Catchment to Coast

Connecting catchment actions to restore marine habitats on Kangaroo Island from 2013–18

Catchment to Coast assisted land managers to undertake best practice land management activities (fencing, revegetation, in-stream remediation) in the Cygnet River and Deep Creek catchments. This work connected and enhanced native vegetation to improve the quality of land-based runoff into Nepean Bay and Pelican Lagoon and reduce the decline of seagrass meadows. Seagrass restoration rehabilitated fragmented marine habitats. Project effectiveness was monitored by terrestrial, freshwater and marine indicators.

Why should we care?

Healthy riparian vegetation plays a critical role in maintaining the health of rivers and in supporting land-based (terrestrial) and freshwater and marine (aquatic) flora and fauna. It can improve stock health by providing shelter and increase crop and pasture yields by acting as a windbreak. Riparian vegetation provides habitat for fauna, including pollinators that prey on crop and pasture pests. Vegetated banks maintain soil structure, slow water runoff, assist water to infiltrate into the soil and reduce bank erosion and topsoil stripping.

Removal and degradation of riparian vegetation threatens soil condition, biodiversity and water quality of freshwater, estuarine and marine ecosystems. Without riparian vegetation, high loads of sediment and nutrients flow into watercourses, reducing the availability of light for aquatic and coastal plant growth and causing smothering algae to grow. This has resulted in the loss of large areas of coastal seagrass meadows in Nepean Bay.

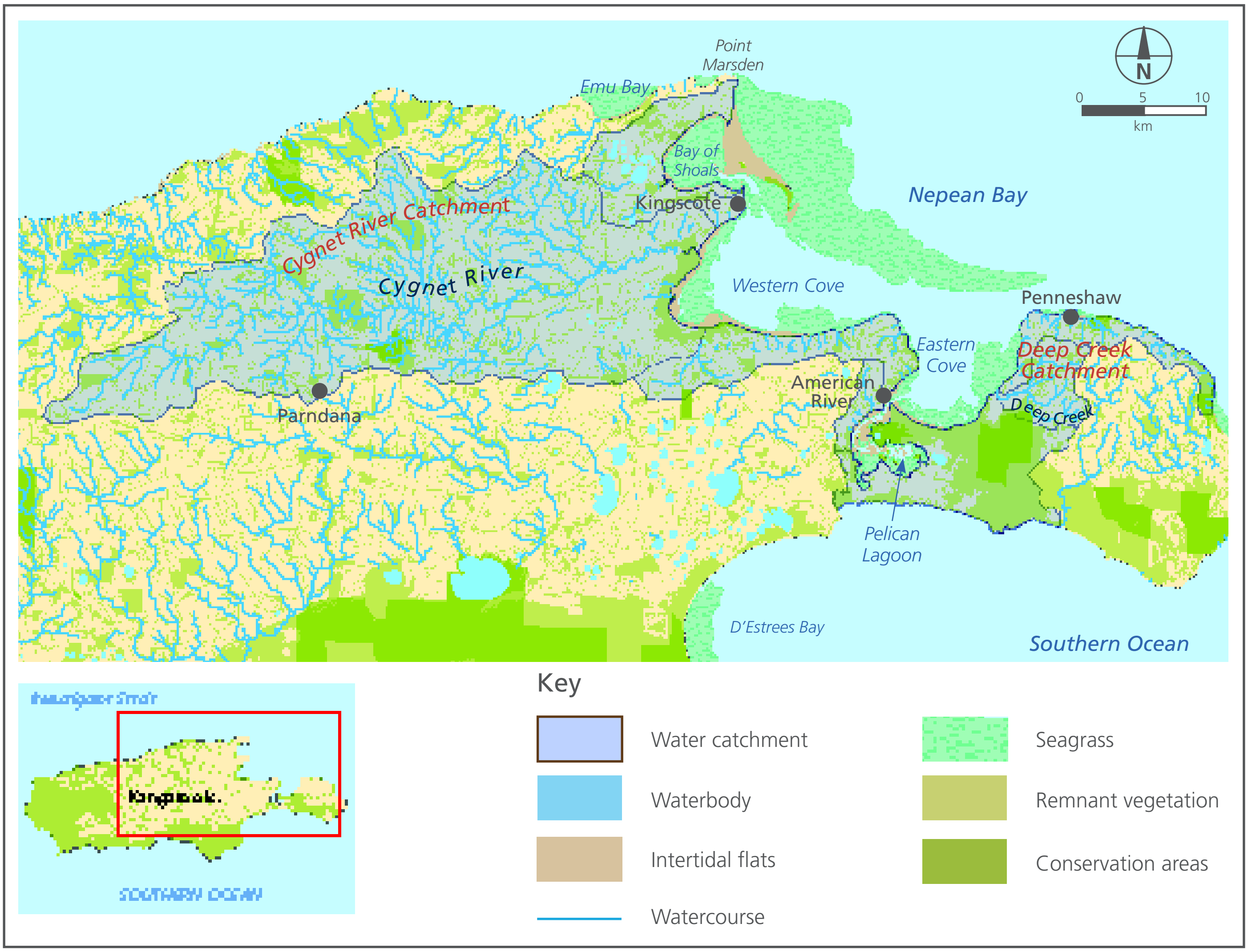
Seagrass loss is a global problem. Approximately 18% of the world's seagrass habitats have been lost through human actions (physical and chemical e.g. dredging, stormwater inputs, agricultural runoff) and natural events such as storms (Green & Short 2003 cited in Duarte et al. 2005; Short & Wyllie-Echeverria 1996). Seagrass meadows are biologically and ecologically important marine ecosystems providing habitat for fish and invertebrate species. They are important nurseries for commercially and recreationally valuable species and deliver ecosystem services such as sediment stabilisation, nutrient cycling and carbon sequestration.

