Government of **Western Australia**
Department of **Water**

Synthesis of seagrass mapping studies conducted by the Water Science Branch of the Department of Water.

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Department of Water

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Disclaimer

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1.1 Introduction

The spatial distribution of seagrass has been formally investigated in 11 estuaries along the southwest coast of Western Australia between 2006 and 2010. These include the Albany Harbours (Princess Royal Harbour & Oyster Harbour), Stokes Inlet, Wellstead estuary, Beaufort Inlet, Wilson Inlet, Irwin Inlet, Walpole-Nornalup Inlets, Hardy Inlet, Leschenault Estuary, Peel-Harvey Estuary and the Swan-Canning estuary.

Background

The 2006 study of the Albany Harbours was funded by South Coast NRM (formerly SCRPT) and forms part of the South Coast Regional Strategy. The objectives of the study were to map the distribution of the different seagrass species found in Princess Royal Harbour and Oyster Harbour and to compare the present distribution with that observed in previous studies (1998 and 1996).

The 2007 survey in Wilson Inlet was conducted to review any changes in seagrass distribution since the previous survey in 1996, and was funded internally by the Water Science branch.

Surveys conducted in Wilson Inlet in 2008 and in 2009/2010 in Stokes Inlet, Wellstead Estuary, Beaufort Inlet, Irwin Inlet, Walpole-Nornalup Inlets and the Leschenault Estuary were conducted by the Department of Water together with Geoscience Australia. The objective of these surveys was to collect baseline data on seagrass composition and distribution in these estuaries. Funding for the project was through the Strategic Reserve of the NAP/NHT as part of the Resource Condition Monitoring endorsed under the State (Western Australia) Natural Resource Management framework.

The 2008 survey of the Hardy Inlet and 2009 survey of the Peel Harvey Inlet were conducted by the Marine and Freshwater Research Laboratory at Murdoch University for the Department of Water. Both studies aimed to examine the long term changes in seagrass and macroalgae abundance and distribution in these estuaries.

The Swan-Canning estuary in 2011 was funded by the Department of Water.

1.2 2006 Albany harbours survey

Methodology

The mapping methodology of the Albany Harbours survey involved acquiring high quality aerial photographs and interpreting the aerial photography to identify seagrass areas. Intersecting transects across these areas were used to ground truth density (percentage cover) and species composition of the seagrass habitats. The ground trothing field work was undertaken by underwater video tows, shore transects, and spot dives and observations from a small punt or boat equipped with GPS tracking equipment. These areas were then digitised in ARC GIS.

Limited resources and the methodology necessitated distributions and densities to be averaged over large areas. Seagrass distributions and changes in density may have

been under or over represented in different parts of the Harbours, making comparisons to previous surveys and estimations of change difficult.

Summary of results

The main species of seagrass recorded during the survey were; *P. australis, P. sinuosa, A. griffithii and A. antarctica.* The two species of *Amphibolis*, could not be differentiated by the remote sensing techniques employed in this study and as a result were grouped into a single category of *Amphibolis* species. Other species recorded in the survey included *P. coriacea*, and *Heterozostera* in Princess Royal Harbour and *Ruppia* species in Oyster Harbour.

A total area of 15.5 km^2 of seagrass was recorded in Princess Royal Harbour during this study. The dominant species of seagrass recorded in the Harbour was *P. sinuosa* which occurred over an area of 11.2 km^2, seconded by *P. australis* which covered an area of 4.1 km^2. The combined total for *P. sinuosa* and *P. australis* (15.3 km^2) includes 1.6 km^2 where these two species overlap and occurred as mixed meadows. The total area of seagrass habitat created by these two species is therefore 13.7 km2. *Amphibolis* and *P. coriacea* meadows accounted for 1.8 km^2 of the seagrass habitat mapped in Princess Royal Harbour.

A total area of 5.6 km^2 of seagrass was recorded in Oyster Harbour during this study. The dominant species of seagrass recorded in the Harbour was *P. australis* which occurred over an area of 3.9 km^2, seconded by *P. sinuosa* which covered an area of 3.1 km^2. The combined total for *P. australis* and *P. sinuosa* (7 km^2) again includes 1.6 km^2 where these two species occurred together as mixed meadows. The total area of seagrass habitat created by these two species is therefore 5.4 km^2. *Ruppia* occurred over an area of 0.2 km^2.

Table 1 Metadata statement for the Albany Harbours seagrass mapping survey

Year	**2006**
Survey type	Towed underwater video / snorkel
Method	Visual estimate
Metric	Percent cover (incorporating 5 categories, <15 %, 16-45 %, 46-75 %, >75 %, patchy *x* %)
Unit of measurement	Transect
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Nil
Additional comments	Nil

