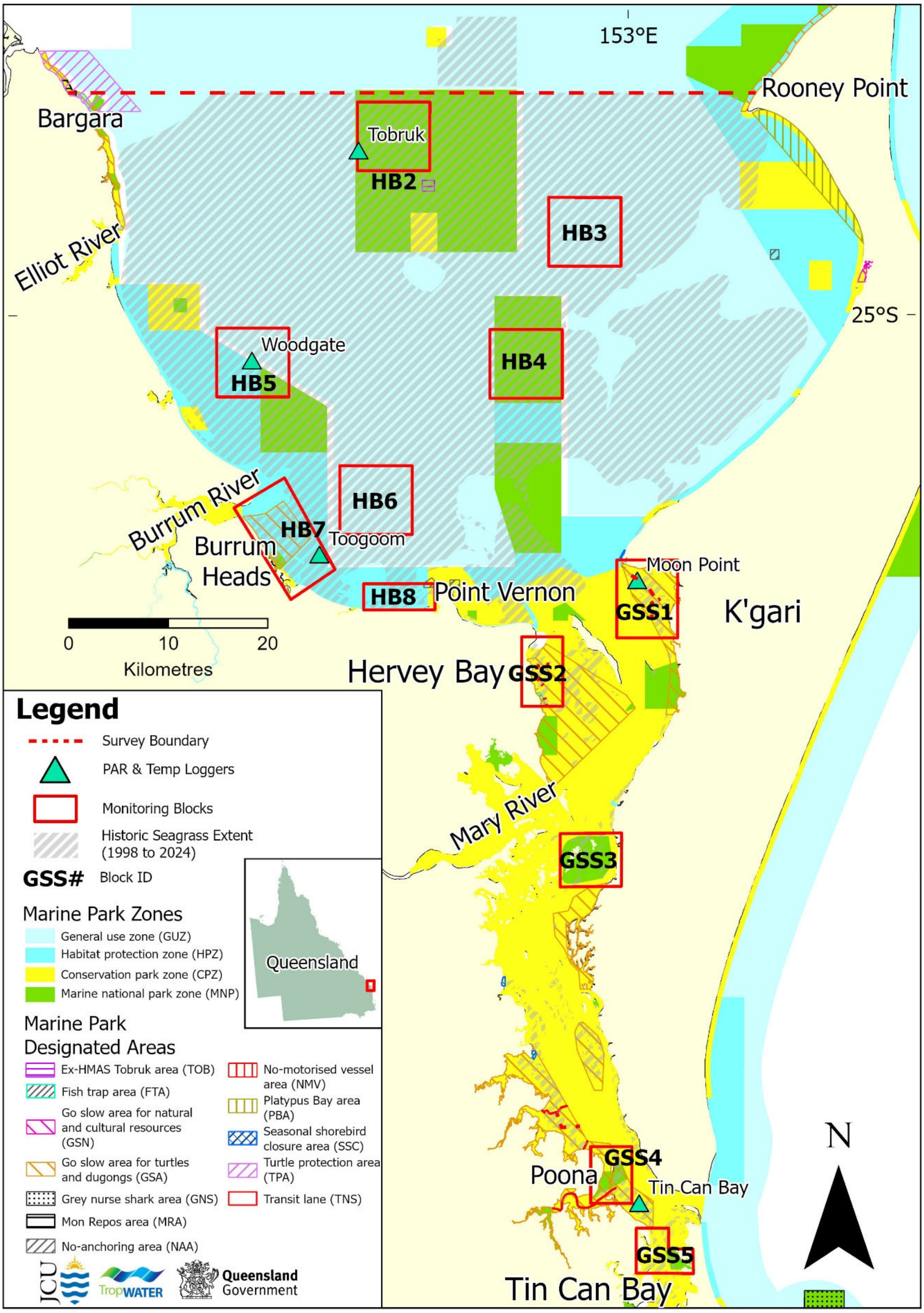

Figure 4. Location of seagrass monitoring blocks and water quality loggers in the Great Sandy Marine Park. Historical seagrass extent from Lee Long et al. 1992 and McKenzie 2017.

4.2 Sampling Methods

Methods for seagrass assessment followed previous surveys in the program and employed standard and extensively reviewed techniques applied for monitoring of seagrasses and benthic communities in Queensland. Techniques also take into account logistical issues associated with naturally high water turbidity and the presence of dangerous marine animals. Sampling methods were based on existing knowledge of benthic habitats and physical characteristics of the location such as depth, visibility and logistical and safety constraints.

Two sampling techniques were used (Figure 7):

1. Intertidal areas: Helicopter surveys at low tide;
2. Subtidal areas: Boat based underwater digital camera mounted on a drop frame.

Figure 5. Methods for mapping and monitoring seagrass for subtidal meadows using (A, B) digital camera mounted on a drop frame connected to CCTV, and for intertidal meadows (C) helicopter aerial surveillance.

At each survey site, seagrass habitat observations were recorded using JCU TropWATER's standard coastal benthic survey data sheet adapted to be compatible with the Queensland Intertidal and Subtidal Ecosystem Classification Scheme (Smith et al. 2025). Data recorded included seagrass species composition, above-ground biomass, seagrass percent cover, percent algal cover, depth below mean sea level (MSL), substrate composition time and position (GPS). The percent cover of other major benthos such as algae (erect macrophytes, calcareous, turf mat, filamentous), hard coral and soft coral at each site was also recorded.

Where seagrass was present, seagrass above-ground biomass was measured using a "visual estimates of biomass" technique (Kirkman 1978, Mellors 1991). At camera drop and helicopter sites this technique involved an observer ranking seagrass biomass within three randomly placed 0.25m^2 quadrats at each site (Figure 5A-C). Percent cover of seagrass and species composition was also recorded for each quadrat.

A photo/video record of quadrats for seagrass sites was also collected for subtidal sites and, when necessary, a Van-veen sediment grab was used to collect a sediment sample for visual classification as well as to confirm species viewed on the screen (Figure 6). For subtidal sites in addition to the 3 quadrat assessments the camera was set within a few metres of the bottom and allowed to drift for approximately 20m to pick up the presence of any sparsely distributed seagrass at the site. For the intertidal helicopter survey, seagrass species were confirmed using a rake dragged through the sediment to collect a sample (Figure 6).

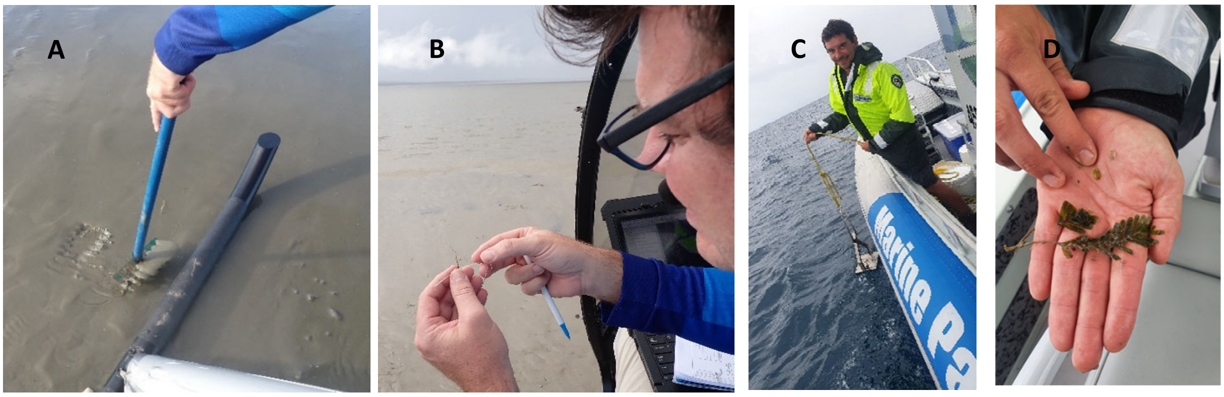

Figure 6. Collecting seagrass and sediment samples for species confirmation in Hervey Bay and Great Sandy Strait from a helicopter using a rake (A & B) and from a boat using a Van veen grab (C & D)

4.3 Geographic Information System

Survey data were entered into a Geographic Information System (GIS) using ArcPro 3.6.2®. Four GIS layers were created to describe seagrass in the survey area: a site layer, meadow layer, biomass interpolation layer and percent cover interpolation layer.

- *Site Layer:* The site (point) layer contains data collected at each site, including:
    - Site number
    - Temporal details – Survey date and time.
    - Spatial details – Latitude, longitude, depth below mean sea level (dbMSL; metres) for subtidal sites.
    - Habitat information – Sediment type; seagrass information including presence/absence, percentage cover, above-ground biomass (total and for each species) and biomass standard error (SE); dugong feeding trail (DFT) presence/absence.
    - Sampling method and any relevant comments.

- *Meadow layer:* The meadow (polygon) layer provides summary information for all sites within each meadow, including:
    - Meadow ID number – A unique number assigned to each meadow to allow comparisons among surveys
    - Temporal details – Survey date.
    - Habitat information – Mean meadow biomass ± standard error (SE), mean meadow percent cover, meadow area (hectares), number of sites within the meadow, seagrass species present, meadow community type and density (Tables 1 & 2), meadow landscape category (Figure 7).
    - Sampling method and any relevant comments.

- *Interpolation layers*: The interpolation (raster) layers describe spatial variation in seagrass biomass or percent cover across each meadow and were created using an inverse distance weighted (IDW) interpolation of seagrass site data within each meadow.

Seagrass meadow boundaries were determined from a combination of techniques. Exposed inshore boundaries were guided by recent satellite imagery of the region (Source: ESRI; Google Earth) and mapped directly during helicopter surveys at low tide. Subtidal boundaries were interpreted from a combination of subtidal survey sites and the distance between sites, field notes, depth contours and recent satellite imagery. Meadow area was measured using the calculate geometry function in ArcPRO®.

Table 1. Nomenclature for Queensland seagrass community types.

Community type	Species composition
Species A	Species A is 90-100% of composition
Species A with Species B	Species A is 60-90% of composition
Species A with Species B/Species C	Species A is 50% of composition
Species A/Species B	Species A is 40-60% of composition

Table 2. Density categories and mean above-ground biomass ranges for each species used in determining seagrass community density in Hervey Bay and the Great Sandy Strait.

Density	Mean above-ground biomass (g DW m^{-2})				
	H. uninervis (thin)	*H. ovalis* *H. decipiens*	*H. uninervis* (wide)	*H. spinulosa*	*Z. muelleri*
Light	< 1	< 1	< 5	< 15	< 20
Moderate	1 - 4	1 - 5	5 - 25	15 - 35	20 - 60
Dense	> 4	> 5	> 25	> 35	> 60

Isolated seagrass patches

The majority of area within the meadow consists of unvegetated sediment interspersed with isolated patches of seagrass.

Aggregated seagrass patches

The meadow consists of numerous seagrass patches but still features substantial gaps of unvegetated sediment within the boundary.

Continuous seagrass cover

The majority of meadow area consists of continuous seagrass cover with a few gaps of unvegetated sediment.

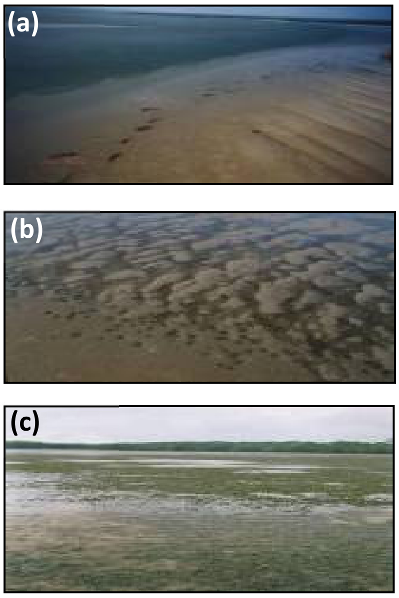

Figure 7. Seagrass meadow landscape categories: (a) Isolated seagrass patches, (b) aggregated seagrass patches, (c) continuous seagrass cover.

4.4 Statistical analyses

Seagrass percent cover and biomass were compared across surveys (Autumn 2022, Spring 2022, Spring 2023, Spring 2024, Spring 2025) using Generalised Linear Mixed Models (GLMM) and Generalised Linear Models (GLM) with Tweedie distributions. GLM was preferred to Generalised Additive Models because there are only 5 survey time points which could lead to model overfitting and misrepresentation of the data. Tweedie distributions are suitable for skewed, non-negative data such as biomass and cover data from Hervey Bay. Tweedie distributions were used with a log link and the optimal power which is calculated for each model depending on the data distribution. A separate GLMM was conducted for each of: (i) overall seagrass biomass and percent cover (all blocks and regions combined); (ii) deep-water and (iii) shallow water blocks in Hervey Bay; and (iv) blocks in the Great Sandy Strait. For the GLMM analysis survey was treated as a categorical predictor variable and sampling block as a random variable. Block HB1 was removed from analysis for overall and Hervey Bay deep-water biomass and cover because it was only surveyed in 2024. Changes in seagrass biomass and percent cover between surveys in each block were analysed using a GLM where survey was the only predictor variable. Plots of model residuals and q-q plots of normalised results were inspected for each analysis to determine if the model was appropriate. Analysis of variance (ANOVA) was used to determine overall model significance and post hoc Tukey's tests were used to determine differences between surveys. Changes in seagrass area across the survey, in Hervey Bay and the Great Sandy Strait and within each block was presented visually because there is no replication and therefore no analysis can be done. Seagrass area data from surveys in 1998 (McKenzie 2017) and 2002 (Campbell and McKenzie 2024) were also included where possible to provide historical context of seagrass condition in the current survey. Direct comparison of seagrass biomass and percent cover could not be done between these surveys and more recent surveys due to differences in survey methods. All analysis was done in R studio using the packages *glmmTMB*, *statmod*, *tweedie*, *ggplot2*, *performance*, *DHARMa* and *emmeans*.

4.5 Monitoring of Benthic Photosynthetically Active Radiation (PAR)

For seagrass, direct measurements of benthic PAR are preferable to measuring TSS or Secchi depth as PAR is more directly relevant to seagrass health and can be measured continuously at relatively low cost. Seagrasses respond to the cumulative PAR that reaches their leaves and having continuous data collected at the seafloor where they grow provides essential context to the light they receive and how this relates to ecologically relevant light thresholds that supports their growth (Rasheed et al 2025).

4.6 Site Selection

Benthic light and temperature monitoring equipment was initially deployed at a subtidal site offshore from Toogoom just south of Burrum Heads in May 2022 (Figure 4, above). The equipment was deployed over bare sediment in shallow subtidal waters that have historically supported patchy high biomass *H. spinulosa* and *H. ovalis* seagrasses. The station is also located near existing shallow subtidal *H. uninervis* meadows. Two additional benthic PAR and temperature monitoring stations were added to the monitoring program in June 2023, in deep-water offshore from Woodgate and Tobruk (Figure 4). The Woodgate monitoring site was established at the periphery of the deep-water meadow where *H. decipiens* had recolonised after flood related losses in 2022 (Bryant et al. 2023). The Tobruk monitoring site was established in deeper water near seagrass (*H. spinulosa*) biomass hot spots detected in November 2022 (Bryant et al. 2023). In late November 2023 two more monitoring sites were established in the shallow waters of Moon Point and Kauri Creek which support *Z. muelleri* and *H. ovalis* seagrasses. The addition of these two sites also allowed a greater understanding of the light conditions within the Great Sandy Strait.

4.7 Methods and Equipment

Submersible OdysseyTM photosynthetic irradiance autonomous loggers (light loggers) were deployed with automatic wiper units which clean the optical surface of the sensor every 15 minutes to prevent marine organisms fouling the sensors (Figure 8). At each location, two independent light loggers and wiper units were deployed on the seabed in two separate deployment cradles connected to a surface float. The presence of dual loggers reduces the risk of data loss through unit malfunction, fouling or disturbance during the three months between equipment exchange and download. Equipment was changed out and downloaded approximately every three months.

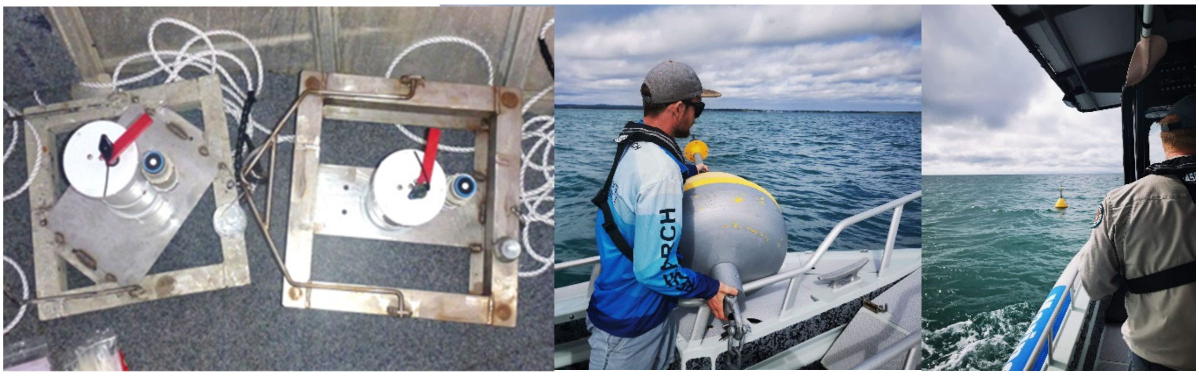

Figure 8. Deploying continuously logging PAR equipment in Hervey Bay May 2022.

Odyssey loggers logged a cumulative reading at 15 minute intervals, which was calibrated and summed to gain total daily benthic light (mol m^{-2} day^{-1}). The raw data captured by the loggers required calibrating to a known light value. Sensors were calibrated against a certified reference irradiance sensor (LI-CORTM LI-192SB Underwater Quantum Sensor) in controlled laboratory conditions. A custom built calibration device held the light loggers a consistent distance from the source light and excluded all external light. To allow for the differences in light absorption properties between air (calibration medium) and water (deployment media), a multiplication factor of 1.33 was applied to data. Following retrieval from the field, a report on the condition and appearance of each data logger was made to identify any fouling of the sensor or issues with the wiping apparatus.

4.8 Analysis

After downloading, the data was adjusted using the most recent calibration factor for each logger and adjusted for submersion (see methods above). The adjusted data was used to calculate a total daily benthic light value for each logger.

At each site the two loggers were compared to determine if there were any significant differences (>20%) in total daily light value. A distance of 10 m can cause loggers to differ substantially during exposure and submersion events due to natural environmental variation, for some sites the distance between loggers meant that differences in excess of 20% were common.

Where failures of one unit were obvious, data was removed from the record (e.g. where a logger failed to record data or where there were exceptionally high readings outside of possible light levels). Data was also removed when fouling had occurred resulting in significantly decreased light readings. If both loggers were deemed to be recording accurately and loggers agreed (difference <20%), the two were averaged and a mean total daily light value was calculated. Where there were no obvious malfunctions and units disagreed by more than 20% in one day, the data for the unit recording the higher value was used as it is more likely to be reading within the 5% error margin for that logger. The lower of the two was considered more likely to have been affected by physical disturbances such as shading by floating debris.

5 RESULTS

5.1 Overall Seagrass Condition

For this round of seagrass sampling across Hervey Bay and the Great Sandy Strait, a total of 415 sites were surveyed within the 12 monitoring blocks (Figure 9). Seagrass was recorded in 67% of sites surveyed and occurred in all monitoring blocks. Across the survey, five seagrass species were recorded: *Z. muelleri*, *H. uninervis*, *H. spinulosa*, *H. ovalis* and *H. decipiens*. Deep-water blocks in Hervey Bay consisted primarily of the three *Halophila* species, while *Z. muelleri* dominated the shallow and intertidal blocks of southern Hervey Bay and the Great Sandy Strait, along with smaller contributions from *H. uninervis*, *H. ovalis*, *H. spinulosa* and *H. decipiens*.

Seagrass biomass at sites within the blocks ranged from 0 to 92 g DW m^{-2}, and percent cover ranged from 0 to 80%. Across the twelve monitoring blocks, total seagrass area was 263 km^2, exceeding that recorded in Spring 2024 (249 km^2) but remaining below the historical maximum of 315 km^2 recorded in 1998 (Figure 12, Table 3). The smallest seagrass area occurred in Autumn 2022 (137 km^2), followed by Spring 2022 (225 km^2) (Figure 10).