What are we doing about it?

The Catchment to Coast project operated from 2013–2018 with $1,980,000 of funding from the Australian Government National Landcare Program and approximately $78,000 of in-kind support from Kangaroo Island land managers. The project aimed to improve estuarine and inshore marine water quality in Nepean Bay and Pelican Lagoon by assisting land managers to undertake catchment rehabilitation activities that enhanced habitat in high value aquatic ecosystems.

To evaluate the effectiveness of these actions and learn more about the connections between Cygnet River and Nepean Bay, seagrass was monitored to detect changes in cover, condition and fish assemblages, and water quality was assessed in Cygnet River and Deep Creek. The project was the third phase of work that began in 2009. See Figure 1.

Figure 1. Catchment to Coast project area



Government of South Australia

Natural Resources Kangaroo Island

Australian Government

National Landcare Programme

What have we achieved?

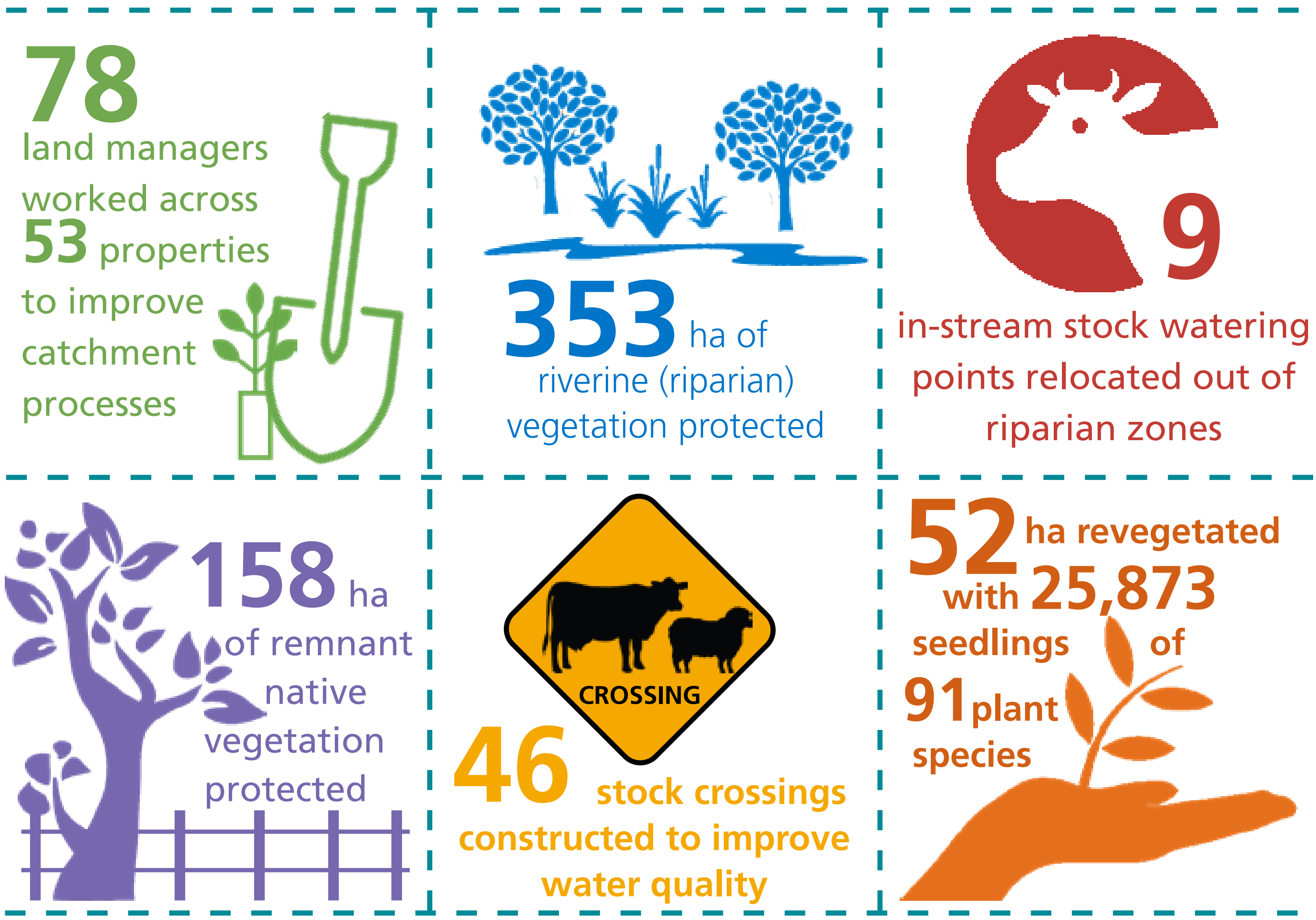
Working with the community to rehabilitate catchments