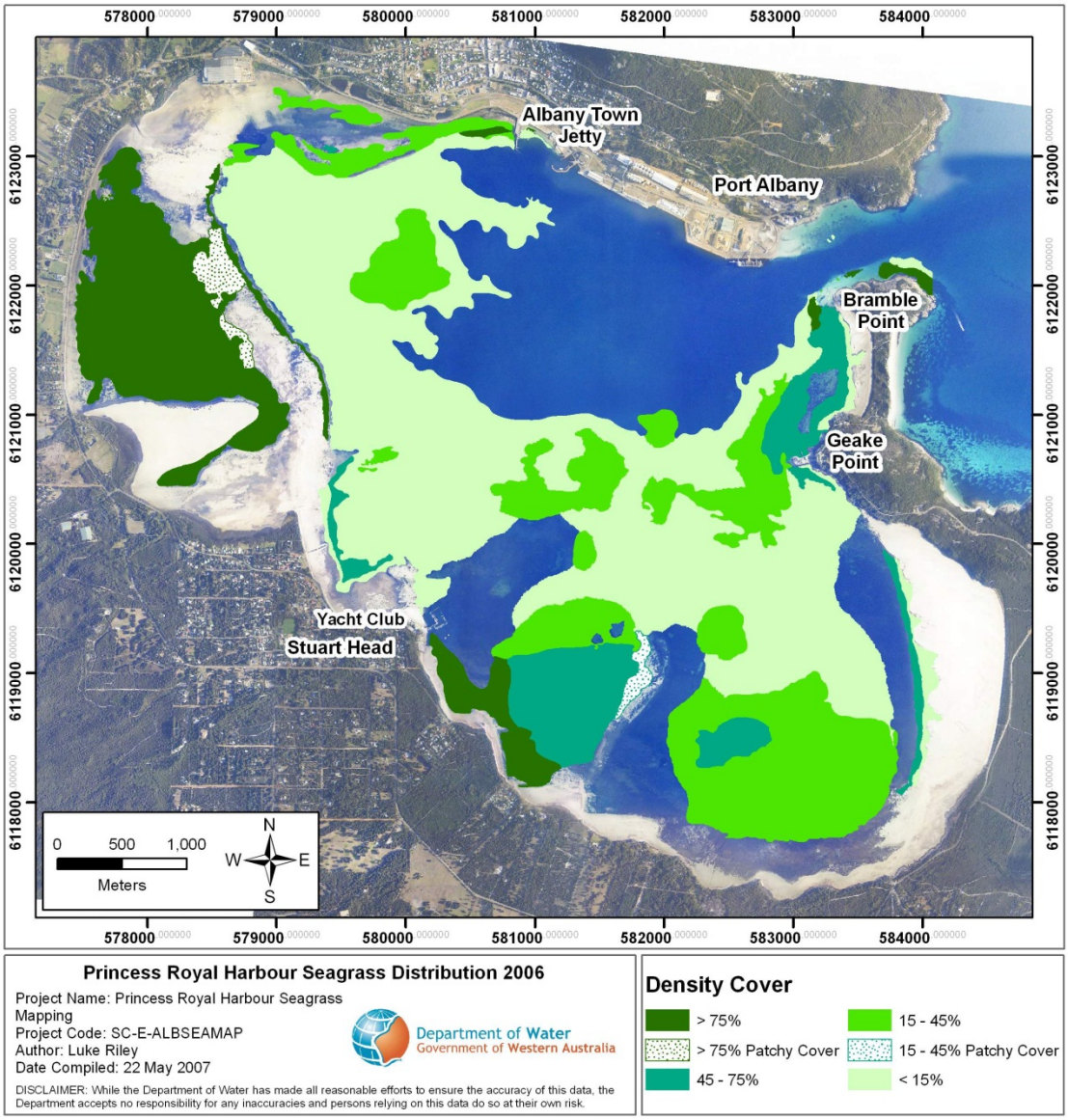

Figure 1 Seagrass distribution in Princess Royal Harbour (2006)

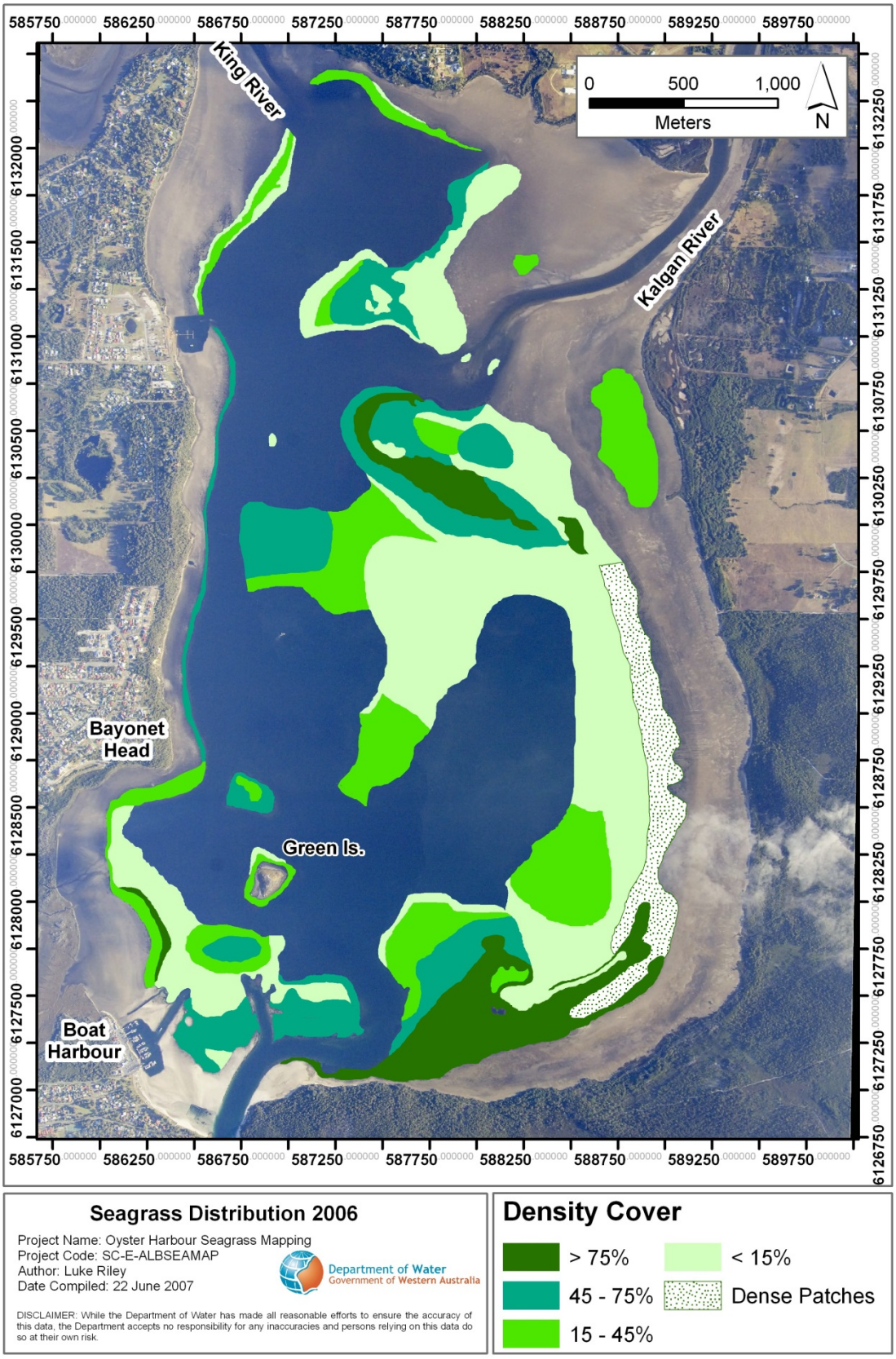

Figure 2 Seagrass distribution in Oyster Harbour (2006)

1.3 2007 Survey of Wilson Inlet

Methodology

The Wilson Inlet seagrass survey was conducted by snorkel tows along predetermined transects in the estuary. The transects were 200-300 m apart running perpendicular to the shoreline to the edge of the seagrass meadow (usually ending before the 3m depth limit). Coordinates were recorded along each transect together with percentage cover classes of seagrass.

Seagrass density changes in Wilson inlet were mapped using ArcView™. Spatial Analyst was used to create the distribution map of seagrass in the Inlet by interpolating density data between the points using the inverse distance weighted method. Given the basin type nature of the Inlet a cut-off boundary of seagrass was *assumed* using the 2 meter contour line of the Wilson Inlet bathymetry layer. Two meters was the **reported depth limit** of seagrass in the Inlet. This showed the central part of the basin to have no seagrass.

The objective of the study was to compare seagrass coverage in the Inlet in 2007 to the coverage recorded in 1996.