Overall seagrass condition in 2025 was the best recorded since the 2022 flooding event, with the highest biomass recorded ($\chi^2(4) = 527.32$, $p < 0.0001$). Percent cover and area had reached their peak in 2024, significantly higher than previous years ($p \leq 0.0036$) but not significantly different with 2025 ($p = 0.947$) (Figure 10, Table 3–5). This indicates that seagrasses had become larger/taller rather than increased in % cover between 2024 and 2025. Mean seagrass biomass in 2025 was 13.97 ± 1.05 g DW m^{-2}, a 635% increase since Spring 2023 and an order-of-magnitude increase relative to Autumn 2022. Mean seagrass cover in 2025 was 16.6 ± 0.9%, approximately four times that recorded in Spring 2022.

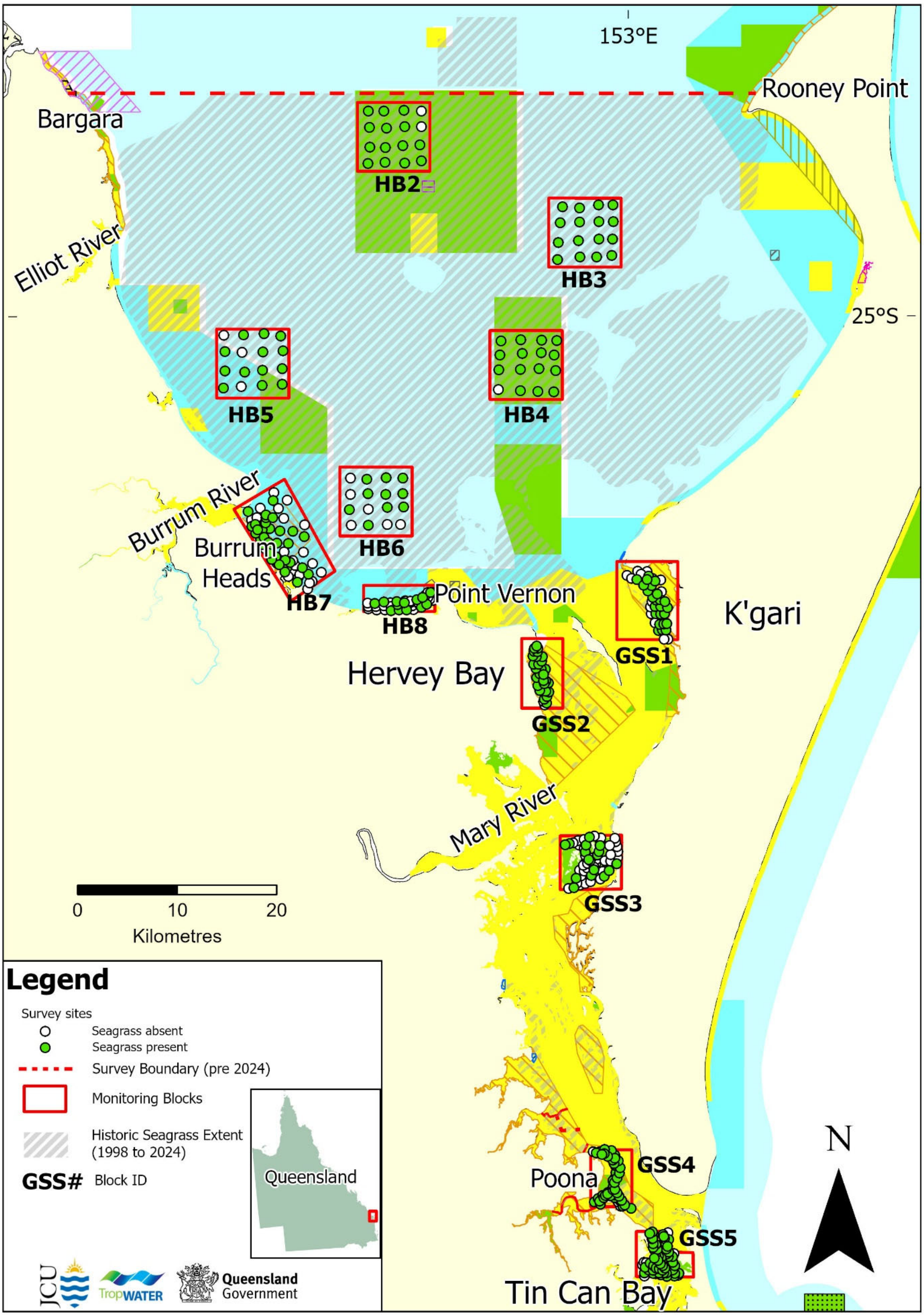

Figure 9. Seagrass monitoring sites with seagrass presence (green dots) or absent (white dots) in each monitoring block in the 2025 survey.

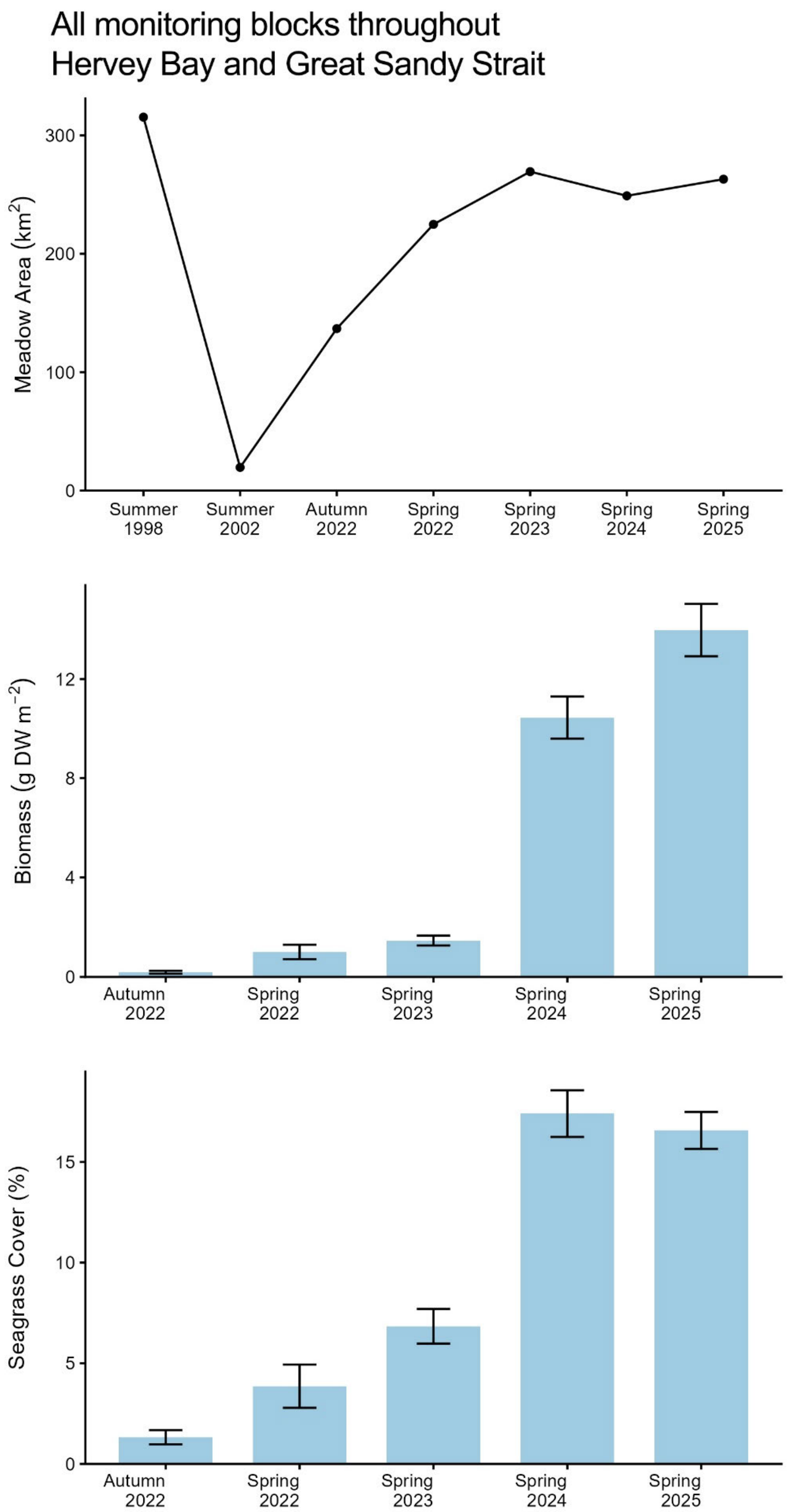

Figure 10. Seagrass area (top) across all 12 monitoring blocks combined in each survey including 1998. Mean (± SE) seagrass biomass (middle) and percent seagrass cover (bottom) in all blocks combined during surveys in Autumn 2022, Spring 2022, 2023, 2024 and 2025.

5.2 HERVEY BAY REGION

5.2.1 Hervey Bay Deep-water (>10m dbMSL) Blocks (HB2 – HB6)

Five deep-water monitoring blocks were surveyed in Hervey Bay (HB2 – HB6) (Figure 11–18). A total of 80 sites were sampled across the five blocks, of which 85% contained seagrass. Seagrass area in the deep-water survey blocks in 2025 was 216.5 km^2, almost double the lowest area recorded in Autumn 2022 immediately following the flooding event, when only 120.77 km^2 of seagrass was mapped within the same blocks (Figure 13). Seagrass area recovered rapidly by Spring 2022 to 207.19 km^2 and has remained relatively stable since then (Figure 12).

Mean seagrass biomass of deepwater seagrasses in 2025 was 4.28 ± 0.48 g DW m^{-2}, significantly higher than in Autumn 2022 (0.82 ± 0.38 g DW m^{-2}) ($\chi^2(4) = 25.168$, $p < 0.0001$). Similarly, mean seagrass cover in 2025 was 13.4 ± 1.4%, significantly higher than 5.30 ± 2.4% in Autumn 2022 ($\chi^2(4) = 19.771$, $p = 0.0006$).

Together, these results showed that overall there was a rapid recovery in deep-water seagrass condition following the 2022 flood disturbance, with biomass and cover returning to higher levels by Spring 2022 and remaining relatively stable through to 2025.

Deep-water blocks were dominated by *Halophila* species, with *H. spinulosa*, *H. ovalis* and *H. decipiens* recorded throughout (Figure 15). The prevalence of these species is consistent with previous surveys.

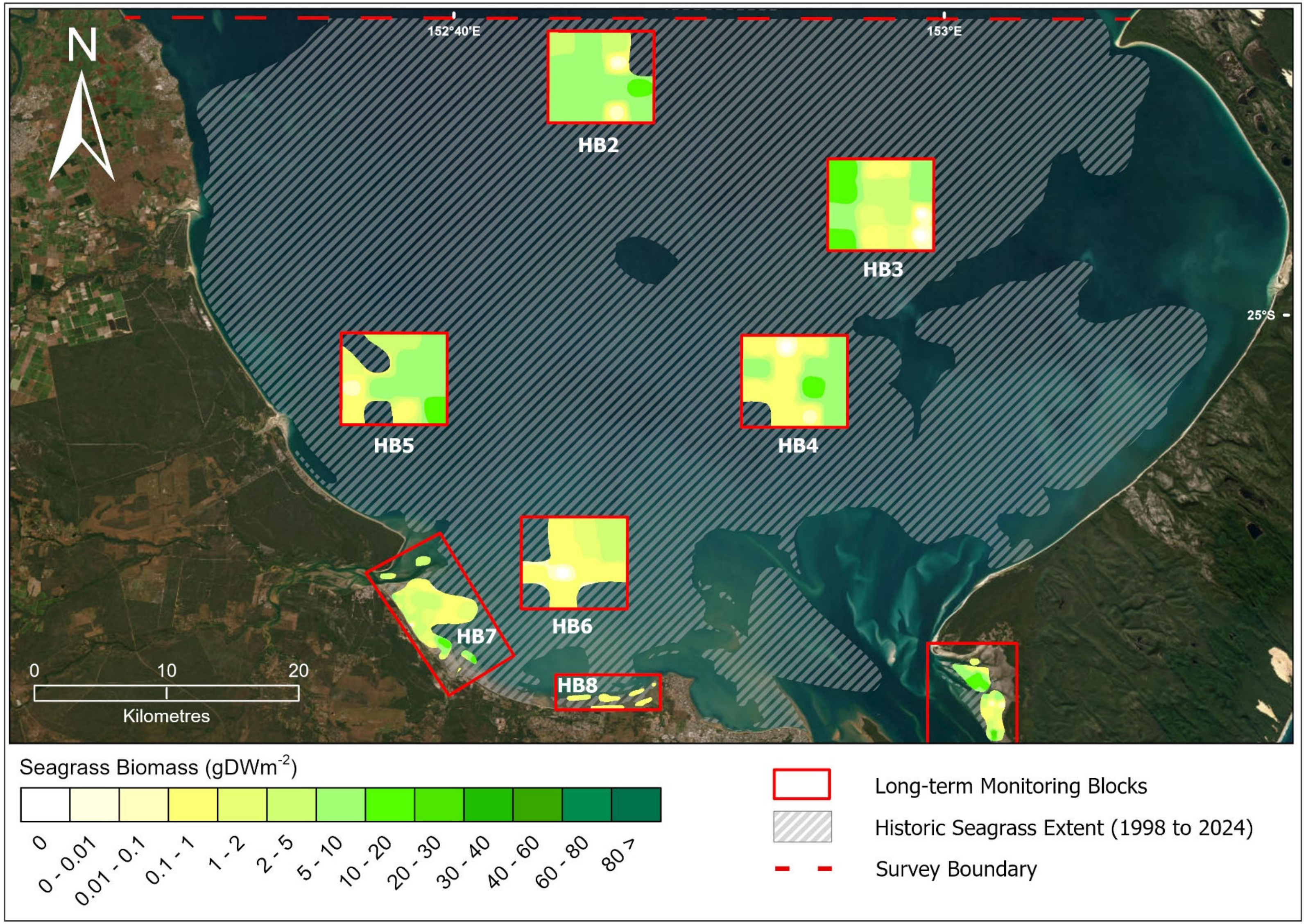

Figure 11. Seagrass biomass across deep and shallow monitoring blocks in Hervey Bay in 2025.

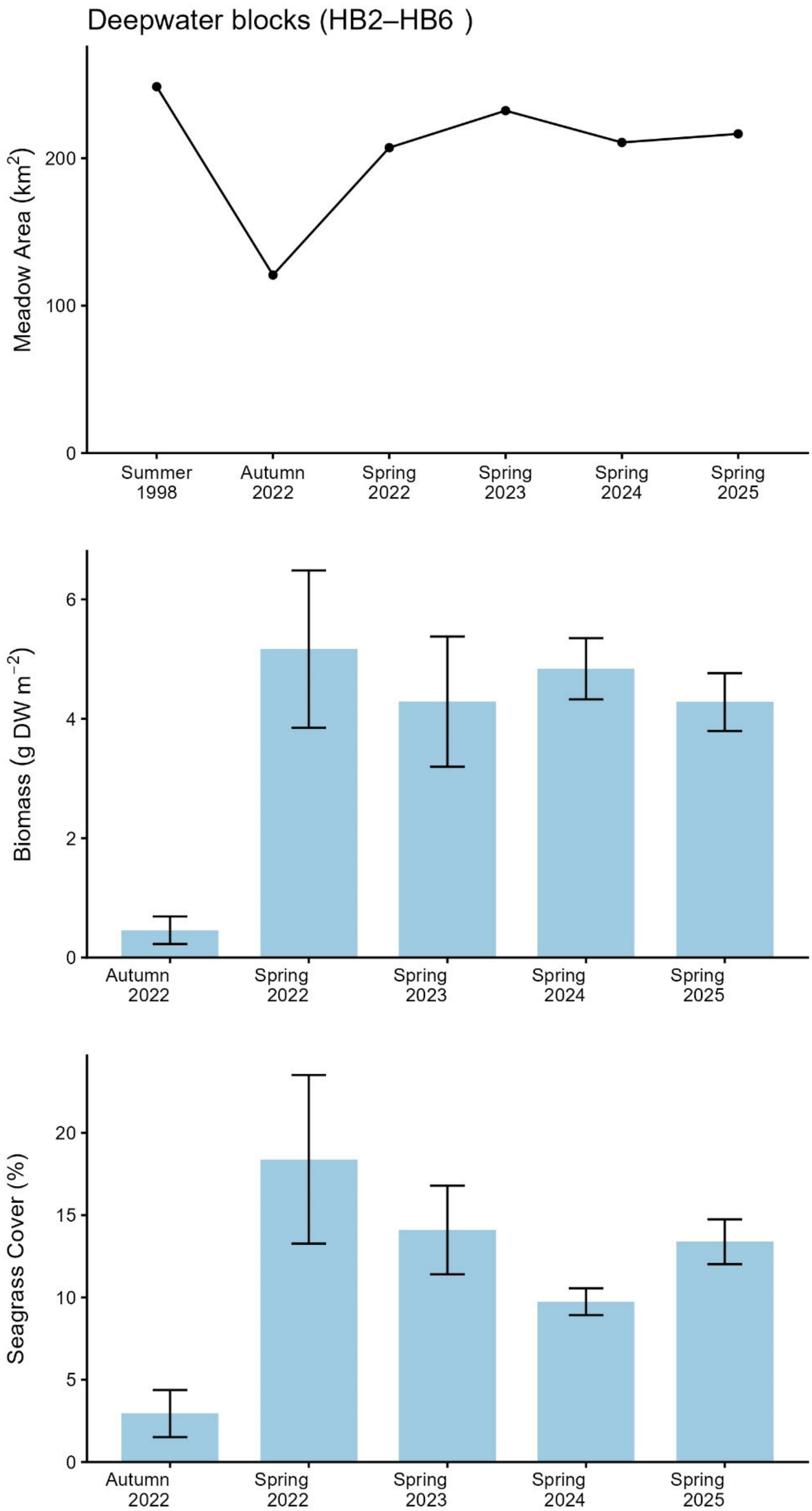

Figure 12. Area of seagrass meadows (top) from deep-water blocks in Hervey Bay in Spring 2025. Mean (±SE) of seagrass biomass (middle) and percent cover (bottom) in seagrass meadows in deep-water monitoring blocks in Hervey Bay across surveys in Autumn 2022, Spring 2022, 2023, 2024 and 2025.

5.2.1.1 Block HB2

Monitoring block HB2 is located in the centre of Hervey Bay at 20–31 metres depth and has the highest biomass and percent cover of seagrass among the deep-water monitoring blocks (Figure 4). Seagrass was recorded at 88% of sites within the block and was dominated by *H. spinulosa*, with *H. ovalis* and *H. decipiens* also present (Figure 13). Seagrass covered an area of 44.7 km² within the block (Figure 14; Table 3), which was lower than all previous surveys (Table 3). Seagrass condition in HB2 recovered quickly following the 2022 disturbance.

Mean seagrass biomass in 2025 was 6.39 ± 0.95 g DW m^{-2}, ranging from 0.05 to 10.6 g DW m^{-2} at individual sites (Figure 14; Table 4). Mean seagrass cover was 18.9 ± 2.5%, ranging from 0 to 27.6% at sites. HB2 has consistently supported the highest biomass and cover among the deep-water monitoring blocks across the five post-flood surveys (Figure 14; Table 4–5).

Biomass was significantly lower in the immediate post flood survey in Autumn 2022 than all subsequent surveys ($p \leq 0.0025$), where no significant differences were recorded (all $p \geq 0.073$) indicating that biomass in HB2 recovered rapidly following the 2022 disturbance and has remained relatively stable since. Percent cover in Spring 2022 was significantly higher than not only Autumn 2022 ($p = 0.0002$) but also higher than more recent surveys in spring 2024 ($p < 0.0001$) and spring 2025 ($p = 0.0010$).