From the beginning of the project land managers were keen to improve the health of the Cygnet River and Pelican Lagoon catchments by protecting native vegetation, revegetating, moving stock watering points out of streams and away from watercourses, and building stock crossings to minimise streambank erosion. The project offered an incentive grant scheme to co-fund land managers to undertake these works. Over the five years 78 land managers from 53 properties participated in the scheme.

These land managers protected 353 hectares of riverine (riparian) vegetation and 158 hectares of remnant native vegetation with fences, to prevent livestock from grazing and trampling this vegetation. To reduce erosion and improve biodiversity land managers revegetated 52 hectares by planting 25,873 native plants, of 91 species suitable to local conditions.

Through these grants nine in-stream stock watering points were relocated out of riparian zones, and 46 stock and vehicle river crossings were built to reduce vegetation damage and disturbance, streambed erosion and nutrient inputs into riparian and aquatic systems.

Integral to this work was the assistance given to land managers from the Kangaroo Island Native Plant Nursery. Each year the nursery propagated over 40,000 native Kangaroo Island plants which were sold to farmers, lifestyle block owners and township residents. The Nursery Manager worked closely with land managers advising them on the best plants for their property and planting methods for success. Seed and propagating material was collected from areas close to the property being revegetated. This invaluable resource supplied all of the native plants used to revegetate riparian and native vegetation through this project.



Working with the community to rehabilitate seagrass

As well as working to restore the land, the community helped to restore some of the seagrass meadows which have been lost from Nepean Bay by planting seagrass to reconnect 1.7 hectares of small, fragmented patches of seagrass meadows. This revegetation was undertaken with the invaluable assistance of 142 volunteers.

Seagrass planting days were held every January in shallow water near healthy meadows off the Brownlow shore. Over the five years volunteers planted 3,500 seagrass sprigs into the bare, sandy seafloor.

The results have been fantastic with 75% of the sprigs surviving. They now cover three times their original area to an extent that the replanted meadows can be viewed via satellite!

These events also helped to raise the awareness of the importance of seagrass ecosystems and provided a hands-on experience that delivered a positive outcome for the local marine environment.

The effects of these works will take time to appear, but hopefully over time the seagrass will slowly and steadily recover.