Summary of results

Seagrass in Wilson Inlet is dominated by the seagrass *Ruppia megacarpa*. Distribution in the Inlet was mainly around the shallow perimeter of the Inlet. Wilson Inlet deepens towards the centre of the basin and seagrass density gradually decreases as water depth increases due to reductions in light attenuation which limit seagrass growth.

The distribution map is constrained by the assumption of the seagrass depth limit and may underestimate coverage in areas that were not surveyed. Similar distribution patterns were observed in 2007 to the survey in 1996.

Table 2 Summary of species and habitat areas in the 2007 Wilson Inlet seagrass mapping survey

Estuary	Species	Area of estuary (km^2)	Area of SAV (km^2)
Wilson Inlet	*Ruppia megacarpa*	48	26.4

Table 3 Metadata statement for the Wilson Inlet seagrass mapping survey conducted by the Department of Water (2007).

Year	2007
Survey type	Snorkel
Method	Visual estimate
Metric	Percent cover (Percent cover (incorporating 5 categories, <15 %, 16-45 %, 46-75 %, >75 %, patchy *x* %)
Unit of measurement	Transects
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	
Additional comments	

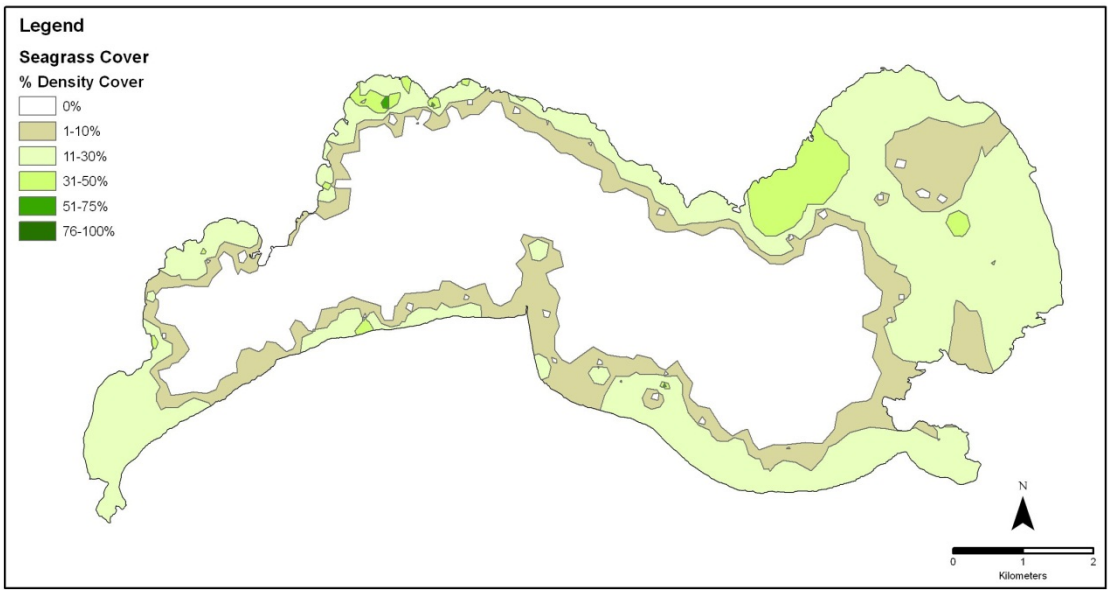

Figure 3 Seagrass distribution in Wilson Inlet (2007)

1.4 2008 Survey of Wilson Inlet

Methodology

This survey was completed in November/December 2008 as a component of a Masters project by Maggie Tran, employed by Geoscience Australia. The main objective of this survey was to characterise the benthos, of which submerged aquatic vegetation (seagrass) was a component/category. Assistance with seagrass identification and classification was provided by Vanessa Forbes from the Department of Water.

Sites were preselected in a grid arrangement over the whole extent of the estuary. Three random sites North, East and South of the site were also surveyed. The distance between fixed and random sites was variable.

The underwater video was deployed at each of the fixed and random sites in each estuary. Camera deployment at each of the sites captured data along transects, with the boat traveling into or with the prevailing winds to minimize movement of the boat and camera. Transects were between 2 and 4 minutes long and covered 50 to 100m at each of the random sites.

Species composition and density (as percentage cover) were assessed in the field from the visual image obtained on the video along with other substrate categorization. All video transects were recorded for verification.

Seagrass density changes in Wilson inlet were mapped by the Department of Water using ArcView^{TM}. Spatial Analyst was used to create the distribution map of seagrass in the Inlet by interpolating density data between the points using the inverse distance weighted method. Given the basin type nature of the Inlet a cut-off boundary of seagrass was ***assumed*** **as the maximum depth** at which seagrass was recorded in the survey (3 m). This showed the central part of the basin to have no seagrass.

Summary of results

Patterns of distribution and percentage cover were similar for both the 2007 and 2008 surveys. Distribution was mainly around the perimeter of the Inlet and *Ruppia megacarpa* was still the main species. The slight increase in seagrass habitat in the Inlet may be real or as a result of using the maximum depth at which seagrass was recorded in the survey (3 m) rather than the assumed depth of 2 m used in 2007.

Table 4 Summary of species and habitat areas in the 2008 Wilson Inlet seagrass mapping survey

Estuary	Species	Area of estuary (km^2)	Area of SAV (km^2)
Wilson Inlet	*Ruppia megacarpa*	48	29.2

Table 5 Metadata statement for the Wilson Inlet seagrass mapping survey conducted by Geoscience Australia and the Department of Water (2008).

Year	**2008**
Survey type	Underwater video (video tows)
Method	Visual estimate
Metric	Percent cover (incorporating six categories, zero, 1-10%, 11-30%, 31-50%, 51-75% and 76-100%)
Unit of measurement	Transects
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Physical profiles, biomass estimates
Additional comments	