5.2.1.2 Block HB3

HB3 is located in the central region of Hervey Bay, with sites ranging from 18–25 m depth (Figure 4). Seagrass was recorded at all survey sites within the block and consisted of *H. spinulosa* and *H. ovalis*, consistent with previous surveys (Figure 15). In Autumn 2022, seagrass covered just under half of the block (23.66 km²), but in all subsequent surveys seagrass extended across the full monitoring area (Figure 15; Table 3).

Mean seagrass biomass in HB 3 in 2025 was 4.91 ± 1.22 g DW m^{-2}, ranging from 0 to 14.4 g DW m^{-2} at individual sites (Figure 18; Table 4). Biomass was generally higher in later surveys compared to Autumn 2022 and significantly higher in Spring 2022 and 2024 ($p = 0.044$). Seagrass cover in 2025 ranged from 0 to 40% at sites, with a mean of 13.9 ± 3.5% (Table 5). Although the highest cover was observed in Spring 2022, statistical analysis indicated no significant differences in cover among surveys (all $p \geq 0.79$) (Figure 18; Table 5).

HB3 recovered rapidly in spatial extent following the 2022 disturbance, but has displayed a high variability in biomass and cover since then, which is typical for *Halophila*-dominated meadows

5.2.1.3 Block HB4

HB4 is located in the central region of Hervey Bay at depths ranging from 16 to 21 m (Figure 4). Seagrass was recorded in 94% of survey sites (Figure 13). *Halophila spinulosa* was the dominant seagrass species, accompanied by *H. ovalis* and *H. decipiens* (Figure 12). Seagrass covered 46.4 km² and has remained relatively similar between all surveys (Figure 16; Table 3).

Seagrass biomass for HB4 was 3.76 ± 1.05 g DW m^{-2} and cover 9.7% in 2025 (Figure 16; Table 4). Biomass and percent cover were significantly lower in the immediate post flood survey in 2022 than for all subsequent surveys ($p \leq 0.0005$) (Figure 16; Table 5) but since that time has shown considerable variability between surveys, typical of deep water *Halophila* communities.

5.2.1.4 Block HB5

HB5 is located on the western side of Hervey Bay, closer to the mainland than blocks HB 2–4, at depths of 9 to 16 m (Figure 4). Seagrass was recorded at 81% of sites in HB5, with all three *Halophila* species represented (Figure 17). No seagrass was recorded in this block in Autumn 2022 immediately post flood; however seagrass area recovered quickly by the next survey in Spring 2022 and has remained relatively stable since then with a substantial spatial extent in 2025 of 41 km² (Figure 17; Table 3).

Seagrass biomass and cover in this block have recovered steadily in each survey since 2022. In 2025 both were the highest recorded since monitoring began, with a mean biomass of 4.61 ± 0.96 g DW m^{-2} (ranging from 0 to 12.6 g DW m^{-2} at individual sites) and cover of 16.7% (Figure 17; Table 4) and significantly higher than in the early post flood surveys ($p = 0.0001$ biomass and $p < 0.0001$ cover).

Species composition has varied across surveys, with only *H. decipiens* present in 2022, *H. spinulosa* and *H. ovalis* dominant in 2023, a more even representation of all three species in 2024, and a near equal split between *H. spinulosa* and *H. ovalis* in 2025 (Figure 17).

5.2.1.5 Block HB6

HB6 is the most southern deep-water monitoring block and the closest to the Burrum River and mouth of the Great Sandy Strait (Figure 4). Seagrass was recorded at 63% of sites within the block and consisted predominantly of *H. decipiens*, with some *H. ovalis* and *H. spinulosa*, consistent with previous surveys (Figure 13). Seagrass covered 33.7 km² in 2025, higher than the first 2022 survey post flood and similar to all subsequent surveys. Area for this block remains below the highest historically recorded extent of 50.24 km² in 1998 (Figure 18; Table 3).

Seagrass biomass in HB6 ranged from 0 to 3.07 g DW m^{-2}, with a mean of 0.99 ± 0.31 g DW m^{-2} (Figure 18; Table 4). Biomass has been higher in all subsequent surveys than the Autumn 2022 post flood survey but has displayed considerable variability since that time with no significant differences recorded ($p \geq 0.0608$). Similarly, no significant differences in percent cover were detected among surveys (all $p \geq 0.0723$), although mean cover was substantially higher in all surveys subsequent to the immediate post flood survey.

Species composition in HB6 was dominated by *H. decipiens*, with *H. ovalis* and *H. spinulosa* comprising the remainder (Figure 18). The continued dominance of *H. decipiens* is consistent with low light conditions having the lowest light requirement of all the *Halophila* species.

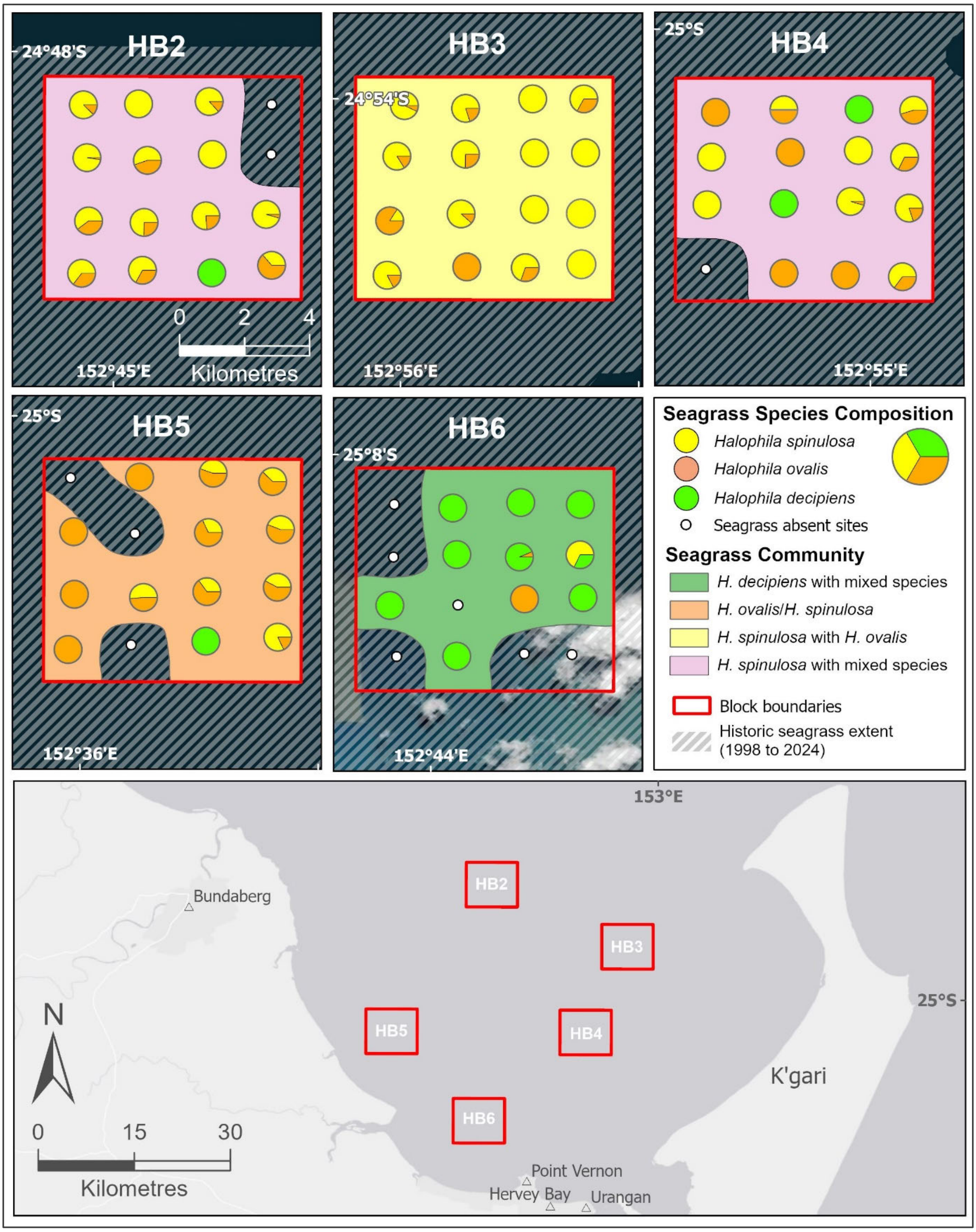

Figure 13. Seagrass site and meadow location and species composition in the blocks HB2, HB3, HB4, HB5 and HB6 in the deep-water monitoring blocks Hervey Bay.

Hervey Bay Subtidal Block (HB2)

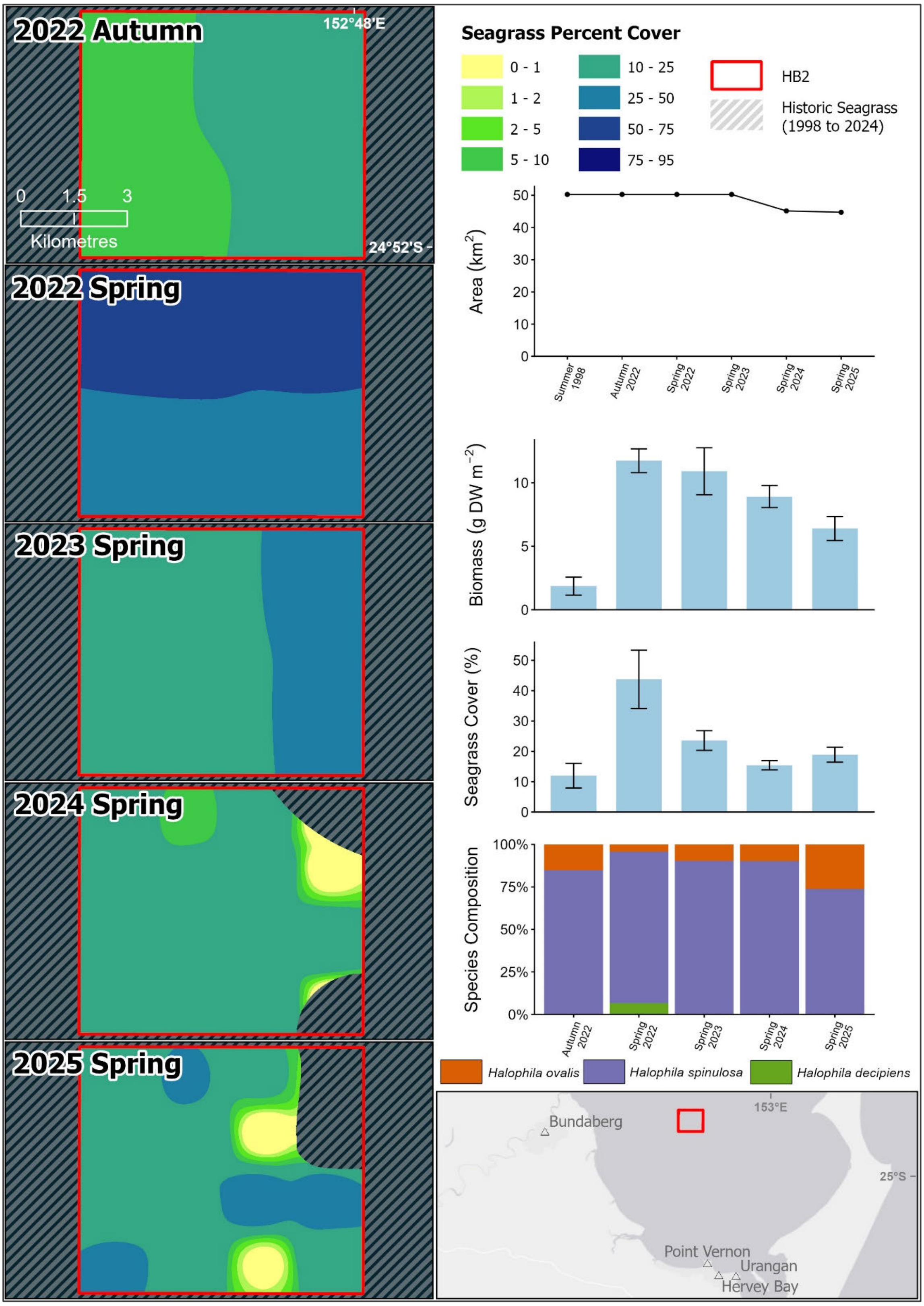

Figure 14. Seagrass area and percent cover in monitoring block HB2 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in HB2 each survey (right side). Block location is at the bottom right.

Hervey Bay Subtidal Block (HB3)

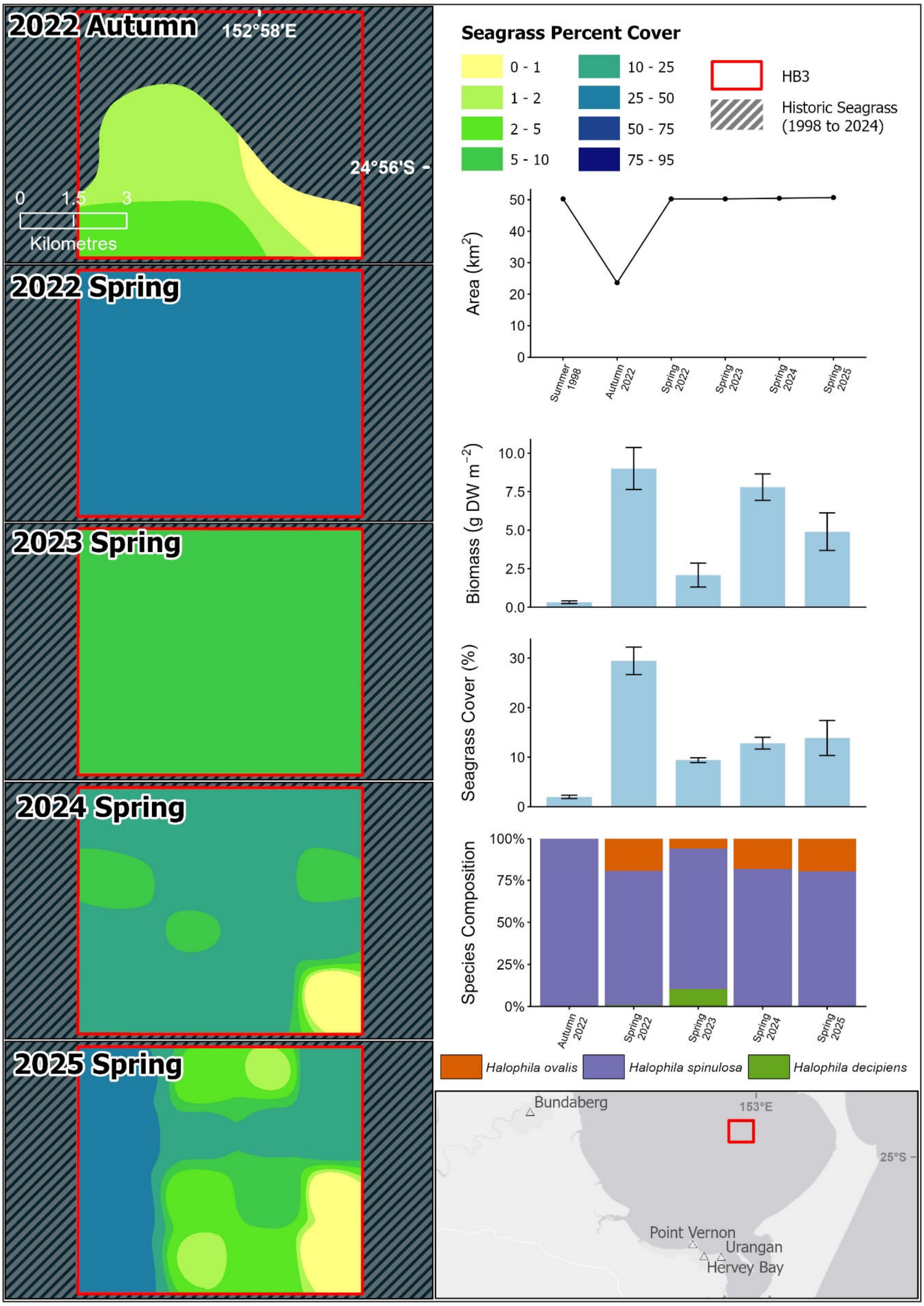

Figure 15. Seagrass area and percent cover in monitoring block HB3 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in HB3 each survey (right side). Block location is at the bottom right.

Hervey Bay Subtidal Block (HB4)

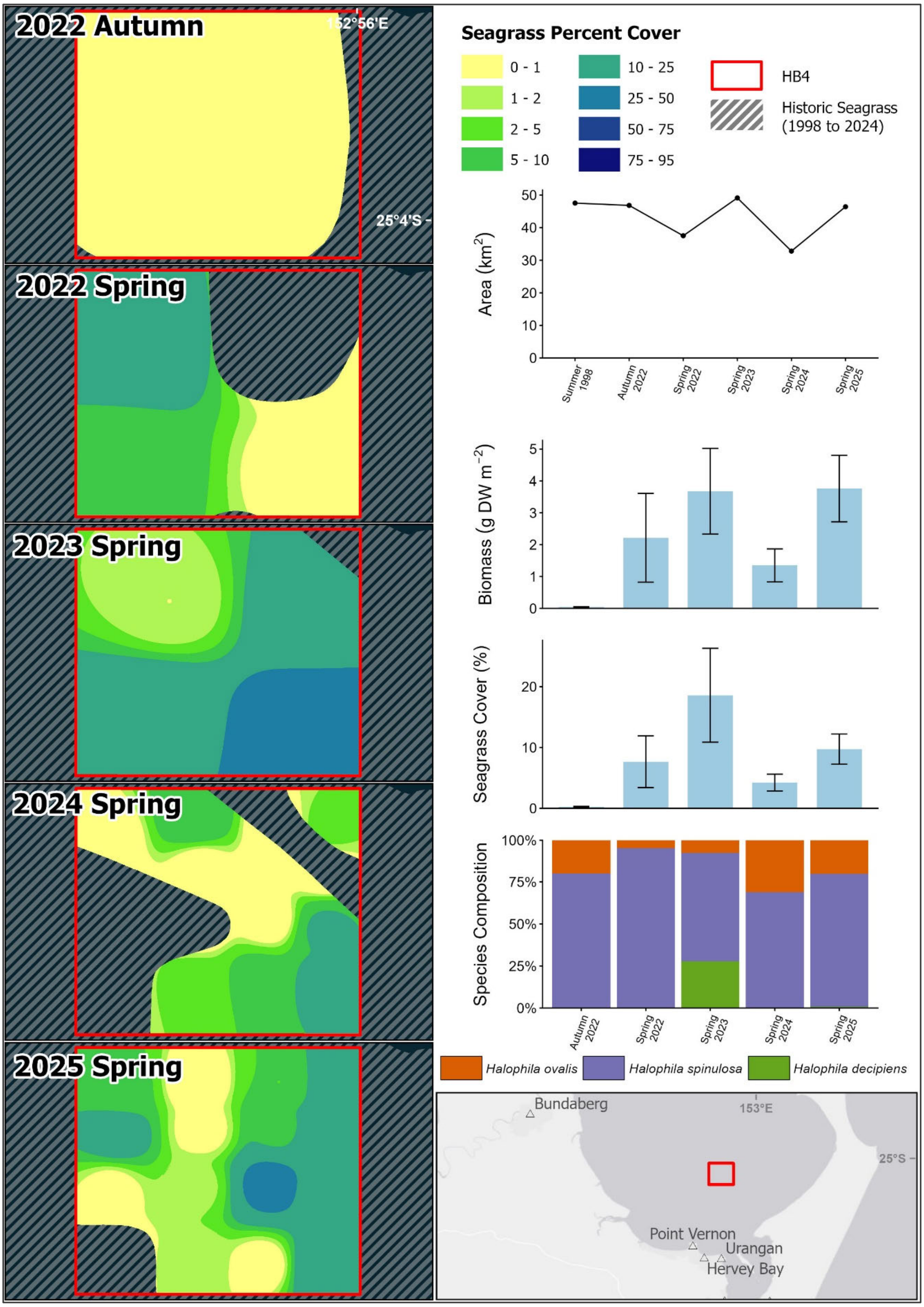

Figure 16. Seagrass area and percent cover in monitoring block HB4 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in HB4 each survey (right side). Block location is at the bottom right.