1.7 ha of fragmented seagrass meadows revegetated over **5** years

3,500 seagrass sprigs planted by **142** volunteers

75% of planted seagrass sprigs survived

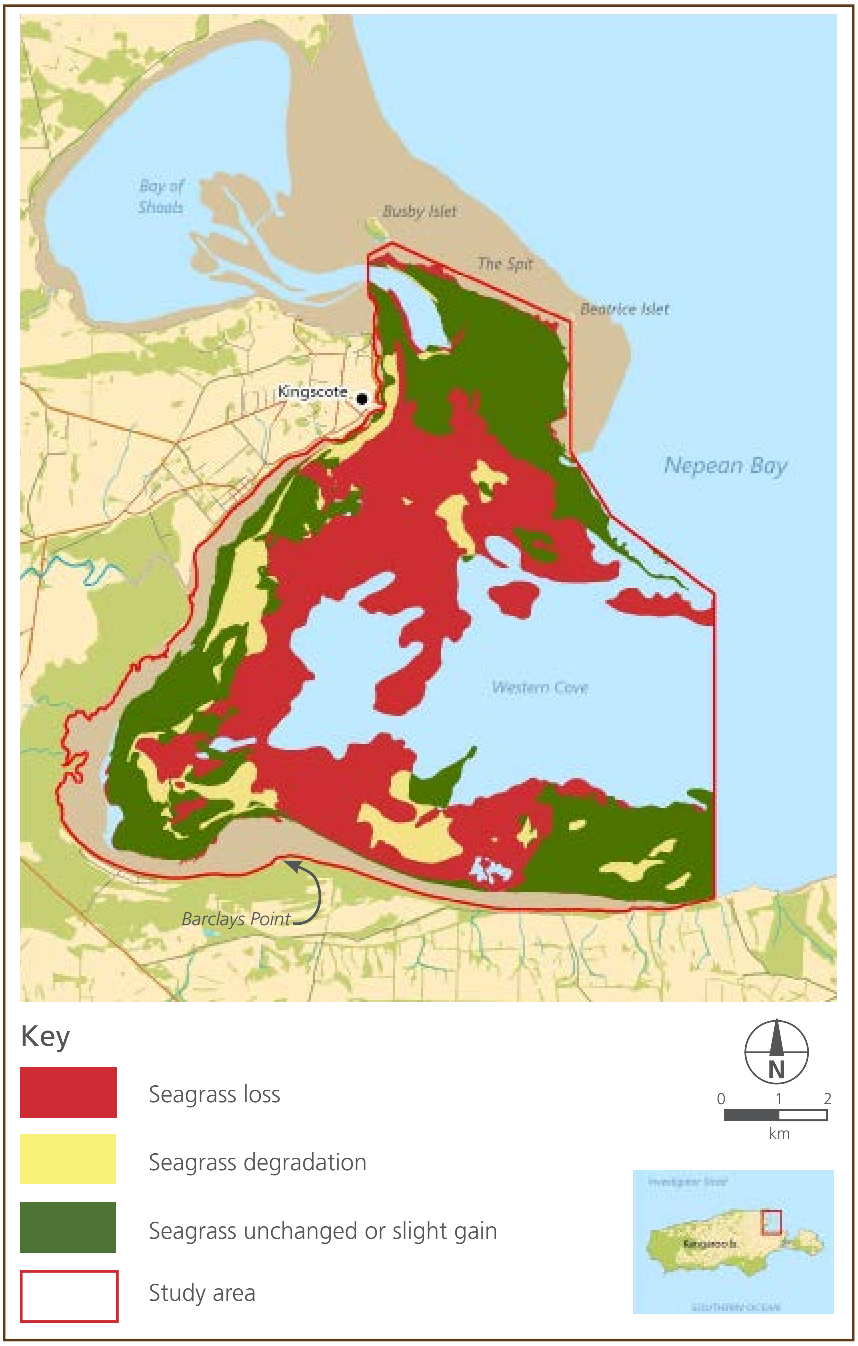
planted seagrass sprigs grown to cover **3X** their original area

Figure 2. Volunteers planting seagrass sprigs in Western Cove near Brownlow.

Understanding Nepean Bay

This project focused on Western Cove, the area within Nepean Bay where seagrass has been lost. Western Cove is a shallow, sheltered embayment, generally less than 10 metres deep, which covers 12,156 hectares and experiences low levels of tidal flushing. It lies to the south of Kingscote, Kangaroo Island's largest township, and is surrounded by tidal mudflats, extensive networks of tidal creeks, samphire saltmarshes and sandy coves. The mouth of the Cygnet River, Kangaroo Island's largest watercourse, is located within Western Cove. The Cygnet River catchment is Kangaroo Island's largest catchment, and drains 14% (60,632 hectares) of the island's land area. Land use in the catchment is predominantly agricultural (68% excluding forestry) and very little remnant native vegetation remains (26%). See Figure 1. Located less than 200 metres north of the Cygnet River mouth, is the Septic Tank Effluent Drainage (STED) system that services the townships of Kingscote and Brownlow. The STED system has operated since January 1980.