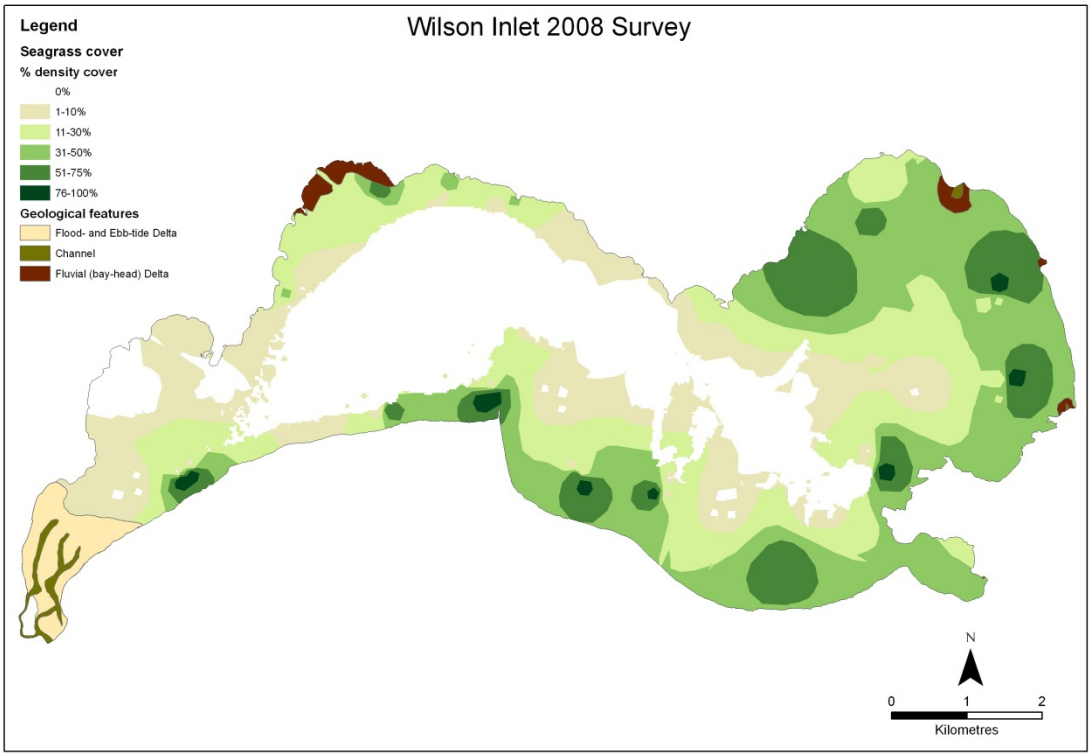

Figure 4 Seagrass distribution in Princess Wilson Inlet (2008)

1.5 2009/10 south coast and southwest coast estuary surveys

Methodology

(The following methodology was adapted from the Wilson Inlet survey in 2008 conducted by Geoscience Australia with the Department of Water).

Maps of submerged aquatic vegetation (predominantly seagrass) were prepared from geo-referenced underwater video data captured in each of the six estuaries in March and April 2009.

Site selection in each estuary involved the preparation of a 250m by 250m grid referenced aerial image of the estuary. 'Fixed' sites were determined by the intersection of the easting and northing lines on the map and were evenly spaced across the extent of the estuary to optimise the area covered across the estuary. Associated with each of the fixed sites were four 'random' sites located North, East, South and West of each 'fixed' site. The distance between fixed and random sites depended on distance between fixed sites with the objective to maximise coverage between sites.

The underwater video was deployed at each of the fixed and random sites in each estuary. At the fixed sites, the camera was deployed while the boat was anchored to capture precise point data that corresponded to other sediment and water quality data collected. Camera deployment at each of random sites captured data along transects, with the boat traveling into or with the prevailing winds to minimize

movement of the boat and camera. Transects were between 2 and 4 minutes long and covered 50 to 100m at each of the random sites.

Species composition and density (as percentage cover) were assessed in the field from the visual image obtained on the video. All transects are recorded for verification.

Seagrass density changes in the estuaries were mapped by the Department of Water using ArcView™. Spatial Analyst was used to create the distribution map of seagrass in the Inlet by interpolating density data between the points using the inverse distance weighted method. In the absence of bathymetry data the depth limit of seagrass distribution could not be shown. In these instances seagrass distribution may be overestimated in the deeper sections of the estuary.

Summary of results

Three species of seagrass are typically found in estuaries on the south and south west coast of Western Australia. These are *Ruppia megacarpa*, *Halophila ovalis*, and *Zostera muelleri*.

Ruppia megacarpa is a perennial species distributed widely throughout Western Australia and was recorded in all 6 estuaries surveyed in 2009 (and Wilson Inlet in 2008).

Halophila ovalis is widespread throughout Western Australia and occurs in nearshore marine and estuarine waters up to 5 m deep. Halophila was only found to occur in the Leschenault Estuary of the south and south-west coast estuaries studied here (Table 6).

Zostera muelleri is a perennial species found in subtidal marine or estuarine environments. Of the 7 estuaries surveyed in 2008 and 2009 it was only recorded in the Leschenault Estuary towards the marine entrance known as ‘the cut’. Records have also shown it to occur at the marine entrance of the Nornalup Inlet although it was not recorded in this survey.

Another submerged aquatic plant species recorded in the estuaries included the charophyte *Lamprothamnium papulosum.*

Table 6 Summary of species and habitat areas in Stokes Inlet, Wellstead estuary, Beaufort Inlet, Irwin Inlet, Walpole Nornalup Inlet, Leschenault estuary seagrass mapping survey

Estuary	Species	Area of estuary (km^2)	Area of SAV (km^2)
Stokes Inlet	*Polyphysa peniculus*	14	0.2
Wellstead Estuary	*Ruppia megacarpa, Lamprothamnium papulosum*	3	1.7
Beaufort Inlet	*Ruppia megacarpa*	7	2.9
Irwin Inlet	*Ruppia megacarpa*	13	7.5
Walpole-Nornalup Inlets	*Ruppia megacarpa* *Zostera muelleri*	14.8	0.4
Leschenault Estuary	*Ruppia megacarpa* *Halophila ovalis* *Zostera muelleri*	27	19.5

Table 7 Metadata statement for the Stokes Inlet, Wellstead estuary, Beaufort Inlet, Irwin Inlet, Walpole Nornalup Inlet, Leschenault estuary seagrass mapping survey

Year	**2009/10**
Survey type	Underwater video (drop camera and video tows)
Method	Visual estimate
Metric	Percent cover (incorporating six categories, zero, 1-10%, 11-30%, 31-50%, 51-75% and 76-100%)
Unit of measurement	Points and transects
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Physical profiles, sediment mud content
Additional comments	Nil