Hervey Bay Subtidal Block (HB5)

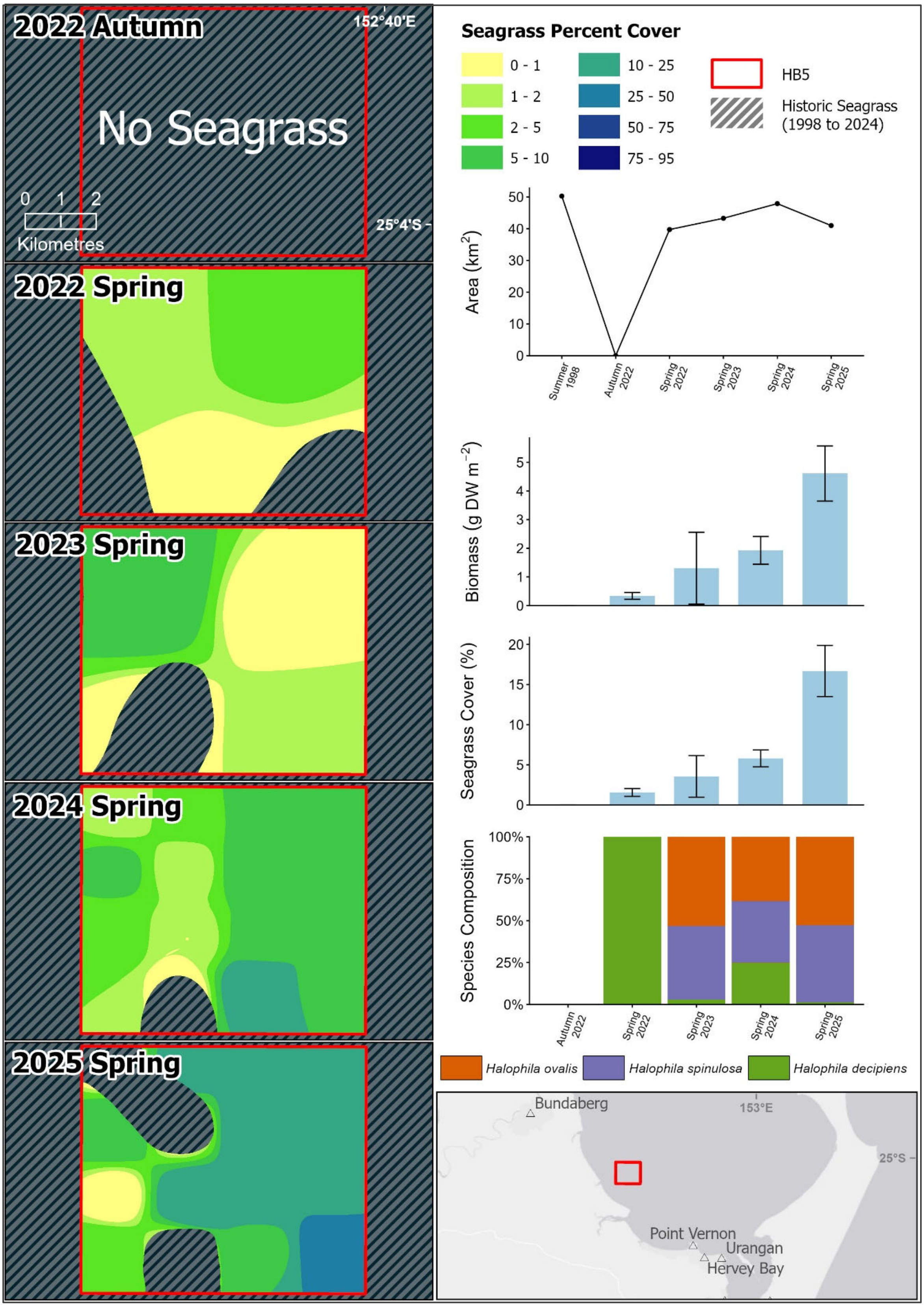

Figure 17. Seagrass area and percent cover in monitoring block HB5 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in HB5 each survey (right side). Block location is at the bottom right.

Hervey Bay Subtidal Block (HB6)

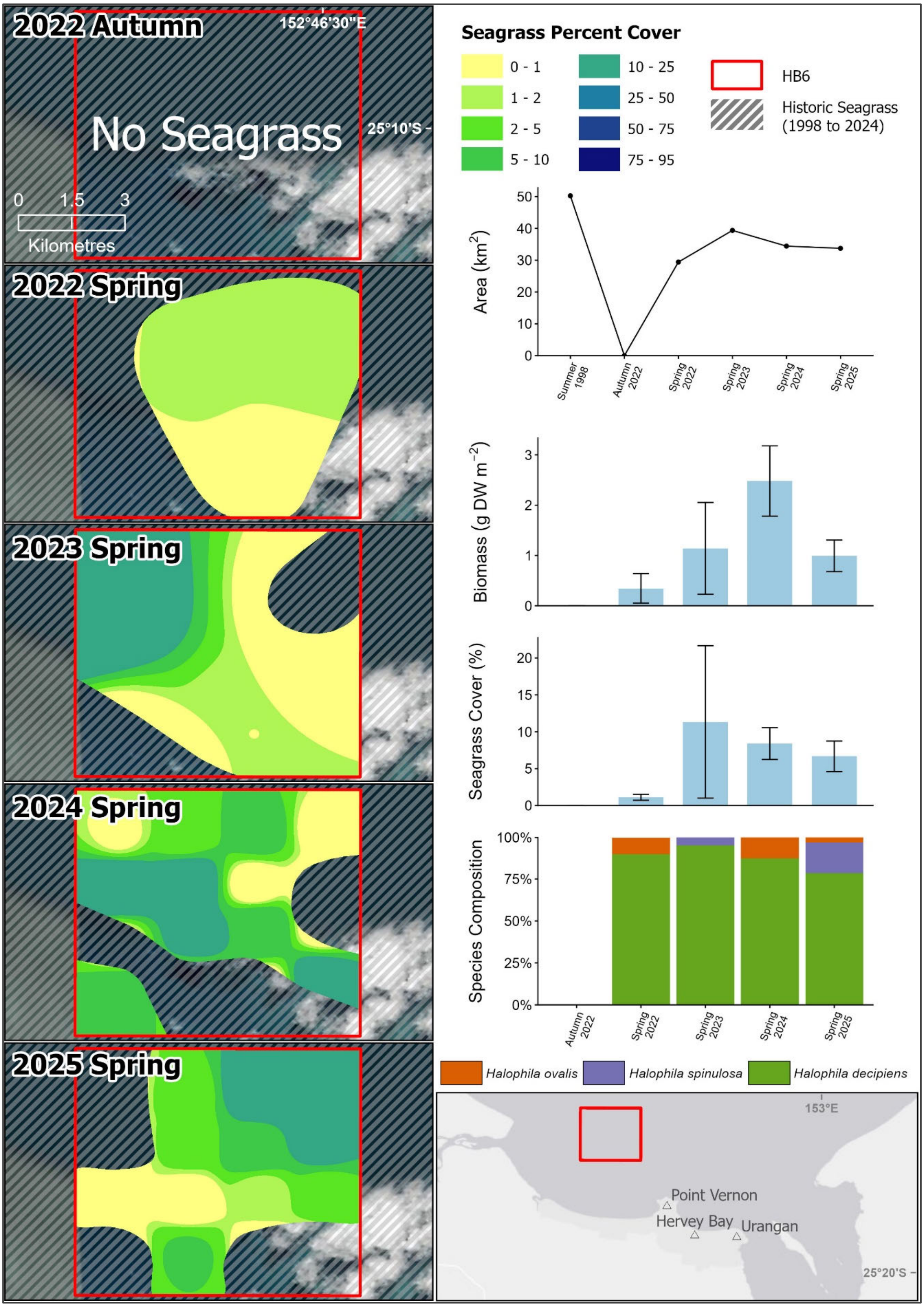

Figure 18. Seagrass area and percent cover in monitoring block HB6 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in HB 6 each survey (right side). Block location is at the bottom right.

5.2.2 Shallow Hervey Bay Monitoring Blocks (HB7, HB8)

There are two shallow water monitoring blocks in southern Hervey Bay, located at Burrum Heads (HB7) and west of Point Vernon (HB8) (Figure 11). These coastal meadows extend from the intertidal into shallow subtidal areas and support larger growing higher light requiring seagrass species (*Z. muelleri*, *H. uninervis*) compared to the deep-water blocks (Figure 20). In Autumn 2022, seagrass extent across these meadows was limited to just 10.5 km² and consisted of low biomass and low percent cover *H. uninervis* (Figure 21–22). Seagrass area increased to 20.8 km² in 2025, exceeding the 2022–2024 surveys, although still less than half of the historical 46.1 km² recorded in 1998 (Figure 19).

Seagrass biomass and cover were similar between 2024 and 2025 (Table 4–5), with both years significantly higher than for all previous year values (biomass - $\chi^2(4) = 107.19$, $p < 0.0001$; cover -$\chi^2(4) = 80.507$, $p < 0.0001$). Mean seagrass cover in 2025 across these blocks was 5.8 ± 1.0%, compared with 1.54 ± 0.4% in Spring 2022 (Figure 19).

Recovery of seagrass in this area of the GSMP appears to have lagged behind all other zones although in the past 2 years there has been a substantial jump in biomass and cover.

5.2.2.1 Block HB7

HB7 is located on the mainland coast between Burrum Heads and Toogoom in the southwest of Hervey Bay (Figure 4). Seagrass was recorded at 56 sites within the block, consisting predominantly of *Z. muelleri* in the shallow intertidal areas, with *H. uninervis* becoming more prevalent in the subtidal and a band of *H. ovalis* occurring between these zones (Figure 20). Seagrass covered an area of 18.3 km² in 2025, nearly double the footprint recorded throughout the 2022 post flood surveys (~9.35 km²) (Figure 21; Table 3). Despite this improvement, the area of seagrass in 2025 remains less than half that mapped in 1998 (39.3 km²).

Mean seagrass biomass in 2025 was 3.0 ± 0.54 g DW m^{-2}, ranging from 0 to 13.5 g DW m^{-2} (Figure 21; Table 4). Seagrass cover was 7.6 ± 1.3% in 2025, representing a slight decline from 2024 (9.6 ± 2.3%). Both biomass and cover were significantly higher in the last two surveys (2024 and 2025) than earlier post flood surveys (all $p < 0.0008$). Seagrass species composition in the two immediate post flood surveys was dominated by *H. uninervis* but has shifted to be dominated by *Z. muelleri* from 2023 onwards (Figure 21).

5.2.2.2 Block HB8

HB8 is an intertidal block located to the west of Point Vernon (Figure 4). Seagrasses within this block are sparse, patchy with very low cover and biomass. In 2025 the meadow was fragmented into six separate areas and while collectively area (2.50 km²) had declined from 2024 it remained similar to all previous years spring surveys and substantially greater than the immediate post flood survey in Autum 2022. Despite these increases the area of seagrass was only 37% of the historical area mapped in 1998 (6.7 km²) (Figure 20; Table 3). Seagrass biomass in HB8 was the lowest of all monitoring blocks, with a mean of 0.51 ± 0.11 g DW m^{-2} (Figure 20; Table 4). Biomass and cover of seagrasses have remained low and variable throughout the post flood monitoring period with both significantly higher in 2024 than in all other surveys but no other significant differences recorded.

During the 2025 survey, seagrass within this block had a particularly thin morphology. Under the rapid assessment methodology, distinguishing between thin leafed *Z. muelleri* and *H. uninervis* can be difficult so the apparent shift from *Z. muelleri* to *H. uninervis* in 20254 should be interpreted with caution (Figure 21).

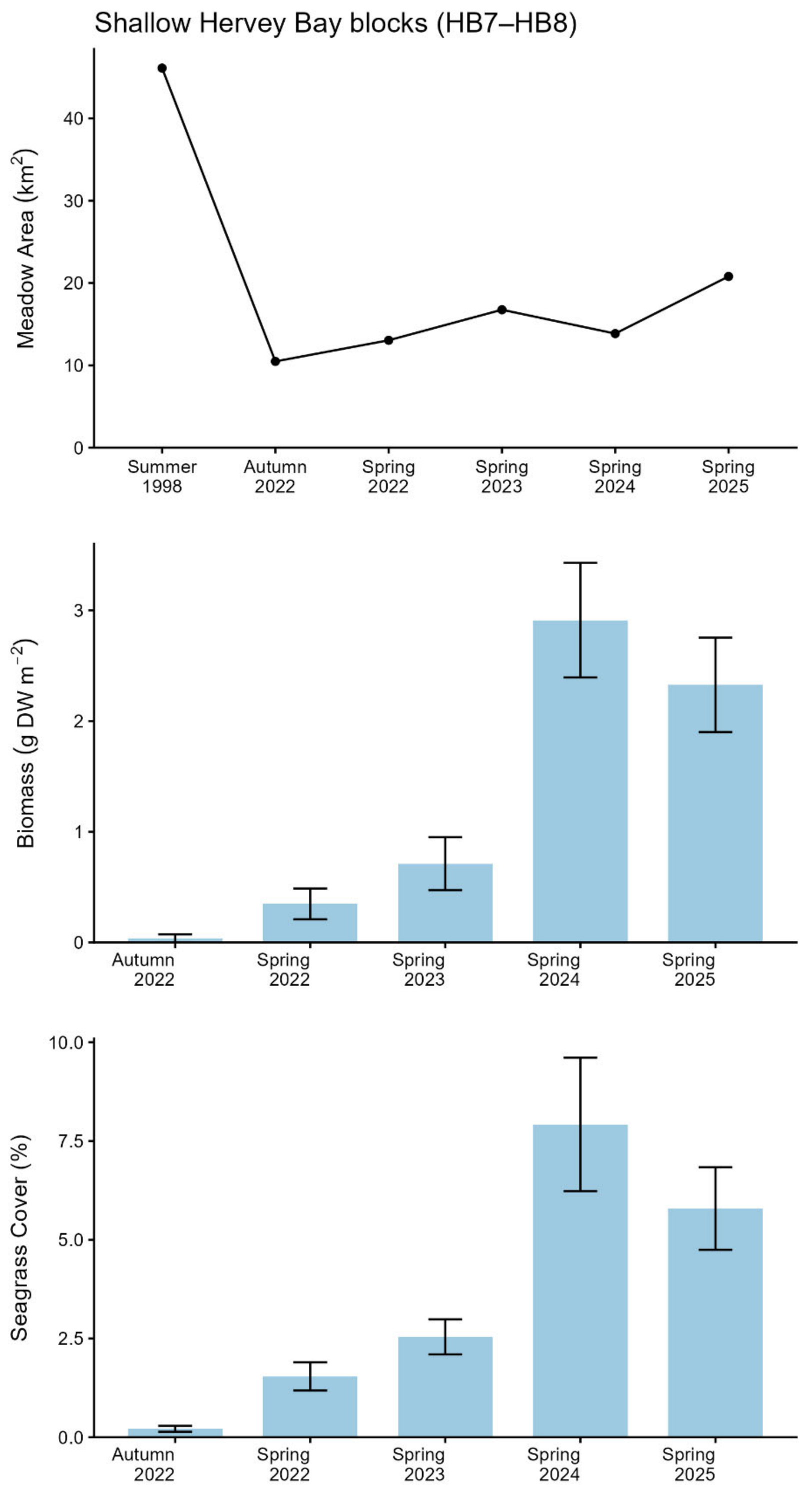

Figure 19. Seagrass meadow area from shallow Hervey Bay blocks across surveys. Mean (±SE) of seagrass biomass (top) and percent cover (bottom) in seagrass meadows in shallow water monitoring blocks in Hervey Bay across surveys in Autumn 2022, Spring 2022, 2023, 2024 and 2025.

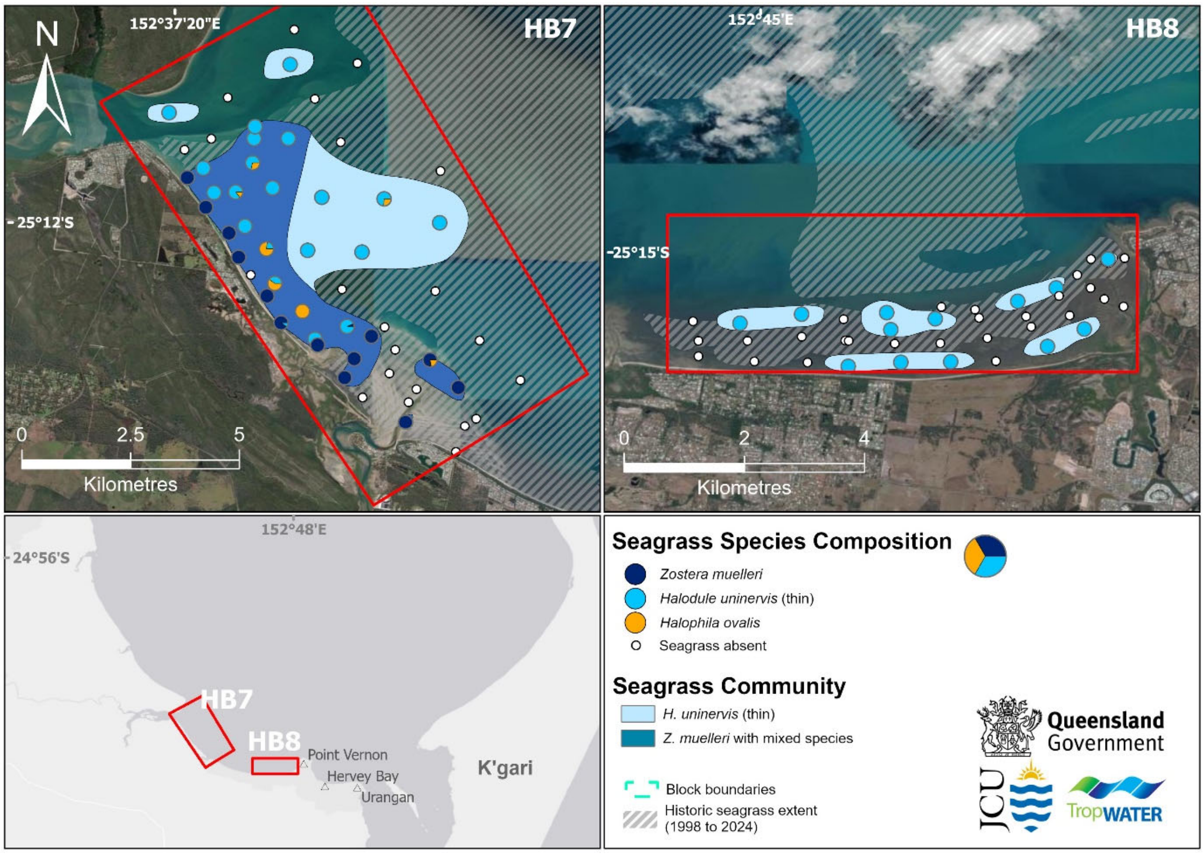

Figure 20. Seagrass site and meadow location and species composition in the blocks HB7 and HB8 in the shallow water monitoring blocks in Hervey Bay Spring 2025.