Figure 3. Seagrass loss in Western Cove from 1964–2016



Historical loss

In the mid-1990s the local fishing community began reporting the loss of seagrass meadows from Nepean Bay. To investigate project staff analysed aerial photographs of Nepean Bay from 1964 to 2016 and discovered between 1964 and 2009 almost half of the seagrass within Nepean Bay was lost. The photographs revealed that in 1964 4,115 hectares of dense seagrass meadows lined the periphery of Nepean Bay from north of Kingscote to Red Banks, and extended into the centre of Western Cove, covering 42% of the bay. No drift macroalga was present.

By 1981 these dense seagrass meadows had declined by 40% and only covered 2,436 hectares, with losses across the bay, including a large patch off Barclays Point. Drift macroalga was recorded for the first time covering 1% of the study area. This loss continued for 29 years until 2009, when only 1,955 hectares of dense seagrass meadows (20% of the bay) remained. Over this time drift macroalga increased to cover 9% of Nepean Bay. See Figure 3.

Around 2009 the loss of seagrass ended and since then over 200 hectares of seagrass have regrown in Nepean Bay. This coincided with increased land manager effort to protect and restore riparian and native vegetation with Cygnet River and Deep Creek catchments.

Around the world eutrophication is one of the most common causes of seagrass loss. This occurs when an excess of nutrients and minerals wash into a water body, such as a bay, and stimulate the growth of aquatic plant and algal life. An increase in epiphytic algae (algae that grows on the surface of another plant) and drift macroalgae in seagrass meadows, reduces the amount of light available to seagrass plants for photosynthesis, and smothers them, causing seagrass plants to stress and die.

The loss of seagrass meadows from Nepean Bay followed the Kangaroo Island 'Soldier Settlement Scheme'. This land settlement scheme for World War II serviceman resulted in broadscale clearance of around 120,000 hectares of native vegetation (Nunn 1981) and the spread of superphosphate fertiliser to enhance soil fertility across much of Kangaroo Island from 1948. These actions would have greatly increased the flow of sediments and nutrients from the land into the inshore coastal waters of KI, particularly from catchments draining into Nepean Bay, such as the Cygnet River. Once these inputs entered Western Cove they would have been retained within the cove for a long period of time, as the low and unpredictable tidal flows cause Western Cove to be poorly flushed.

Figure 4. Healthy seagrass in Boxing Bay.

3,507 ha of seagrass (almost 50%) lost from Nepean Bay from 1964 to 2009

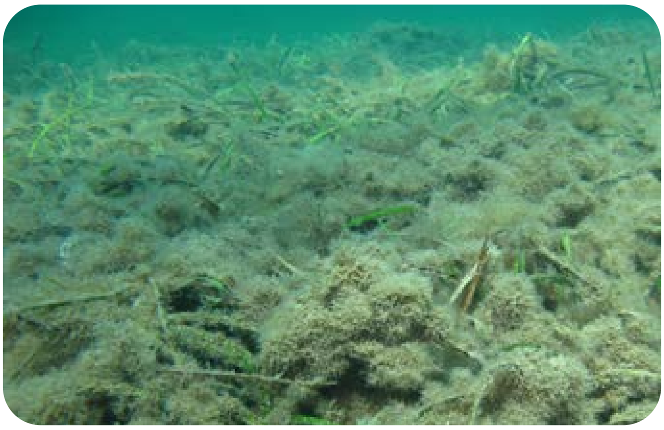


Figure 5. Seagrass smothered with macroalgae.