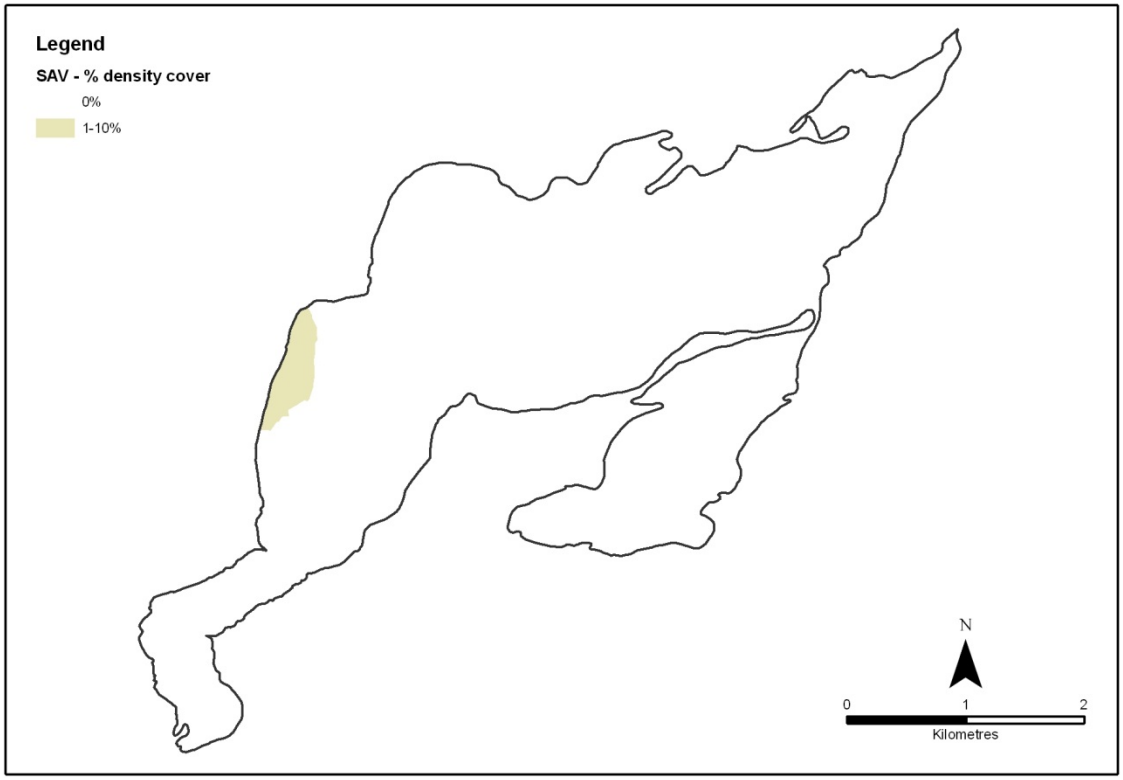

Figure 5 Seagrass distribution in Stokes Inlet (2009/10)

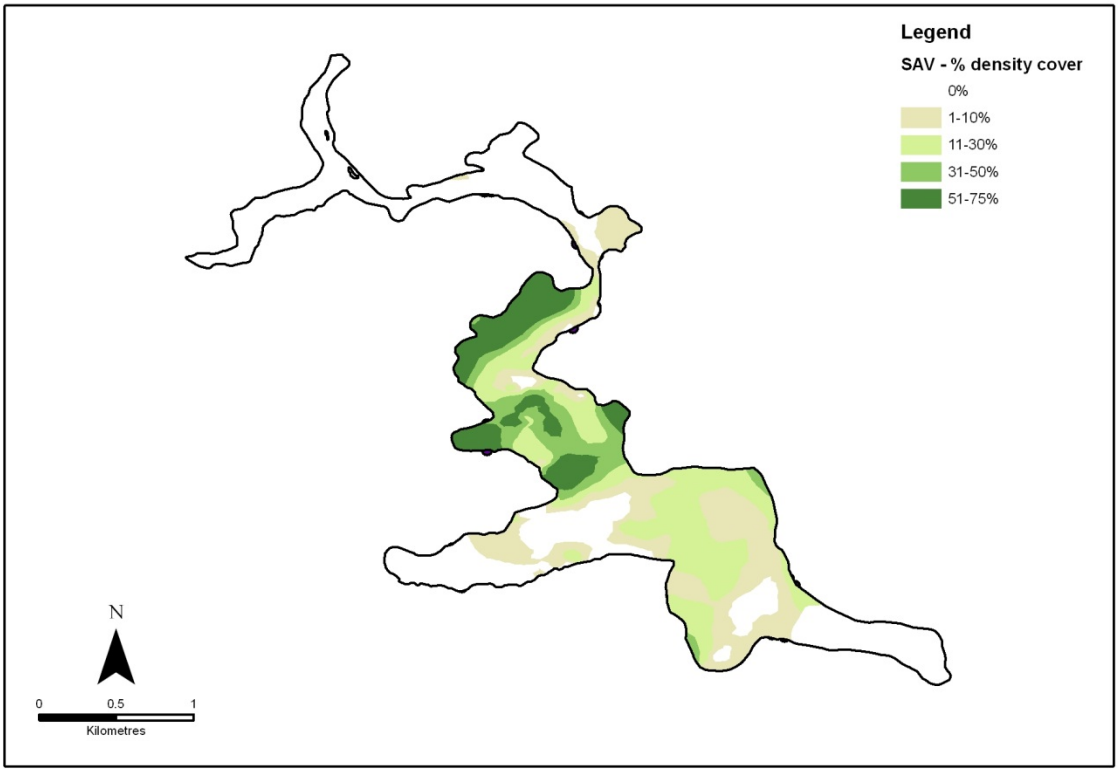

Figure 6 Seagrass distribution in Wellstead estuary (2009/10)

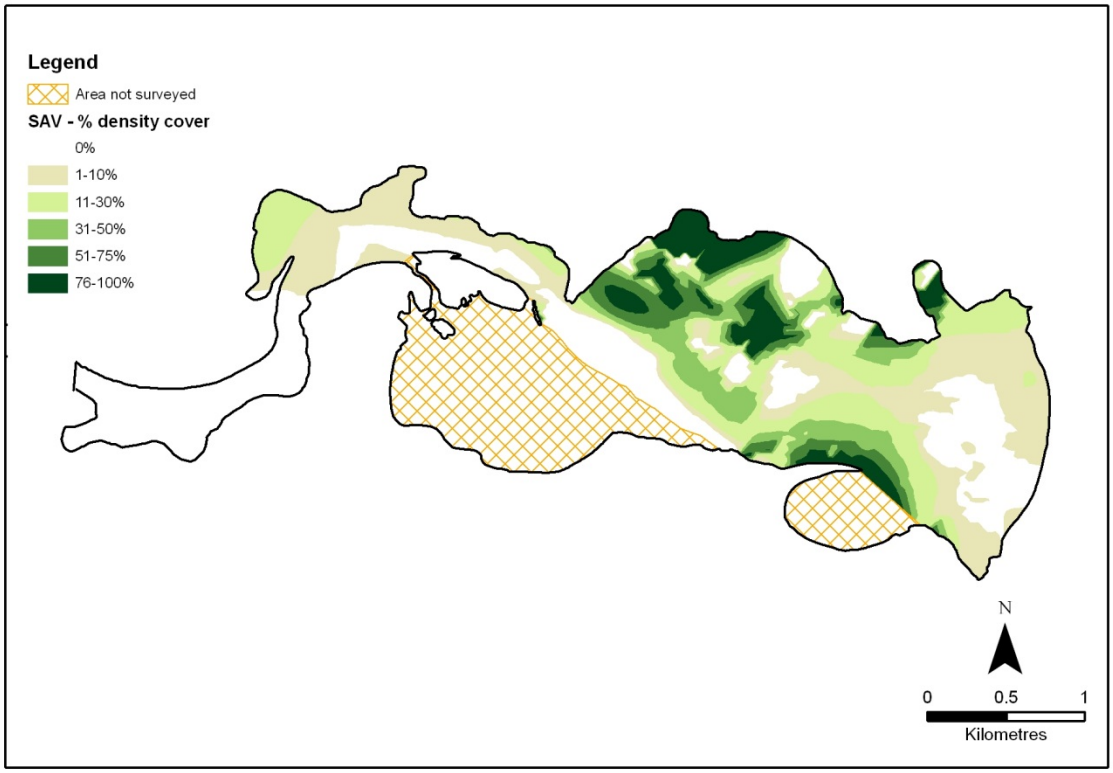

Figure 7 Seagrass distribution in Beaufort Inlet (2009/10)