Hervey Bay Shallow Block (HB7)

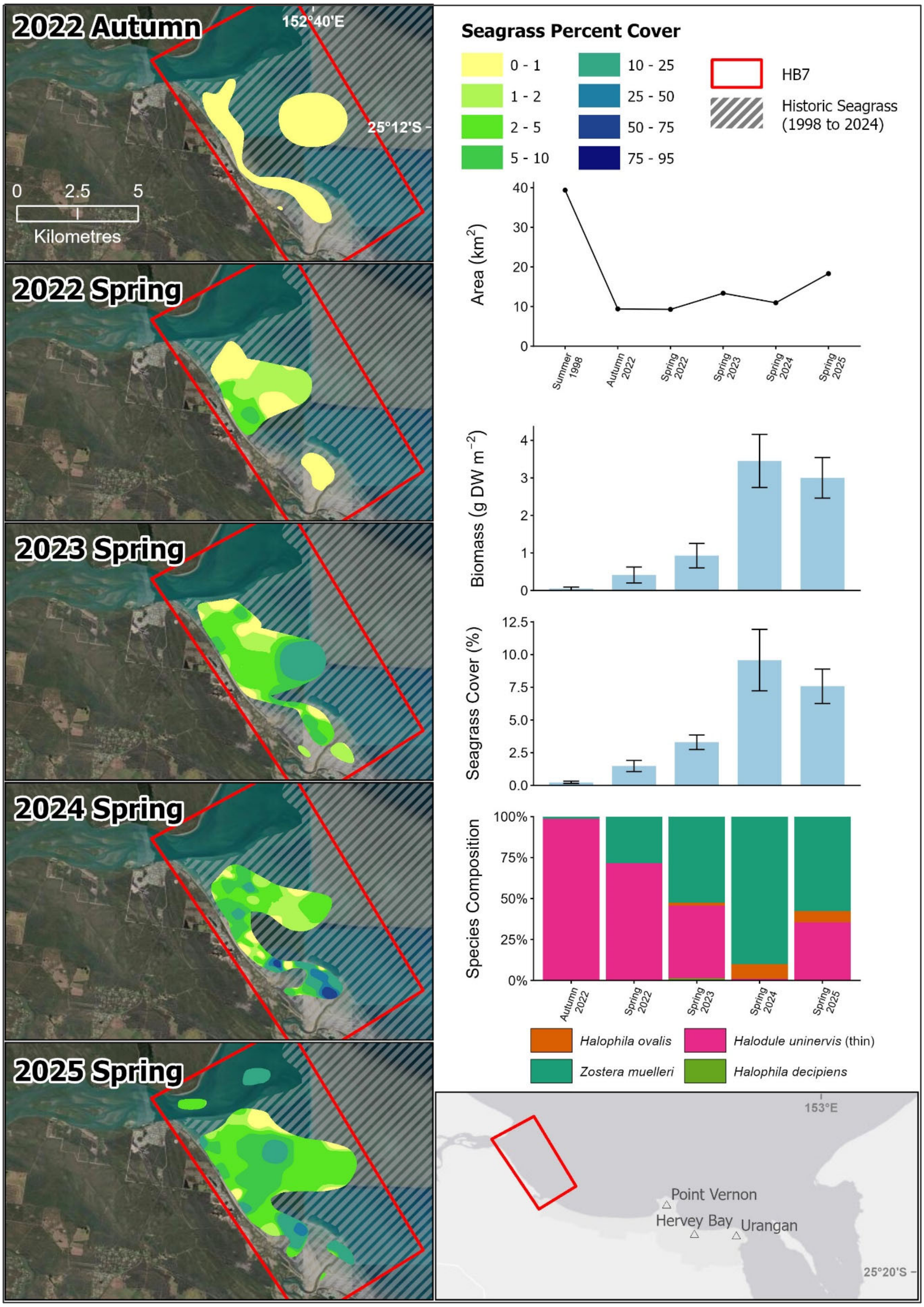

Figure 21. Seagrass area and percent cover in monitoring block HB7 in each survey (left side) and total meadow area, seagrass mean (± SE) biomass and percent cover, and species composition in HB7 each survey (right side). Block location is at the bottom right.

Hervey Bay Shallow Block (HB8)

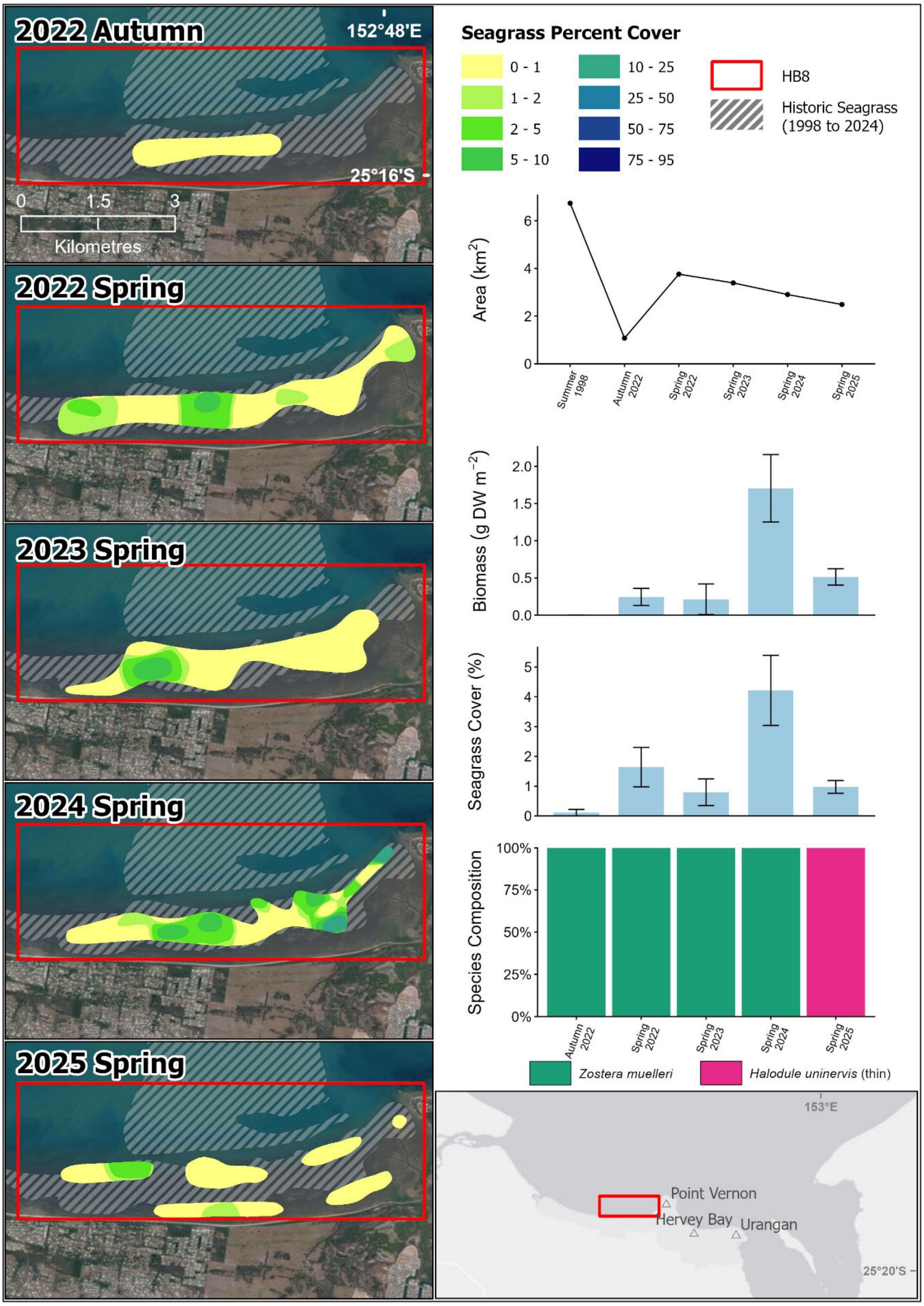

Figure 22. Seagrass area and percent cover in monitoring block HB8 in each survey (left side) and total meadow area, seagrass mean (± SE) biomass and percent cover, and species composition in HB8 each survey (right side). Block location is at the bottom right.

5.3 GREAT SANDY STRAIT REGION

The five monitoring blocks in the Great Sandy Strait are predominantly intertidal and consist of seagrass meadows dominated by *Z. muelleri*, with some *Halophila* species (*H. ovalis*, *H. decipiens* and *H. spinulosa*) (Figure 23–26). A total of 239 sites were surveyed in the five Great Sandy Strait blocks, with seagrass present at 68% of sites (Figure 25–26). Combined seagrass area in the GSS blocks was 25.7 km^2, the largest area recorded in the program and exceeding the historical 1998 extent within these areas (20.7 km^2) by approximately 5 km^2.

This region had the greatest improvement in seagrass condition between 2024 and 2025 with seagrass biomass and percent cover substantially higher than in Hervey Bay. During 2024 and continuing in 2025 there was a substantial shift in the morphology of *Z. muelleri* here from the narrow leaf form to the much thicker and taller wide leafed growth form. Mean seagrass biomass in 2025 for the GSS region was 21.37 ± 1.54 g DW m^{-2} (range: 0–92 g DW m^{-2}), a significant increase from Autumn 2022 (0.14 ± 0.1 g DW m^{-2}; maximum 1.4 g DW m^{-2}) (Figure 24; Table 4) ($\chi^2(4) = 678.72$, $p < 0.0001$). Seagrass cover in 2025 (21.0 ± 1.3%) remained similar (slightly lower) to 2024 (22.7 ± 1.7%) which is consistent with the change in *Zostera muelleri* to larger growing leaves (increased biomass) but maintaining a similar % cover. Like biomass, seagrass cover was significantly higher than the very low cover recorded in Spring 2022 (0.6 ± 0.1%) and also 2023 (Figure 24; Table 5) ($\chi^2(4) = 389.11$, $p < 0.0001$).

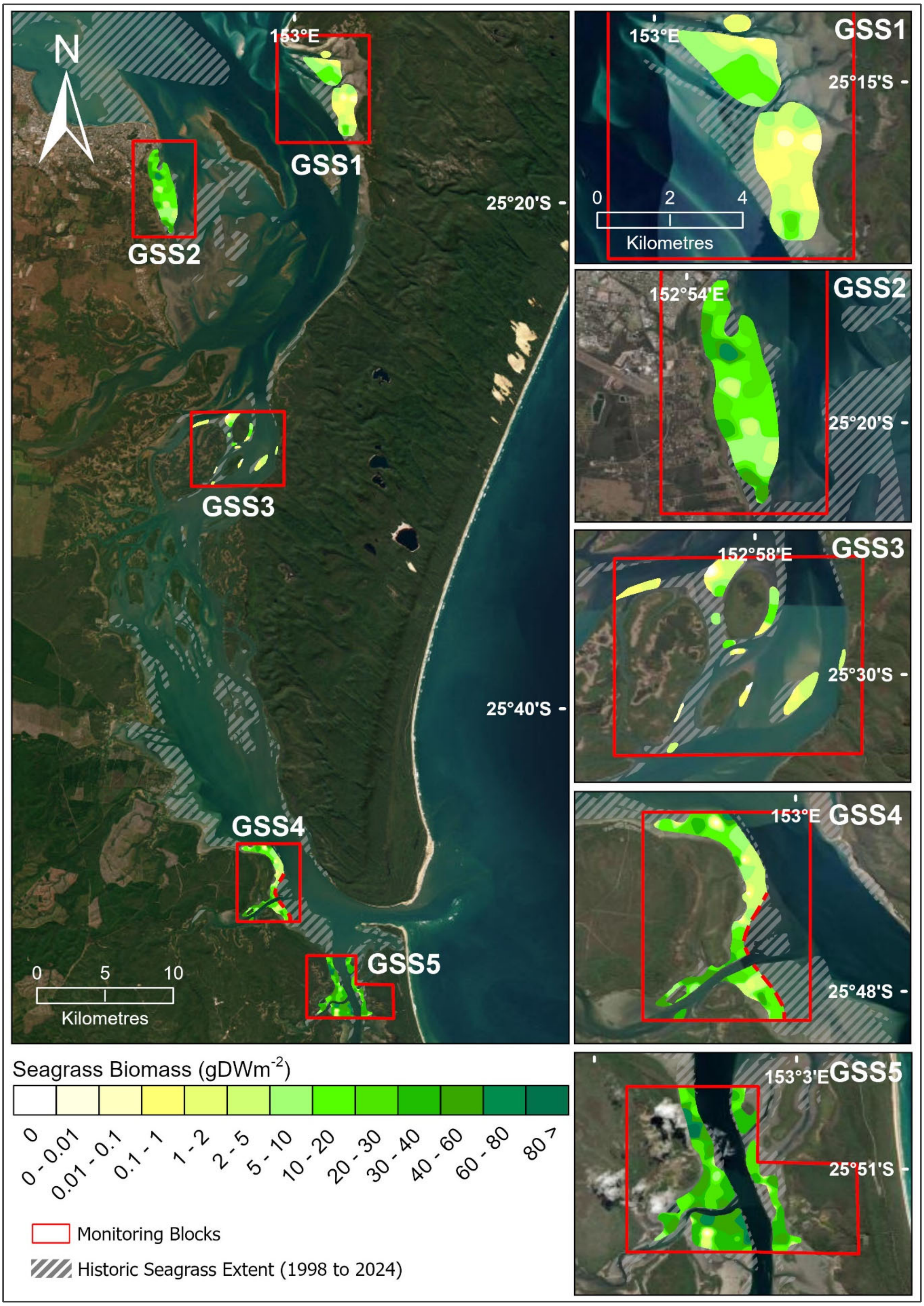

Figure 23. Seagrass biomass across monitoring blocks in the Great Sandy Strait in 2025.

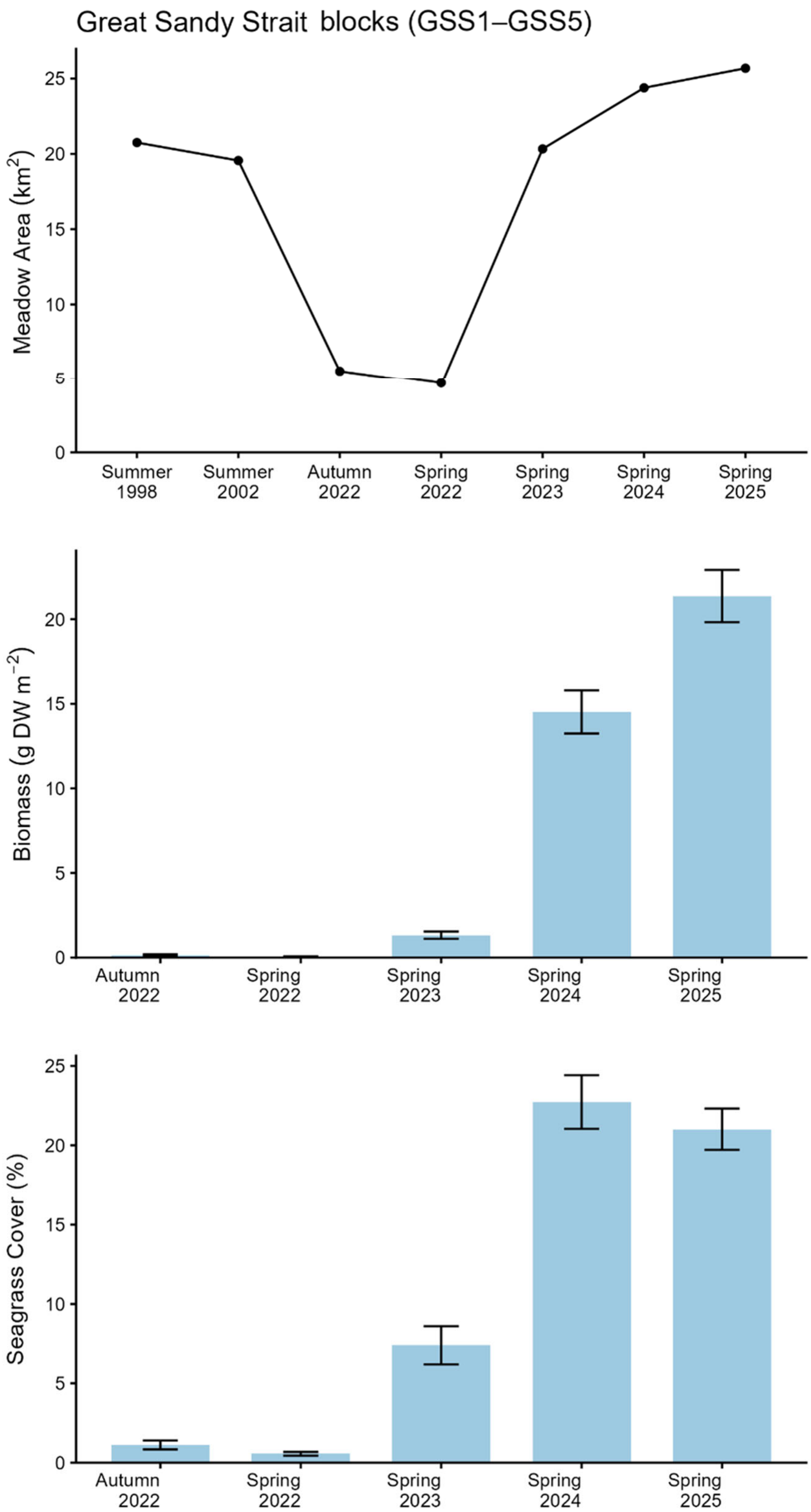

Figure 24. Seagrass meadow area in the 5 monitoring blocks in the Great Sandy Strait across surveys. Mean (±SE) of seagrass biomass (top) and percent cover (bottom) in seagrass meadows in monitoring blocks in the Great Sandy Strait across surveys in Autumn 2022, Spring 2022, 2023, 2024 and 2025.

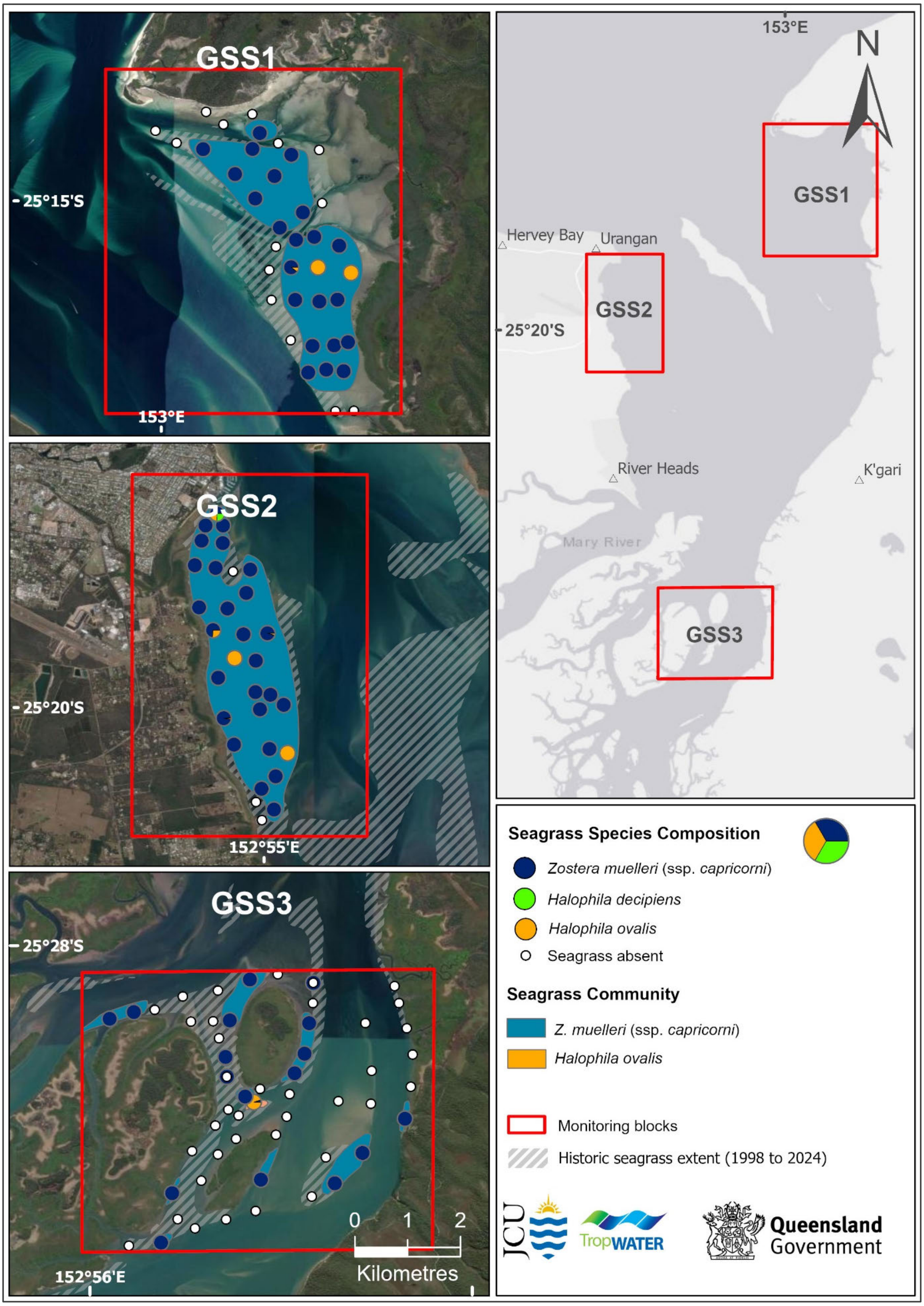

Figure 25. Seagrass site and meadow location and species composition in the blocks GSS1, GSS2, and GSS3 in the northern section of the Great Sandy Strait.