Figure 6. Seagrass cover in Western Cove from1964–2016

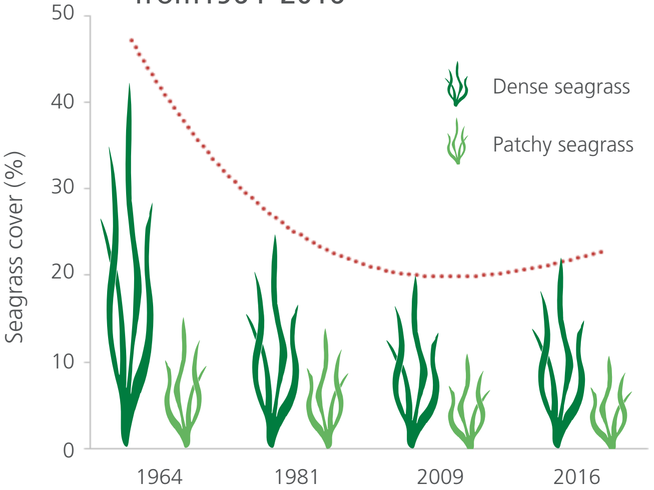
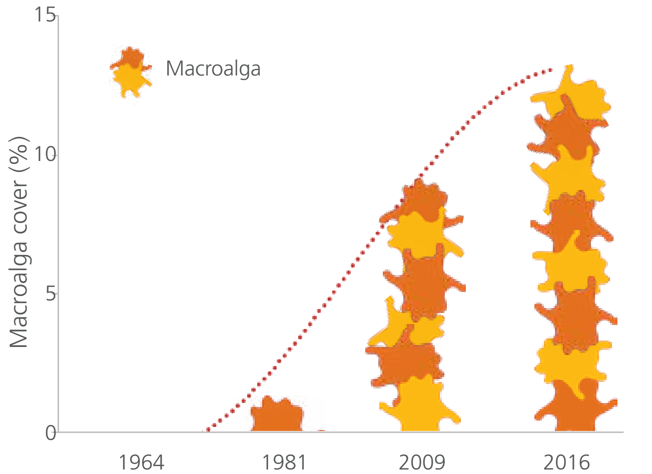


Figure 7. Macroalga cover in Western Cove from 1964–2016



Seagrass health, condition, extent, monitoring

Seagrass meadows are the dominant vegetation in Western Cove, covering 3,600 hectares or 30% of the total area. Several different species of seagrass are found in these meadows including: *Posidonia sinuosa*, *Posidonia australis*, *Posidonia angustifolia*, *Halophila australis*, *Zostera* species, *Lepilaena* species and *Amphibolis antarctica*. The KI NRM Board first began investigating seagrass loss within Nepean Bay in 2004, building on past research undertaken by South Australian Research and Development Institute. The aim was to gain an understanding of how land-based actions in the catchment were impacting on the adjoining marine systems. Monitoring was established to detect changes in seagrass meadow extent and condition within Nepean Bay, to establish trends in seagrass health and identify any further loss of cover. This project continued that work, monitoring seagrass health between 2009 and 2017.

Figure 8. Seagrass monitoring locations

The following locations were monitored within Nepean Bay:

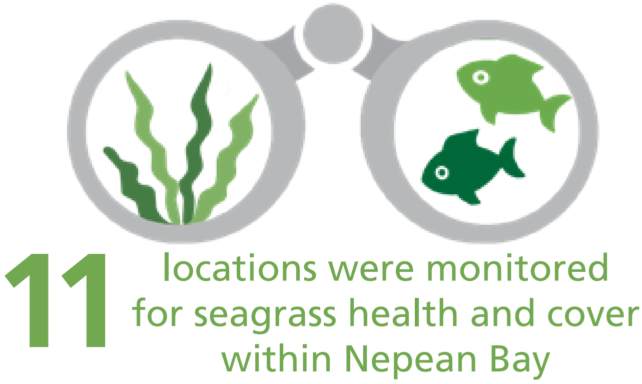
1. Bay of Shoals
2. Brownlow
3. Central Western Cove
4. Cygnet Mouth
5. Deep Creek
6. Island Beach
7. Offshore Nepean Bay
8. Pelican Lagoon
9. Red Banks
10. South Spit
11. Tidal Pool

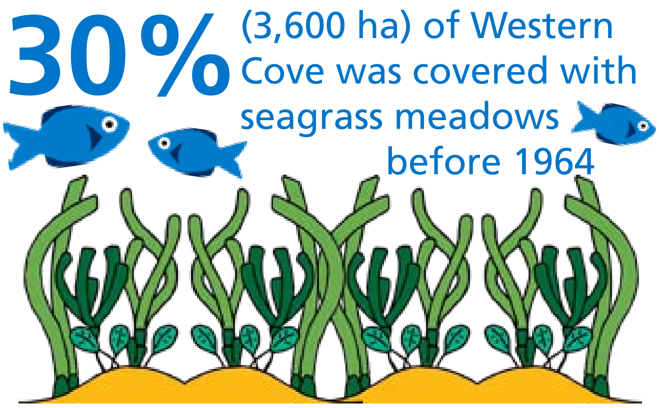
A control site with extensive, healthy seagrass meadows was also monitored at Emu Bay. See Figure 8. At each site seagrass canopy cover, epiphyte (an organism that grows on the surface of a plant) load and drift macroalgae were measured to assess seagrass extent and condition. Surface-based underwater videography was used to capture the data. This was later analysed using a visual estimation technique.