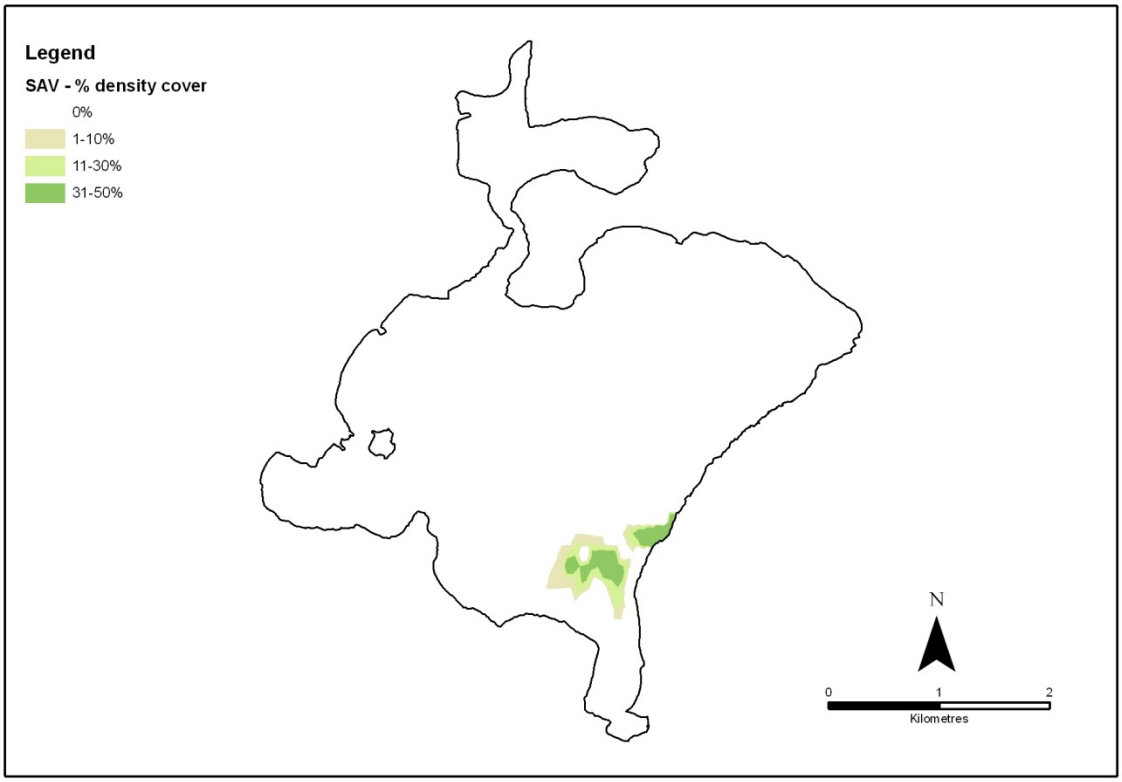

Figure 8 Seagrass distribution in Walpole-Nornalup Inlet (2009/10)

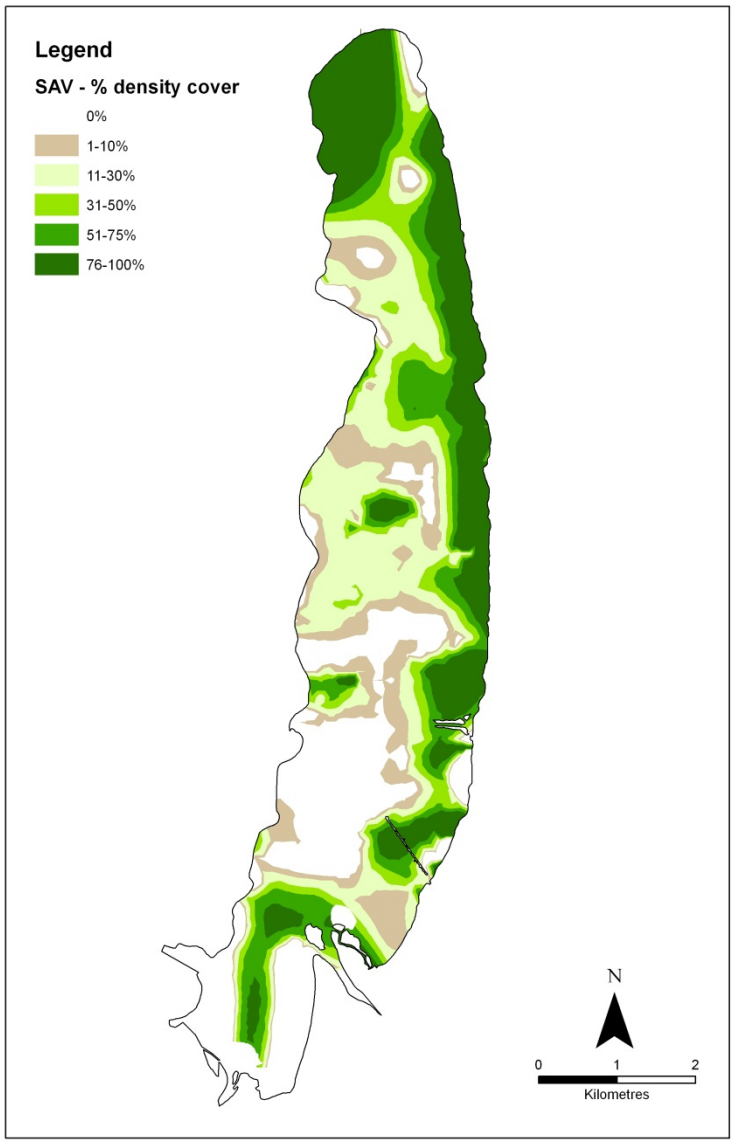

Figure 9 Seagrass distribution in the Leschenault Estuary (2009/10)

1.6 2008 survey of the Hardy Inlet

Methodology

An aquatic flora survey of the Hardy Inlet was conducted in April 2008 from the top of Molloy Island and the Scott River Basin to the mouth of the Inlet. The survey employed broad-scale characterisation techniques such as manta tows along transects, to cover the large area. Coverage estimates of seagrass and macroalgae were carried out according to that of English *et al.* (1994). Percentage cover was estimated on a scale of 0 to 100%, incorporating five categories, 0-10%, 11-30%, 31-50%, 51-75% and 76-100%. The GPS location of the beginning and end of transects were recorded. GPS coordinates and depths were also taken at points of interest and where there were any visual changes in habitat.