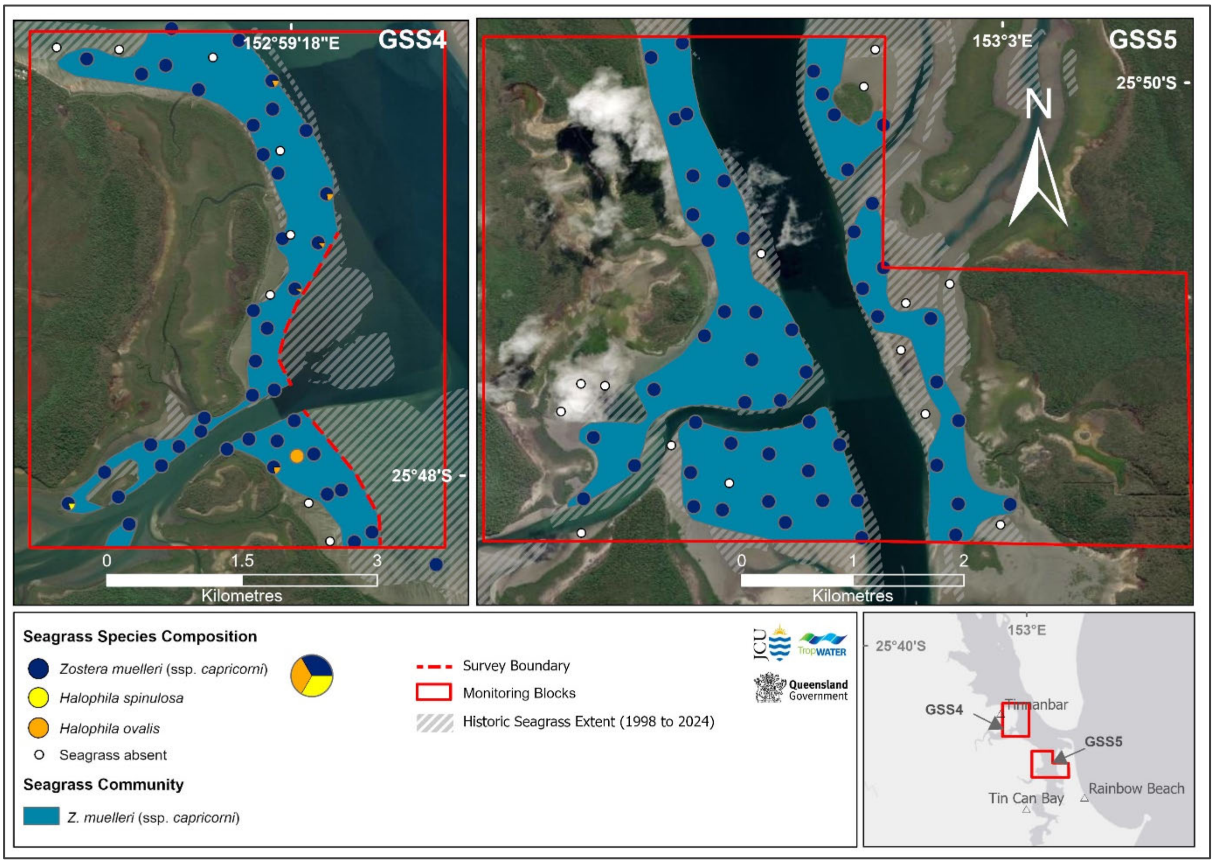

Figure 26. Seagrass site, meadow location and species composition in blocks GSS4 and GSS5 in the southern section of the Great Sandy Strait.

5.3.1 Great Sandy Strait Blocks

5.3.1.1 Block GSS1

GSS1 is located on the intertidal banks of K'gari between Moon Point and Blackfellow Point and consists of two meadows dominated by *Z. muelleri* (Figure 4; Figure 24–26). Seagrass area in GSS1 in 2025 was 8.4 km², the largest area recorded for this region (Figure 24; Figure 27; Table 3) Seagrass area in this block recovered to historical levels by Spring 2023 and has maintained its footprint since then.

Seagrass biomass and cover showed a significant increase in 2023 and 2024 ($p < 0.0001$). Mean biomass in 2025 (5.24 ± 1.23 g DW m^{-2}) declined from 2024 (12.94 ± 2.2 g DW m^{-2}) ($p = 0.0027$) but remained significantly higher than biomass observed in both 2022 surveys (Figure 27; Table 4). While biomass declined, seagrass cover was maintained in 2025 reaching 26.1 ± 4.2% (Figure 27; Table 5). This apparent discrepancy was likely to due to very high levels of turtle and dugong herbivory across this meadow with cropped seagrass blades commonly observed across the meadow.

Seagrass in GSS1 was dominated by *H. uninervis* (thin form) in Autumn 2022 and has progressively shifted to dominance by *Z. muelleri* (Figure 27).

5.3.1.2 Block GSS2

GSS2 is located on the coast to the south of Urangan and was dominated by *Z. muelleri*, with some *H. ovalis* and *H. decipiens* present in 2025 (Figure 25; Figure 28). Seagrass in the block covered 6.5 km², the largest area recorded across all surveys including historical pre flood surveys in 1998 and 2002 (Figure 28; Table 3). Seagrass biomass and percent cover in GSS2 was among the highest of all monitoring blocks in 2025, with a mean biomass of 22.7 ± 3.11 g DW m^{-2} (ranging from 0 to 70.47 g DW m^{-2}) and cover of 22.5 ± 2.7% (Figure 28; Tables 4; 5).

This meadow was substantially impacted by floods in 2022 and underwent a significant recovery first in % cover in 2023 ($p<0.0001$) with the recruitment of the colonisng species *Halophila ovalis* followed by a significant increase in biomass in 2024 ($p < 0.0001$) with the return of dominance of *Zostera muelleri* (97.6% of the biomass) (Figure 28). Biomass and cover were maintained at these high levels in 2025 and together with the record mapped area indicate this meadow had fully recovered from impacts of the 2022 floods.

5.3.1.3 Block GSS3

GSS3 is located in the centre of the Great Sandy Strait around Turkey Island (Figure 4; Figure 29). This block was not surveyed in Spring 2022. In 2025 seagrass in GSS3 occurred on the shallow banks surrounding the islands and was dominated by *Z. muelleri* with a small patch of *H. ovalis* present near the centre of the block (Figure 29). Seagrass area in 2025 was 1.7 km², and while this was less than half of that in 2024 (4.5 km²), it still remained substantially higher than any other survey both in the post flood program and in historical surveys conducted in 1998 and 2002 (Figure 29; Table 3).

Mean seagrass biomass in 2025 was 4.28 ± 1.38 g DW m^{-2}, the highest recorded for this block, and a significant increase from 2023 and 2024 ($p < 0.0001$ & $p=0.0093$ respectively). Seagrass cover has remained low throughout the monitoring program being less than 5% in every survey (Figure 29; Table 5). Seagrass species composition had a marked increase in colonising species *Halophila* ovalis and *Halodule* uninervis in 2023 but has since returned to be dominated by *Z. muelleri* in 2024 and 2025 (Figure 29).

5.3.1.4 Block GSS4

GSS4 is located in the southern Great Sandy Strait within the intertidal areas surrounding the mouth of Kauri Creek (Figure 30). Seagrass at GSS4 was not surveyed in Spring 2022. In 2025, seagrass communities were dominated by *Z. muelleri*, with small amounts of *H. spinulosa* and *H. ovalis* also present (Figure 26). Seagrass area recovered rapidly from the 2022 losses, increasing from 1 km^2 in Autumn 2022 to 4.1 km^2 in 2025, which is comparable to the historical maximum area recorded in 1998 (4.2 km^2) (Figure 30; Table 3).

Seagrass biomass and % cover has shown substantial recovery with consecutive significant increases in biomass in 2023 (0.38 ± 0.21 g DW m^{-2} ($p = 0.0055$)), 2024 ($p < 0.0001$) and 2025 (19.25 ± 2.77 g DW m^{-2} ($p = 0.0004$)) (Figure 30; Table 4). Percent cover had reached 15.9% ± 2.3% in 2025, similar to the previous year, and significantly higher ($p < 0.0001$) than all other years in the post flood monitoring program (Figure 30; Table 5).

A succession of seagrass species from colonisers to more stable species also occurred along with the recovery in area and biomass. In 2023 there was a high proportion of the colonising species *Halophila ovalis* and opportunistic *Halodule uninervis* (narrow leaf form) that were displaced by *Z. muelleri* in 2024 and 2025 (Figure 30).

5.3.1.5 Block GSS5

GSS5 is the most southern monitoring block in the program, situated at the northern entrance to Tin Can Bay (Figure 23). In 2022 there were significant losses of seagrass here, but area of the meadows had recovered in 2024 and 2025 (4.98 km^2) to be the highest ever recorded including historical pre-flood surveys from 1998 and 2002 (Figure 36; Table 3).

In 2025 it supported some of the densest seagrass meadows across GSMP. Seagrass biomass increased significantly to 35.49 ± 2.71 g DW m^{-2} in 2025 ($p = 0.0040$), the highest biomass recorded across all monitoring blocks and surveys (Figure 31; Table 4). This is a marked increase compared with the very low biomass observed following the 2022 floods and the following year in 2023, where mean biomass values did not exceed 0.4 g DW m^{-2} (Figure 31; Table 4). Seagrass cover showed a similar pattern of recovery, increasing from 3.2 ± 0.7% in 2023 to 27.6 ± 2.1% in 2025.

During the early stages of recovery in 2023 colonising and opportunistic species made up a significant proportion of the seagrass biomass but by 2025 had been completely displaced by *Z. muelleri.*

Great Sandy Strait Block (GSS1)

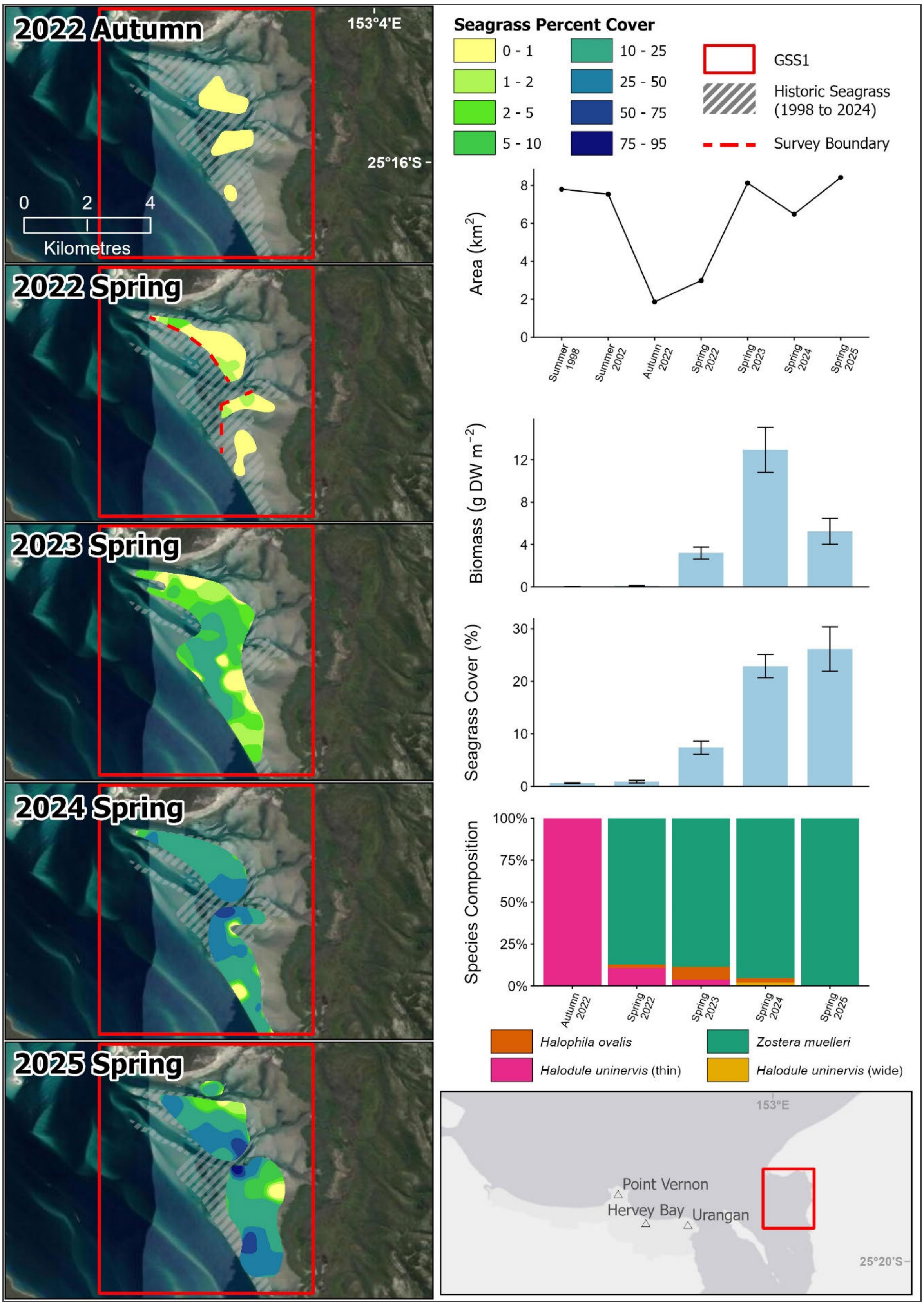

Figure 27. Seagrass area and percent cover in monitoring block GSS1 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover and species composition in GSS1 each survey (right side). Block location is at the bottom right.

Great Sandy Strait Block (GSS2)

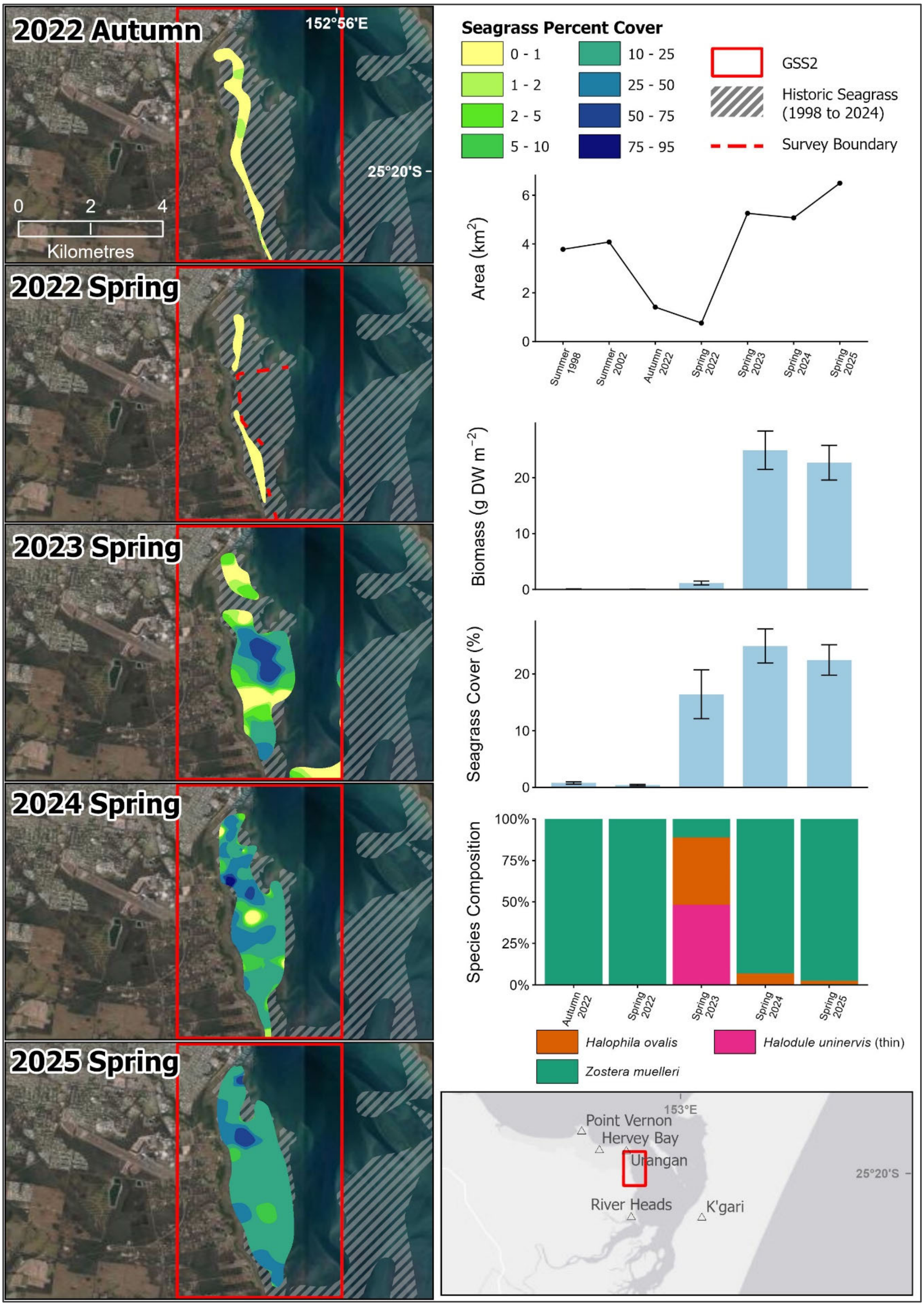

Figure 28. Seagrass area and percent cover in monitoring block GSS2 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in GSS2 each survey (right side). Block location is at the bottom right.

Great Sandy Strait Block (GSS3)

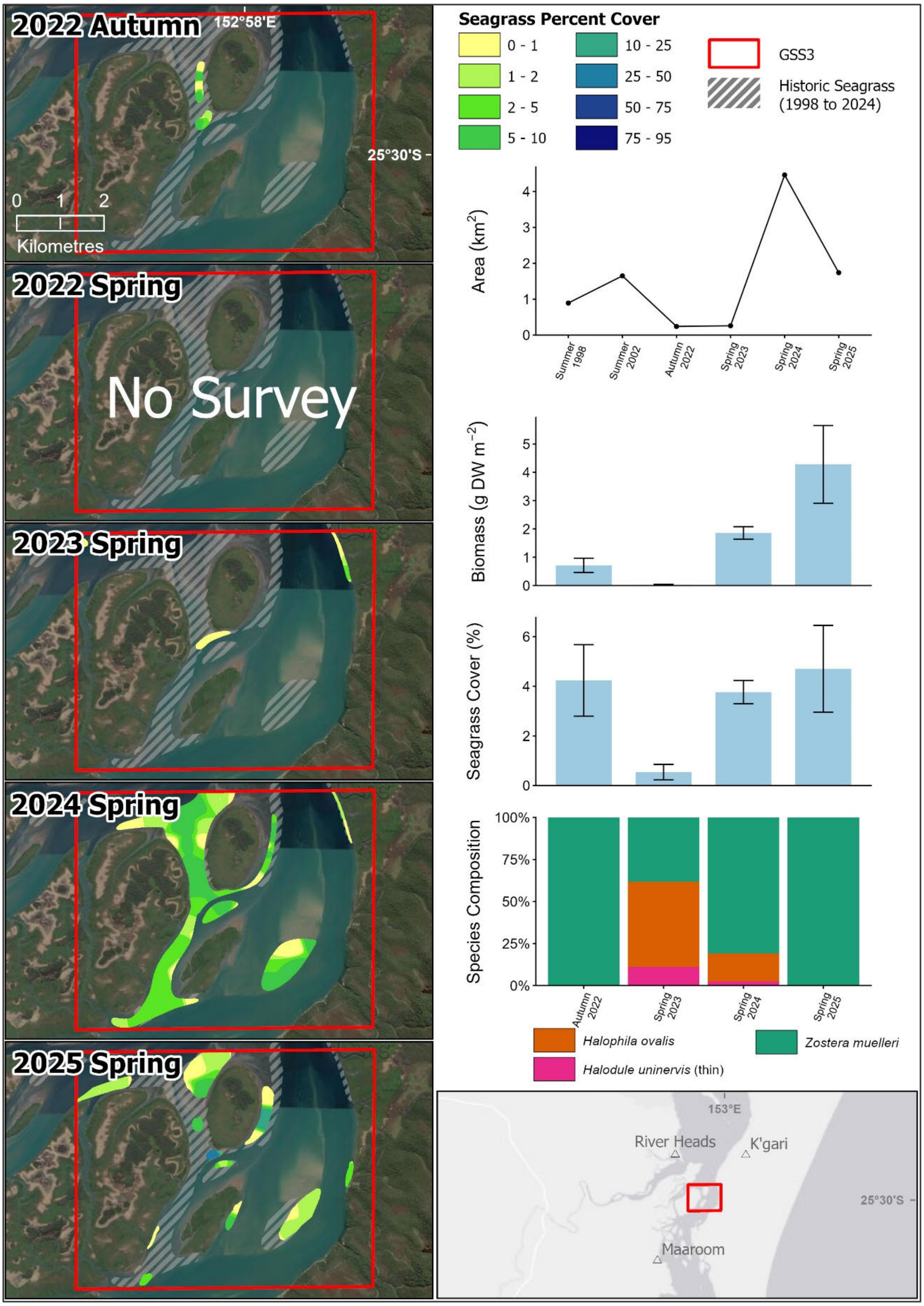

Figure 29. Seagrass area and percent cover in monitoring block GSS3 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in GSS3 each survey (right side). Block location is at the bottom right.