The monitoring found no seagrass was lost in Nepean Bay after 2009 and seagrass cover increased during this time by 12%. Seagrass cover was stable at some locations and increased at the Tidal Pool, Cygnet Mouth and Pelican Lagoon. Seagrass cover varied in the Bay of Shoals; decreasing when there were high levels of microalgae and increasing when the levels of macroalgae were lower. However, overall seagrass health did not improve and the amount of drift and epiphyte macroalgae was still significant.

The fact that no further seagrass loss was detected is encouraging, and indicates that some of the threatening processes that contributed to the historic loss of seagrass within Western Cove are no longer a factor, or have reduced in intensity. It is clear however, threatening processes are still at work, with moderate to high epiphyte loads and an abundance of opportunistic macroalgae pointing to a nutrient rich system. This indicates that processes which impact on the health and survival of seagrass meadows are still present and active in Nepean Bay, and will continue to pose a threat in the future. What has changed in Western Cove to support the natural recovery of seagrass meadows remains unclear, and whether seagrass meadows continue to recover their former extent may not be known for many years to come.

Figure 9. Project staff investigating macroalgae growth on seagrass.





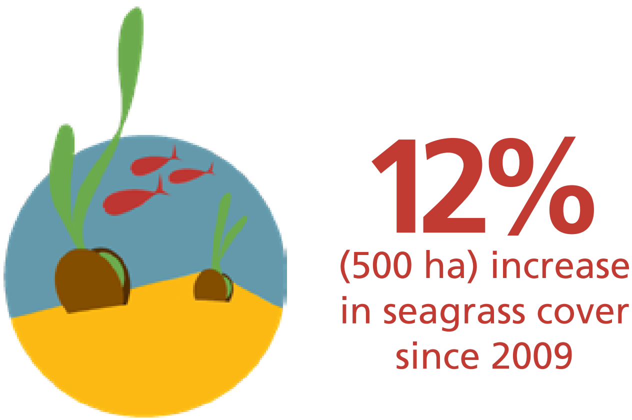


Figure 10. Posidonia sinuosa seeds.

Fish assemblages

Healthy seagrass meadows are structurally complex and have a variety of habitats used by fish and other marine animals. As seagrass meadows are impacted from human activities they become more fragmented and the quality of habitat decreases, often resulting in a decline in fish diversity and abundance. Fish are useful indicators for detecting environmental change, as they are sensitive to disturbance, such as habitat modification. To detect changes in the diversity and abundance of fish in seagrass meadows in Nepean Bay over time, baseline datasets were established against which relative abundance, fish diversity, and community composition can be measured in the future. Baited Remote Underwater Video Systems (BRUVS) were used at seagrass monitoring sites within Nepean Bay to:

- Explore links between seagrass habitat condition indicators and fish diversity, relative abundance and composition.
- Assess changes in fish diversity, relative abundance and composition between years and seasons.

BRUVs were baited with minced pilchards and lowered to the sea floor where they were left to record for 60 minutes. The footage was later analysed to determine species diversity and abundance.

The monitoring found fish were more diverse in Eastern Cove, where the seagrass meadows were healthy, than in Western Cove where seagrass meadows had declined. 86 species of fish, three species of cephalopod (octopus, squid, cuttlefish), and one species of marine mammal were recorded interacting with the BRUVs. Fourteen of these species are targeted by commercial fisheries. Five of the species are protected, or partially protected, and another five species are considered to have conservation significance. The most common species recorded were little weed whiting and King George whiting. The most abundant (numerous) species were yellow-headed hulafish, bait fish and slender bullseye, all of which are schooling species.

Figure 11. Deploying a BRUV off Deep Creek.

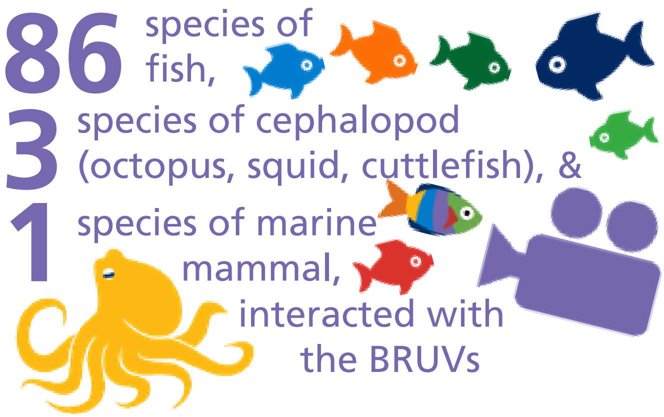


Figure 12. Tommy ruff, western-striped trumpeters, a fiddler ray and salmon visit a BRUV.