Summary of results

Ruppia megacarpa is the dominant seagrass in the Hardy Inlet. Historical surveys also identified *Ruppia maritima*, *Halophila ovalis and Zostera mucronata* in the estuary. These species were not present in the 2008 survey.

Table 8 Metadata statement for the Hardy Inlet seagrass survey

Year	2008
Survey type	Snorkel (manta tows)
Method	Visual estimate
Metric	Percent cover (incorporating five categories, 0-10%, 11-30%, 31-50%, 51-75% and 76-100%)
Unit of measurement	Transect
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Depth
Additional comments	Notes were taken of epiphyte growth and macroalgal accumulations

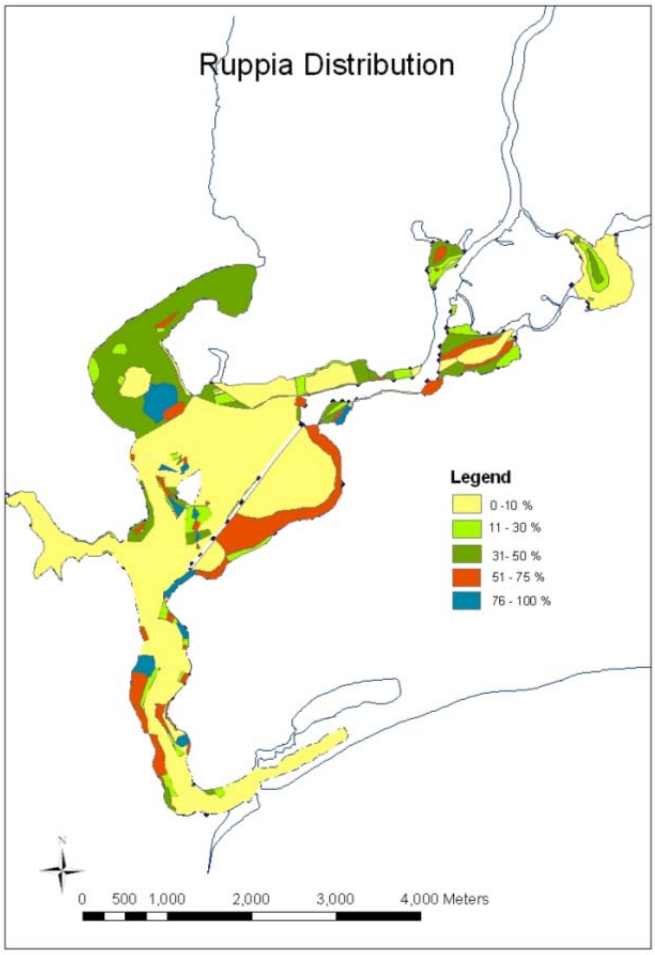

Figure 10 Seagrass distribution in the Hardy Inlet (2008) (map produced by MAFRL)

1.7 2009 survey of the Peel-Harvey estuary

Methodology

The Marine and Freshwater Research Laboratory (MAFRL) conducted stratified macroalgae and seagrass sampling of 45 sites within the Peel-Harvey Estuary in November / December 2009. The percentage of total area covered by macroalgae and seagrass at each site was determined visually by a snorkel diver making a number of passes over the area while being towed on a manta line behind a boat.

Core samples of macroalgae and seagrass were also collected to determine the dry weight biomass of representative percentage classes.

The dry weights were entered into Geographic Information Systems (GIS) software to determine total biomass and generate contour maps of distributions for individual components as well as the whole system. The GIS method applied in this study involved interpolation of field measurements across the study area (not sampled) and summing up individual cell values, to obtain total weight of the biomass in the Peel-Harvey system.

Summary of results

Channel area were dominated by *Halophila* spp. and *Ruppia* sp., changing to *Halophila* spp. in the centre of the basin, with *Ruppia* becoming dominant at sites in the far north east. The northern sites near Mandurah Channel comprised mainly *Zostera* sp. whereas the major species in the southern sites were *Ruppia* sp. Seagrass was not recorded in the central and southern regions of the Harvey Estuary.

Only one site in the south of the Peel Inlet (west of Robert Bay) showed a significant percentage cover of Charophyta being *Lamprothamnium* sp.

Table 9 Metadata statement for the 2009 Peel-Harvey estuary seagrass survey

Year	2009
Survey type	Snorkel (manta tows)
Method	Visual estimate
Metric	Percent cover (incorporating five categories, 0-10%, 11-30%, 31-50%, 51-75% and 76-100%)
Unit of measurement	Transect
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Depth, seagrass and algae biomass estimations
Additional comments	Samples were also analysed for total nitrogen and phosphorus concentrations as estimations of nutrient loads bound in plant biomass.