Great Sandy Strait Block (GSS4)

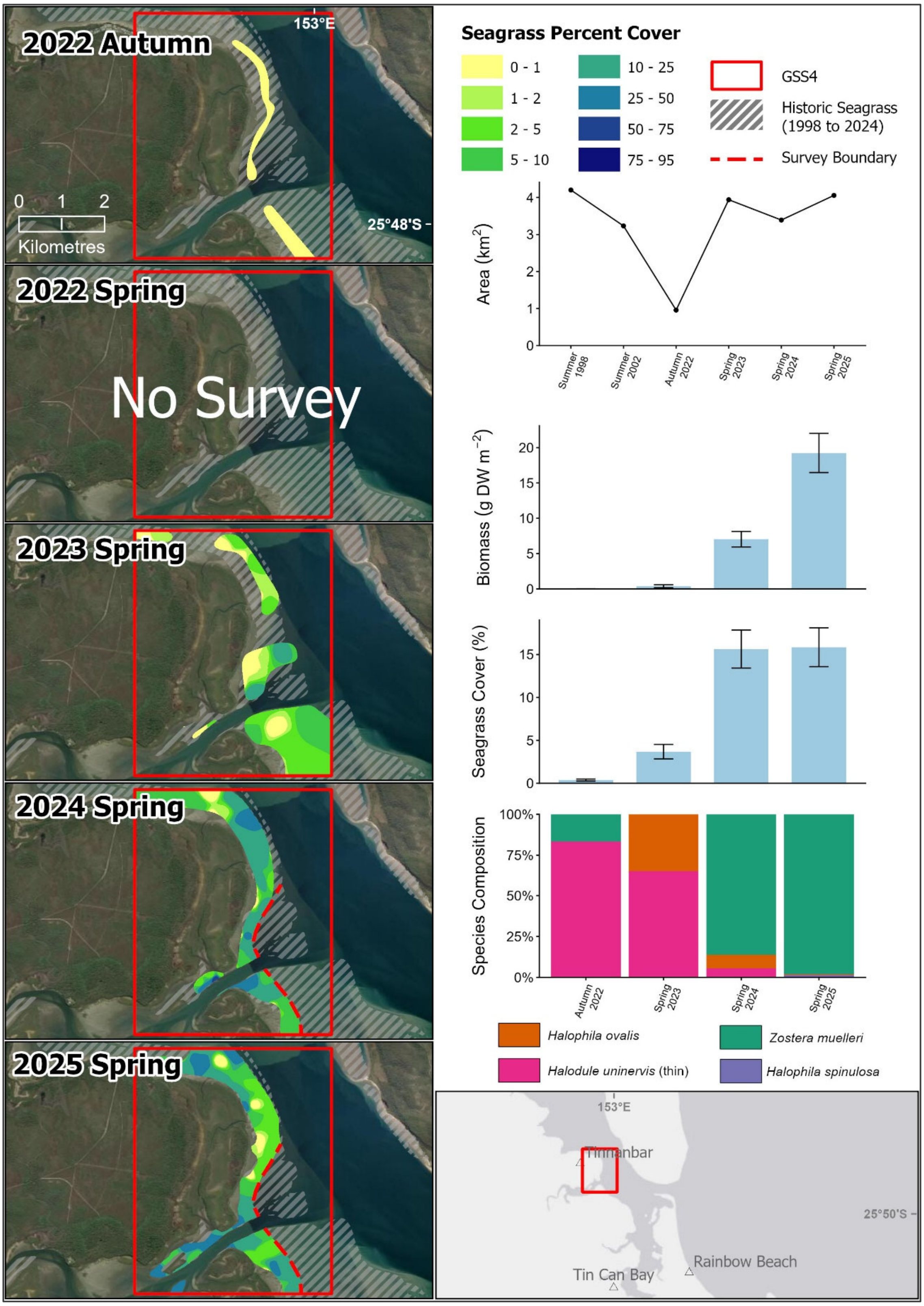

Figure 30. Seagrass area and percent cover in monitoring block GSS4 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in GSS4 each survey (right side). Block location is at the bottom right.

Great Sandy Strait Block (GSS5)

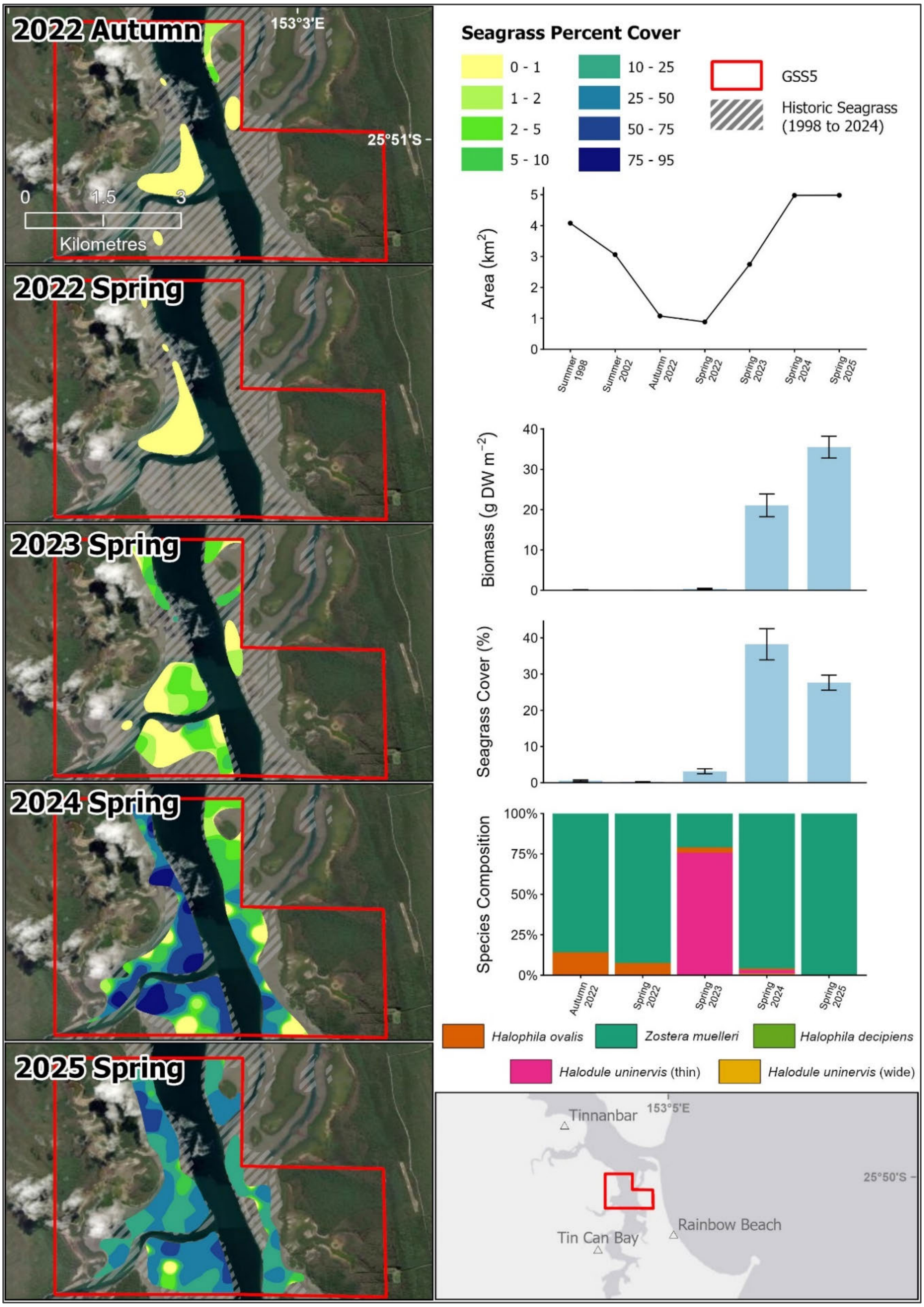

Figure 31. Seagrass area and percent cover in monitoring block GSS5 in each survey (left side) and total meadow area, seagrass mean (±SE) biomass and percent cover, and species composition in GSS5 each survey (right side). Block location is at the bottom right.

Table 3. Total area (km^2), of seagrass at survey blocks mapped in Hervey Bay and the Great Sandy Strait in December 1998, February 2002, May, October/November 2022 and August to November 2023, October 2024 and October/November 2025. NS = not surveyed, NC = not calculated.

Total area (km^2)							
Block	**Dec 1998**	**Feb 2002**	**May 2022**	**Oct/ Nov 2022**	**Aug to Nov 2023**	**Oct 2024**	**Oct/ Nov 2025**
GSMP	**315.4**	**19.6**	**136.8**	**224.9**	**269.4**	**249.0**	**263.0**
□ **GSS**	**20.7**	**19.6**	**5.5**	**4.6**	**20.3**	**24.4**	**25.7**
– GSS 1	7.8	7.5	1.9	3.0	8.1	6.5	8.4
– GSS 2	3.8	4.1	1.4	0.8	5.3	5.1	6.5
– GSS 3	0.9	1.6	0.2	NS	0.3	4.5	1.7
– GSS 4	4.2	3.2	1.0	NS	3.9	3.4	4.1
– GSS 5	4.1	3.1	1.1	0.9	2.7	5.0	5.0
□ **HB deep**	**248.6**	**NS**	**120.8**	**207.2**	**232.3**	**210.7**	**216.5**
– HB 2	50.3	NS	50.3	50.3	50.3	45.1	44.7
– HB 3	50.3	NS	23.7	50.3	50.3	50.5	50.7
– HB 4	47.6	NS	46.9	37.5	49.1	32.8	46.4
– HB 5	50.2	NS	0.0	39.7	43.3	47.9	41.0
– HB 6	50.2	NS	0.0	29.4	39.4	34.4	33.7
□ **HB shallow**	**46.1**	**NS**	**10.5**	**13.0**	**16.8**	**13.9**	**20.8**
– HB 7	39.4	NS	9.4	9.3	13.4	11.0	18.3
– HB 8	6.7	NS	1.1	3.8	3.4	2.9	2.5

Table 4. Mean biomass (g DW m^{-2}) of seagrass at survey blocks mapped in Hervey Bay and the Great Sandy Strait in December 1998, February 2002, May, October/November 2022 and August to November 2023, October 2024 and October/November 2025. NS = not surveyed, NC = not calculated. Means are based on all blocks surveyed each year.

Mean biomass (g DW m^{-2})							
Block	**Dec 1998**	**Feb 2002**	**May 2022**	**Oct/ Nov 2022**	**Aug to Nov 2023**	**Oct 2024**	**Oct/ Nov 2025**
GSMP	**NC**	**NC**	**0.21 ± 0.06**	**1.00 ± 0.29**	**1.46 ± 0.20**	**10.45 ± 0.85**	**13.97 ± 1.05**
□ **GSS**	**NC**	**NC**	**0.14 ± 0.05**	**0.05 ± 0.01**	**1.32 ± 0.22**	**14.52 ± 1.28**	**21.37 ± 1.54**
– GSS 1	NC	NC	0.01 ± 0.00	0.10 ± 0.03	3.20 ± 0.57	12.94 ± 2.12	5.24 ± 1.23
– GSS 2	NC	NC	0.06 ± 0.03	0.03 ± 0.01	1.14 ± 0.33	24.95 ± 3.43	22.70 ± 3.11
– GSS 3	NC	NC	0.71 ± 0.25	NS	0.03 ± 0.01	1.86 ± 0.22	4.28 ± 1.38
– GSS 4	NC	NC	0.02 ± 0.01	NS	0.38 ± 0.21	7.05 ± 1.10	19.25 ± 2.77
– GSS 5	NC	NC	0.07 ± 0.03	0.02 ± 0.00	0.35 ± 0.13	21.07 ± 2.82	35.49 ± 2.71
□ **HB deep**	**NC**	**NC**	**0.82 ± 0.38**	**5.17 ± 1.32**	**4.29 ± 1.09**	**4.84 ± 0.51**	**4.28 ± 0.48**
– HB 2	NC	NC	1.86 ± 0.71	11.74 ± 0.93	10.91 ± 1.85	8.92 ± 0.87	6.39 ± 0.95
– HB 3	NC	NC	0.33 ± 0.09	9.01 ± 1.36	2.09 ± 0.77	7.80 ± 0.86	4.91 ± 1.22
– HB 4	NC	NC	0.04 ± 0.01	2.22 ± 1.39	3.68 ± 1.34	1.35 ± 0.52	3.76 ± 1.05
– HB 5	NC	NC	0	0.33 ± 0.12	1.30 ± 1.26	1.93 ± 0.49	4.61 ± 0.96
– HB 6	NC	NC	0	0.34 ± 0.29	1.14 ± 0.91	2.48 ± 0.70	0.99 ± 0.31
□ **HB shallow**	**NC**	**NC**	**0.04 ± 0.04**	**0.35 ± 0.14**	**0.71 ± 0.24**	**2.91 ± 0.52**	**2.33 ± 0.43**
– HB 7	NC	NC	0.04 ± 0.04	0.41 ± 0.21	0.93 ± 0.33	3.45 ± 0.71	3.00 ± 0.54
– HB 8	NC	NC	<0.001	0.25 ± 0.12	0.21 ± 0.21	1.71 ± 0.45	0.51 ± 0.11

Table 5. Mean percent cover of seagrass at survey blocks mapped in Hervey Bay and the Great Sandy Strait in December 1998, February 2002, May, October/November 2022 and August to November 2023, October 2024 and October/November 2025. NS = not surveyed, NC = not calculated. Means are based on all blocks surveyed each year.

Mean Percent Cover							
Block	**Dec 1998**	**Feb 2002**	**May 2022**	**Oct/ Nov 2022**	**Aug to Nov 2023**	**Oct 2024**	**Oct/ Nov 2025**
GSMP	**NC**	**NC**	**1.5 ± 0.4**	**3.9 ± 1.1**	**6.8 ± 0.9**	**17.4 ± 1.2**	**16.6 ± 0.9**
□ **GSS**	**NC**	**NC**	**1.1 ± 0.3**	**0.6 ± 0.1**	**7.4 ± 1.2**	**22.7 ± 1.7**	**21.0 ± 1.3**
– GSS 1	NC	NC	0.6 ± 0.1	0.9 ± 0.2	7.4 ± 1.3	22.9 ± 2.2	26.1 ± 4.2
– GSS 2	NC	NC	0.8 ± 0.2	0.4 ± 0.1	16.4 ± 4.3	24.9 ± 3.0	22.5 ± 2.7
– GSS 3	NC	NC	4.2 ± 1.4	NS	0.5 ± 0.3	3.8 ± 0.5	4.7 ± 1.7
– GSS 4	NC	NC	0.4 ± 0.1	NS	3.7 ± 0.8	15.6 ± 2.2	15.9 ± 2.3
– GSS 5	NC	NC	0.6 ± 0.2	0.2 ± 0.1	3.2 ± 0.7	38.2 ± 4.3	27.6 ± 2.1
□ **HB deep**	**NC**	**NC**	**5.3 ± 2.4**	**18.4 ± 5.1**	**14.1 ± 2.7**	**9.7 ± 0.8**	**13.4 ± 1.4**
– HB 2	NC	NC	12.0 ± 4.1	43.8 ± 9.6	23.6 ± 3.2	15.4 ± 1.5	18.9 ± 2.5
– HB 3	NC	NC	2.0 ± 0.3	29.4 ± 2.8	9.4 ± 0.5	12.8 ± 1.2	13.9 ± 3.5
– HB 4	NC	NC	0.2 ± 0.1	7.7 ± 4.2	18.6 ± 7.7	4.2 ± 1.4	9.7 ± 2.5
– HB 5	NC	NC	0	1.6 ± 0.5	3.6 ± 2.6	5.8 ± 1.0	16.7 ± 3.2
– HB 6	NC	NC	0	1.1 ± 0.4	11.3 ± 10.3	8.4 ± 2.2	6.7 ± 2.1
□ **HB shallow**	**NC**	**NC**	**0.2 ± 0.1**	**1.5 ± 0.4**	**2.5 ± 0.4**	**7.9 ± 1.7**	**5.8 ± 1.0**
– HB 7	NC	NC	0.2 ± 0.1	1.5 ± 0.4	3.3 ± 0.6	9.6 ± 2.3	7.6 ± 1.3
– HB 8	NC	NC	0.1 ± 0.1	1.6 ± 0.7	0.8 ± 0.4	4.2 ± 1.2	1.0 ± 0.2

5.4 PAR, Temperature & River Flow

Benthic light measured as Photosynthetically Available Radiation (PAR) collected at the three deeper subtidal monitoring sites at Toogoom, Woodgate and Tobruk showed total daily PAR followed a seasonal pattern with peaks generally occurring during the warmer months and declines during winter (Figure 32). The Toogoom and Woodgate sites had quite similar PAR levels and trends with extended periods of light above the likely PAR threshold supporting positive growth for deepwater *Halophila* species (~2 mol m^{-2} day^{-1} minimum light requirement). Both also had periods of PAR below this level, a likely driver of seasonal and interannual changes that typify these deepwater seagrass habitats. The deepest PAR monitoring site at Tobruk had the lowest light levels and much shorter periods of time where light was likely to be at levels that would support expansion of seagrass growth with PAR peaks typically not exceeding ~3–4 mol m^{-2} day^{-1} (Figure 32).

In late November 2023, two additional PAR monitoring sites were established in shallow seagrass meadows at Moon Point and Kauri Creek, extending PAR coverage into the Great Sandy Strait (Figure 33). These sites consistently recorded substantially higher PAR values with rolling averages frequently exceeding 10–20 mol m^{-2} day^{-1} and generally maintained well above the minimum growth requirements for the shallow species *Zostera muelleri* (6 mol m^{-2} day^{-1}) (Figure 33). Water temperature at deeper sites was cooler than the shallow sites, with peaks well below temperatures likely to impact these species. At shallow sites there were some temperature peaks above 30 ^{0}C but these did not extend long enough to be a concern for the seagrass species that occurred in these meadows (Rasheed et al 2025).