Species richness varied between sites and habitats, with the richest being in Eastern Cove and the poorest in Western Cove. Sites with seagrass and reef habitat recorded the highest species richness, followed closely by rocky reef habitat. Sparse seagrass and sand had the lowest species richness. Several species were identified as being cosmopolitan, and were recorded in all types of habitat, while others were found to be unique to certain habitat types. Twenty-six species were only found in seagrass meadows.

Seagrass restoration

As well as revegetating native vegetation on land, the project investigated methods of revegetating seagrass. Two methods were trialled: planting freshly harvested sprigs of seagrass into the seafloor and depositing sand-filled hessian bags with seagrass seeds and fruits onto the seafloor. For both methods the restoration trials were undertaken in bare patches of sand adjacent to healthy seagrass beds. Two seagrass species that generally grow in different areas were trialled: southern tapeweed (*Posidonia australis*) which generally grows in shallow water and smooth strapweed (*Posidonia sinuosa*) which generally grows in deeper water.

Transplanting seagrass sprigs was much more successful than depositing seagrass seeds in hessian bags. However, only *Posidonia australis* seagrass sprigs planted in shallow water had a steady survival rate. The trials with seeded hessian bags produced poor results, with very low levels of seed germination and survival, and the early disintegration of the hessian bags. The trials showed the importance of selecting the right species for the site and the impact of environmental factors on seagrass growth such as water movement, the reworking of soils and sediments by animals or plants around the seagrass springs (bioturbation), seasonality and the presence of opportunistic macroalgae and seagrass wrack (organic material made of seagrass and/or algae and other marine organisms).

Water circulation

The project also mapped the tidal circulation patterns within Nepean Bay to investigate where catchment-derived nutrients and sediments are transported and deposited.

Drogues (drift units to measure water circulation) were deployed at 13 sites in a grid across Western Cove. These units measured the hydrodynamics of Nepean Bay to identify movements of nutrients and algae and to help identify areas at risk from outflows from Cygnet River. Deployments were made to coincide with periods of fair weather and low wind speeds during winter/spring between July 2014 and November 2016. The monitoring indicated Western Cove is poorly flushed by the tide during the day, and that nutrient and sediment remained in the cove for a long time.

Subsurface drifters were used to measure tidal flow regimes in Western Cove. These recorded consistent tidal patterns in the north and south of the cove, but inconsistent patterns in the centre of the cove. These inconsistencies made it difficult to relate tidal flow regimes to the movement or retention of nutrients and sediments discharged from Cygnet River.

Figure 13. Assessing hessian bags seeded with Posidonia australis.

Figure 14. Deploying a drogue to track water circulation in Western Cove.

Understanding water flows

To measure the amount and location of nutrients and sediments flowing down the Cygnet River, water quality was monitored every fortnight by composite samplers in the upper and lower catchment of the Cygnet River, which flows directly into Western Cove. The water samples were analysed for concentrations of Total Nitrogen, Total Phosphorus and Suspended Solids.

The monitoring found water quality did not change significantly during the project. However, up to 15 times more nutrients flowed out to sea during wet years, such as 2013 and 2016, compared with dryer years when there was less run-off across the land.

Figure 15. Cygnet River flooding.

This data record has made a significant contribution to establishing benchmarks for annual flow rates, and for nutrient and sediment loads exported from the Cygnet River catchment. The dataset is representative of a range of annual rainfall and flow volume conditions experienced in the catchment. By combining this record with earlier data sets collected during previous Board programs, it has been possible to establish a positive exponential relationship between annual flow rates and the total annual export of nutrient and sediment loads to Nepean Bay. These relationships can be summarised as follows: annual nitrogen load doubles for every additional 17,000 ML of flow; annual Phosphorus load doubles for every additional 13,500 ML of flow; and annual sediment load doubles for every additional 12,000 ML of flow.

References

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Lessons learned

1. Land managers need adequate compensation for loss of productive land for public benefits.

2. Land managers need funding to incentivise practice change to achieve a sufficient level of environmental outcomes to counteract ongoing environmental erosion.
3. Central Western Cove is stagnant causing seagrass loss.