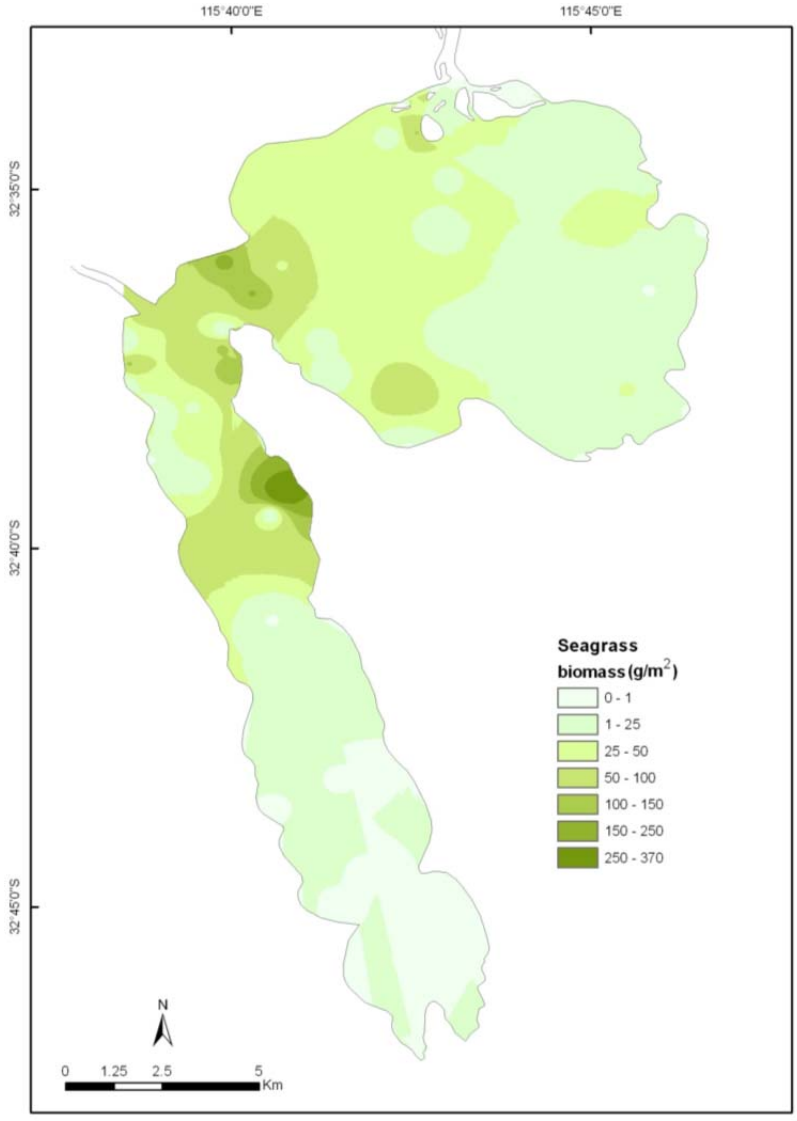

Figure 11 Seagrass distribution in the Peel-Harvey estuary (2009) (map produced by MAFRL)

1.8 Surveys of the Swan-Canning estuary

Methodology

A seagrass survey of the Swan-Canning estuary was conducted in March 2011 by the Department of Water. The survey used underwater video to classify seagrass coverage at fixed points along transects across the estuary. This data was used together with bathymetry and recent aerial imagery to map seagrass in the estuary. Percentage cover was estimated on a scale of 0 to 100% incorporating 6 categories. The GPS coordinates were pre-determined for this study with the help of rapid-eye imagery which identified the presence of submerged aquatic vegetation. Transects spanned across the width of the estuary in different directions. Seagrass distribution is limited by light and therefore depth. Using bathymetry information, GPS coordinates were spaced closer together in the shallower regions to maximise

information on seagrass coverage. Coordinates were 50 m apart in the 0-2m depth range, 100 m apart in the 2-3 m depth range and 500 m apart in areas where depths were greater than 3 m. Depths and readings of photosynthetic active radiation (PAR) were taken at every point.

Seagrass distribution in the estuary was mapped by physically drawing polygons around habitats visible in the aerial imagery in ARC GIS and integrating information from the data collected in the field. The maps may under or over represent seagrass habitats in different parts of the estuary. The distance between transects limited the ability to use interpolation of the density data. Interpolated maps proved too inaccurate.

Summary of results

Seagrass habitats were predominantly located between 'Melville Water' (downstream of the Narrows Bridge) and the Fremantle Port, and downstream of the Shelley Bridge in the Canning River. The dominant species in the estuary is *Halophila ovalis*. Patches and some isolated meadows of *Ruppia megacarpa* were observed in Whalen Bay, Lucky Bay and Freshwater Bay. *Zostera muelleri* predominantly occurred in the marine extent of the estuary and was observed as far upstream as Freshwater Bay.

Table 10 Metadata statement for the 2011 Swan-Canning estuary seagrass survey

Year	**2011**
Survey type	Underwater video camera
Method	Visual estimate
Metric	Percent cover (incorporating six categories, 0, 1-10%, 11-25%, 26-50%, 51-75% and 76-100%).
Unit of measurement	Points (along transects)
Unit size	Field of view (unknown)
Map file links	
Abiotic measures	Depth, physical and PAR profiles
Additional comments	

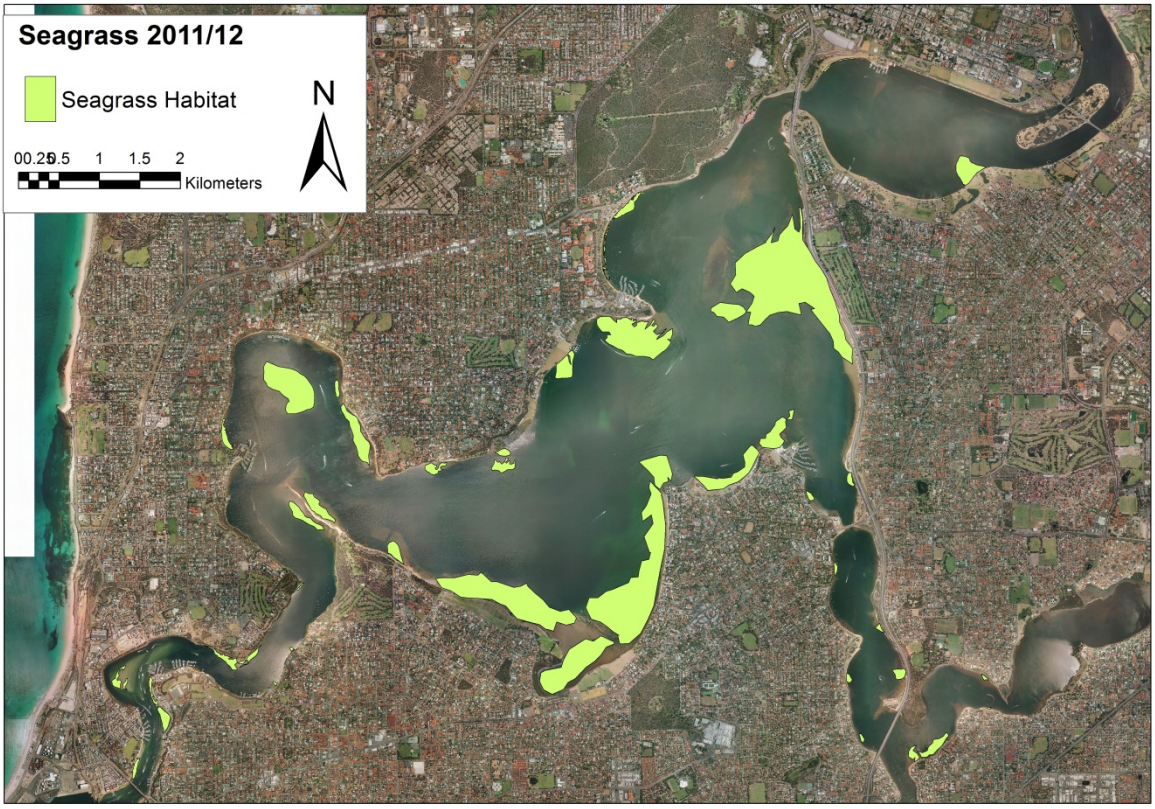

Figure 12 Seagrass distribution in the Swan-Canning estuary (2011)