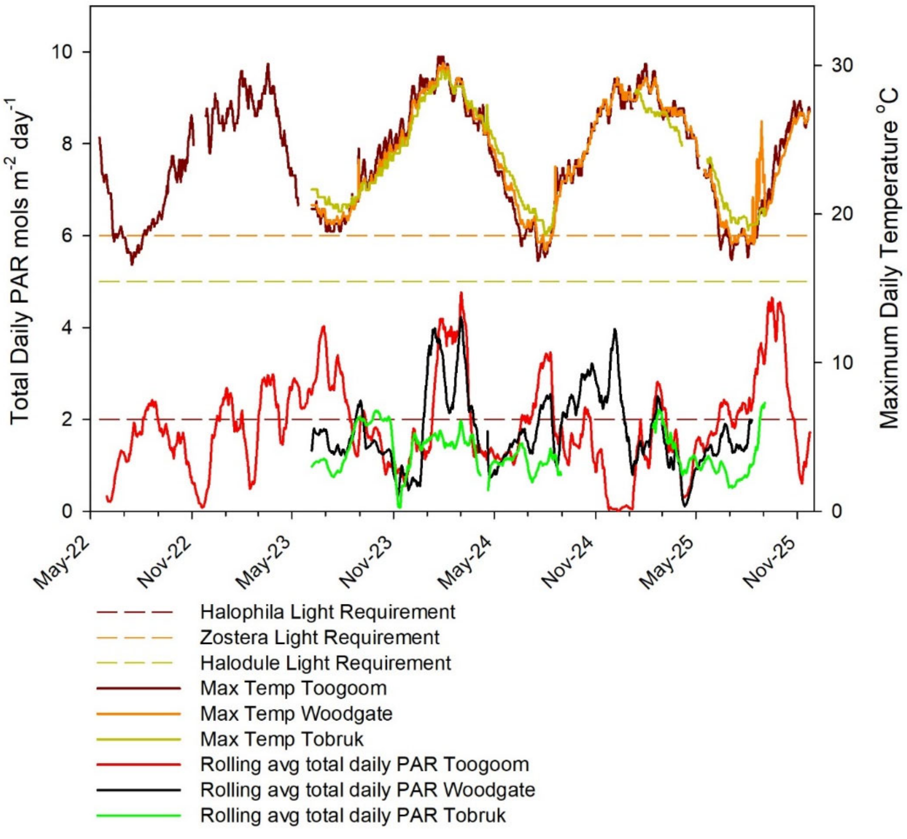

Figure 32. Total Daily PAR (mol m^{-2} day^{-1}) and maximum daily temperature (^{0}C) readings from light logging staitons at Toogoom, Woodgate and Tobruk from May 2022 to December 2025. Light requirements (LR) for three different seagrass genera (*Halophila, Zostera, Halodule*) are also shown (see Rasheed et al 2025).

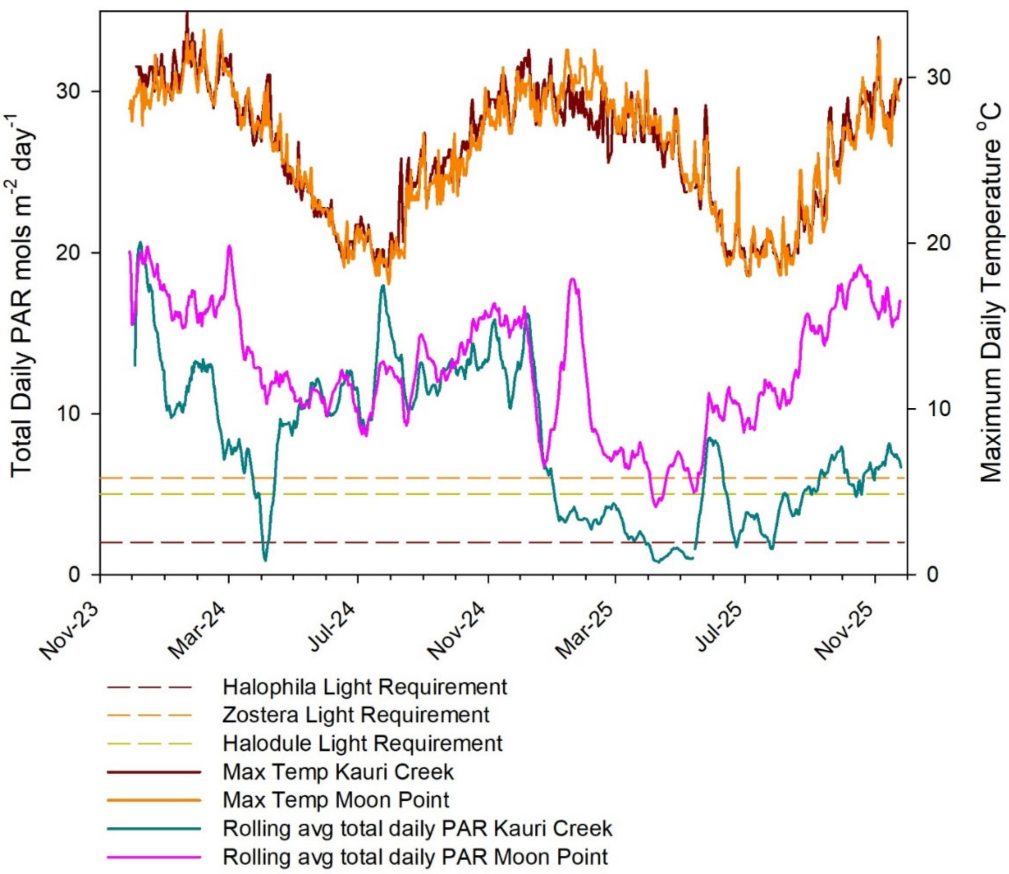

Figure 33. Total Daily PAR (mol m^{-2} day^{-1}) and maximum daily temperature (^{0}C) readings from light logging staitons at Moon Point and Kauri Creek from mid November 2023 to December 2025. Light requirements (LR) for three different seagrass genera (*Halophila, Zostera, Halodule*) are also shown (see Rasheed et al 2025).

There have been no major flood events of the Mary River following the large-scale flooding in early 2022. River discharge remained relatively low throughout 2023 and 2024, with only minor flow pulses observed (Figure 34). There was a comparitvely minor flash flood event in March 2025 associated with Tropical Cyclone Alfred, however this was not at the magnitude likely to generate prolonged, catchment-wide discharge and associated plume conditions that impacted seagrasses so severely following the 2022 floods (Figure 34). Benthic PAR at the two shallow sites did decrease around this time and was likely a reflection of lower incident light associated with high cloud cover and rainfall (Figure 33).

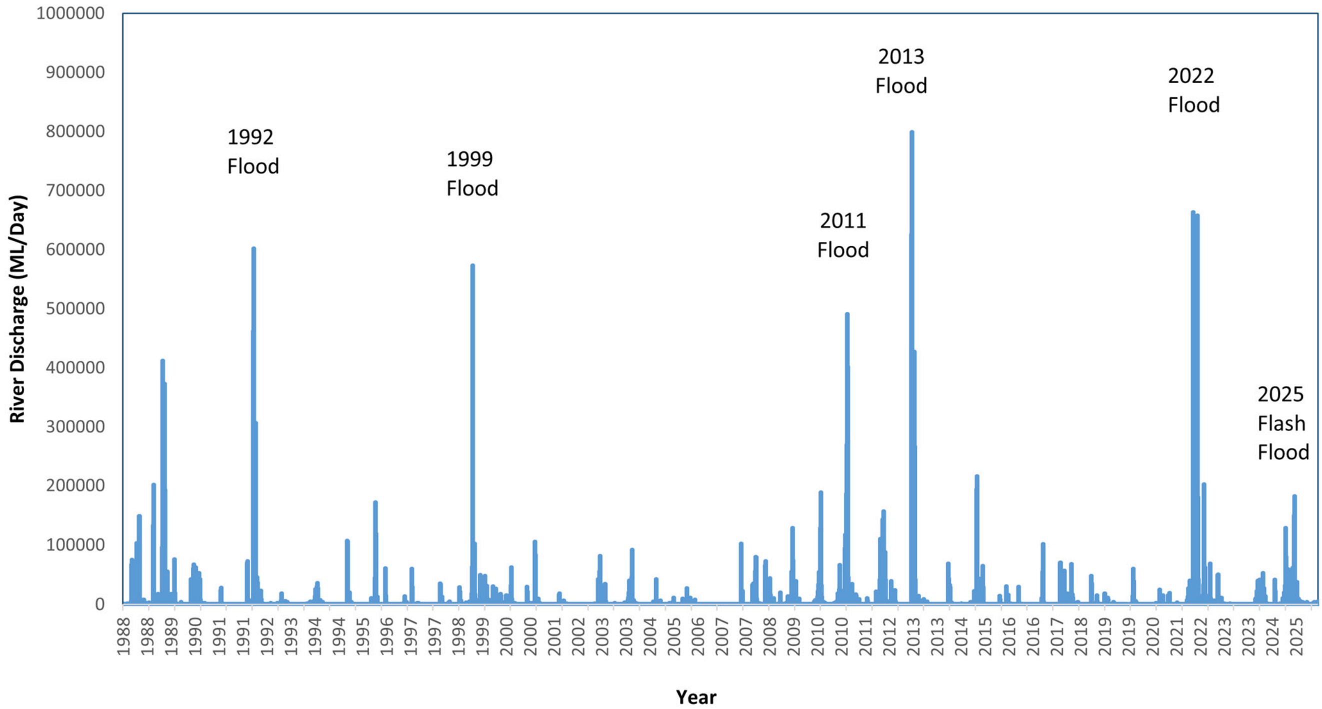

Figure 34. Daily discharge at Home Park gauge (138014A) in the Mary River from 1988 to Dec 2025. Data sourced from the Queensland Government (https://water-monitoring.information.qld.gov.au/

6 DISCUSSION

In 2025 seagrass meadows in the Great Sandy Marine Park (GSMP) continued to recover from the major 2022 flood disturbances that led to significant seagrass declines and impacts to dugongs and green turtles. Overall results from the 2025 monitoring show seagrasses in the best condition recorded since larger scale seagrass assessments and monitoring were re-established in 2022. Many of the monitoring areas had returned to be similar to 27 years ago, the last time such assessments were conducted prior to the 2022 floods. The biggest improvements in 2025 occurred for intertidal meadows within the Great Sandy Strait region, where seagrass area and biomass were at record high levels for many locations. Deeper meadows in Hervey Bay, that had recovered relatively rapidly following the floods, were stable. Only the shallow intertidal meadows on the western side of Hervey Bay potentially remained below pre-flood and historical levels.

Seagrass was present in all 12 of the representative monitoring blocks that comprise the annual long-term monitoring strategy. The total seagrass area within these regions was 263 km^2, a 92% increase compared with the post flood survey in 2022 (York et al. 2022) and approaching a similar spatial footprint to historical surveys from 1998 (McKenzie et al. 2017). Across all the monitoring areas, mean seagrass density measured as above ground biomass was the highest recorded across the five post-flood surveys (13.97 ± 1.05 g DW m^{-2}), and mean percent cover (16.6 ± 0.9%) maintained its peak level from the previous year in 2024.

Not all areas within the monitored extent had the same degree of recovery over the same timeline. The seagrass in the intertidal/shallow subtidal areas in southern Hervey Bay between Burrum Heads and Point Vernon, while much improved, remained well below the historically recorded maximum extent and well below peak biomass and cover measured in the past. The intertidal seagrass between Burrum Heads and Toogoom (HB7) and to the west of Point Vernon (HB8) were still less than half the area recorded in 1998. These meadows had similar biomass and cover to 2024, however percent cover remained under 10% overall, compared to 10-50% in the surveys conducted in the 1990's (Lee Long et al. 1992; Preen et al. 1995) and fluctuating up to 30-40 percent over the last 20 years at the Seagrass-Watch site the lies within this meadow (Seagrass-Watch 2026). It is difficult to know if this difference is specifically related to the flood impacts in 2022, or if the pre-flood baseline had shifted and the current seagrass condition had reached that immediate pre-flood level. Unfortunately no seagrass monitoring at an appropriate spatial scale to compare with the post flood monitoring program had been conducted for more than 20 years prior to the 2022 floods, so it was not possible to assess if the baseline had shifted. .

The biggest increases to seagrasses between 2024 and 2025 occurred within the intertidal seagrass areas of the Great Sandy Strait region. These meadows were particularly heavily impacted from the 2022 floods where they had reduced to 22% of their 1998 distribution and 17% of the area mapped in 2002 (Bryant et al 2023; Rasheed et al 2025). Where seagrasses remained, they were typically less than 1% in cover and 0.1 g DW m^{-2} in biomass (Rasheed et al 2025). While some recovery occurred in 2023 it wasn't until the most recent surveys in 2024 and again in 2025 that major increases occurred. In 2025 area of seagrasses was now larger than for any previous survey. Seagrass biomass also underwent major increases particularly for the *Zostera* dominated meadows in Urangan (GSS2 - 22.7 g DW m^{-2}, Tin Can Bay (GSS-5 - 35.5 g DW m^{-2}), and Kauri Creek (GSS 4 – 19.3 g DW m^{-2}) achieving levels that were higher than recorded prior to the 1999 floods of 29.2 g DW m^{-2} (Urangan) and 7.0 g DW m^{-2} (Kauri Creek) (McKenzie et al. 2000).

Deeper subtidal seagrasses in Hervey Bay, having largely recovered in area in 2023 and 2024, were less affected by the 2022 floods than the shallower meadows of higher light requiring species (Rasheed et al 2025). These meadows have been quite variable in biomass and cover between years which is typical of *Halophila*-dominated meadows. The life cycle of *Halophila* species is characterised by rapid colonisation of suitable habitat following disturbance, relying on short reproductive cycles and maintenance of large seed banks (Kilminster et al. 2015). They are also more susceptible to unfavourable light conditions and can decline rapidly in these environments (Kilminster et al. 2015). While abundances of Hervey Bay deepwater meadows are relatively high compared to the Great Barrier Reef lagoon (Coles et al. 2009), they were still below some historical comparisons in the region with estimates of more than 50 percent cover in 1988 (Lee Long et al. 1992; Preen et al. 1995) and mean biomass for deep-water meadows in 1998 between 20 - 35 g DW m^{-2} (McKenzie et al. 2000), substantially higher than the 4.28 g DW m^{-2} and 13.4% cover for these areas in 2025.

Maintaining adequate light levels to support seagrass growth is a key requirement for seagrass recovery. A range of light (PAR) levels for GSMP seagrass species and more broadly in the Burnett Mary region has been developed as part of updated water quality guidelines for the region (Rasheed et al 2025), and these have been used in this report for comparison/assessment purposes. During 2024 and 2025 these thresholds were achieved and surpassed for the majority of the time for intertidal species (*Zostera* and *Halodule*) and locations, explaining the substantial expansion and recovery that occurred in these meadows. In deeper water areas where there is greater light attenuation, PAR levels were below the *Halophila* thresholds for substantial periods of time, and while this is typical of many deepwater seagrass areas along the Queensland coast (Rasheed et al 2014; Chartrand et al 2018) it may explain the lack of further increases in seagrass abundance in these regions over the past two years.

The availability of benthic PAR data as part of this monitoring program has been a key to understanding the drivers of seagrass change. Extensive research has been able to develop benthic PAR requirements for seagrasses that provide ecologically relevant thresholds to ensure they can maintain positive growth (Rasheed et al 2025; Collier et al 2016). Daily benthic light or photosynthetically active radiation (PAR) is the portion of the light spectrum utilised by plants for photosynthesis and varies across plant communities and the species-specific adaptive responses they have acquired (Dawson and Dennison 1996). Many of the pathways for other water quality parameters (e.g. water clarity and total suspended solids) impacting seagrass condition are linked to their resultant action on benthic PAR. As seagrasses respond to the benthic light environment, direct assessment of benthic PAR is much more effective in understanding impacts than applying a derived threshold using indirect measures such TSS or Secchi depths. Direct monitoring of benthic PAR is now relatively inexpensive, and we recommend that the monitoring program continues to utilise directly measured benthic PAR if possible. This means that rather than using surrogates for benthic light such as TSS and Secchi depths and some form of modelled approach to arrive at benthic light through light attenuation coefficients etc., we can assess against thresholds of benthic PAR, the thing seagrasses are actually responding to and directly measure this.

As seagrasses integrate their light requirements over periods of days to weeks and months (depending on species) limited point in time measurements of the light climate (or its surrogates) are also of limited use compared with the continuously logged data available to this program. The array of benthic PAR locations within the GSMP provides a good representation of the different depths and locations that seagrasses occur within the GSMP as well as a spread of locations likely to be variably influenced by flood plumes and different hydrodynamic regimes.

In most areas within the GSMP, seagrass condition now appears comparable to levels observed prior to the 2022 flood disturbance. While for some locations some metrics remain below the highest historic observations from the 1998 survey, these comparisons should be interpreted cautiously given the differing survey design and effort and the single historical reference point. The consistent approach employed from the post flood program from 2022 provides the best indication of current seagrass recovery and trajectory.

The recovery trajectory from the most recent 2022 floods appeared to be similar to previous large scale flood events that have impacted Hervey Bay and the Great Sandy Strait such as following the 1992 floods when deepwater seagrasses recovered over a similar timeframe (Preen et al 1995) and following the 1999 floods when Great Sandy Strait seagrasses took around three years to recover (Campbell & McKenzie 2004). Following the most recent floods a typical successional pattern of seagrass recovery occurred (Rasheed 2004), particularly in intertidal meadows where colonising *Halophila* and opportunistic *Halodule uninervis* first established in meadows before being displaced by *Zostera muelleri* in the most recent surveys. It was interesting to note that for the Great Sandy Strait, where the most substantial recovery occurred in 2025, this was evident in the above ground biomass but not in percent cover for some meadows. This was due to the key species in these meadows *Zostera muelleri* increasingly dramatically in size with much longer and wider leaves rather than an increase in shoot density and cover, emphasizing the value of incorporating seagrass biomass assessments to monitoring where possible.

Improving seagrass abundance across the region is an encouraging sign for dugong and green sea turtle populations, and associated species (e.g. fish) reliant on or benefitting from seagrass. Both dugong and green turtles have historically occurred throughout Hervey Bay and the Great Sandy Strait, with aerial surveys in 2005, 2011 and 2016 recording densities from low to very high (Cleguer et al. 2023; Rasheed et al. 2025). Following the major floods in early 2022, no dugongs were recorded in the Great Sandy Strait, while widespread seagrass loss coincided with increased turtle strandings across the Great Sandy Bioregion in 2022–2023 (Rasheed et al. 2025). Although recent stranding data were not examined for this report, improving seagrass habitat suggests that foraging conditions for these (and other) species are likely much improved.

Conclusions and recommendations

Overall, the 2025 survey indicates that seagrass condition within the GSMP has largely returned to levels comparable with those observed prior to the 2022 flood disturbance. Some areas were still below historical highs, and continued monitoring will be important to track longer-term trends. Given the importance of seagrass habitats for dugong and turtle foraging in the region, and for the values of the GSMP, continuing the long-term monitoring strategy will be essential for effective management and avoiding the challenges faced in assessing impacts and recovery from the 2022 floods where the most recent appropriate scale data were more than 20 years old. This includes benthic PAR monitoring that provides essential context in assessing seagrass outcomes.

The long-term monitoring strategy, implemented for the second time in 2025, establishes a network of monitoring areas across the major deep-water, subtidal and intertidal seagrass communities throughout the GSMP, including a variety of key management zones and has been effective in tracking seagrass changes and recovery. Coupled with periodic assessments across the broader GSMP approximately every 5 years and ideally coinciding with scheduled dugong population surveys (Rasheed et al 2025) it provides a sound basis for monitoring seagrass condition and informing future management responses. The approach provides a consistent time series of seagrass condition while remaining more logistically feasible and cost-effective than conducting annual broadscale surveys.

We now have four years of monitoring data with this consistent approach and continuing this annually will support the establishment of condition metrics for seagrasses within the GSMP. With one additional year of monitoring, the program will achieve five consecutive years of data, allowing the development of interim baseline condition metrics using the scoring framework outlined by Carter et al. (2023) and implemented across the Regional Report Card network for the Great Barrier Reef including the Gladstone Healthy Harbour Partnership and other Great Barrier Reef catchment partnerships.

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