State of Cockburn Sound Report

2013

Cockburn Sound Management Council

Cover: Top – Aerial image of BP Refinery, Bottom – A nudibranch (a marine snail).
This Page: Looking north into Cockburn Sound across Cape Peron.

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Acronyms

CSMC	Cockburn Sound Management Council
EMP	*Environmental Management Plan for Cockburn Sound and its Catchment* 2005
EQC	Environmental Quality Criteria
EQG	Environmental Quality Guideline
EQMP	Environmental Quality Monitoring Program
EQS	Environmental Quality Standard
HEPA	High Ecological Protection Area
KIC	Kwinana Industries Council
MEPA	Moderate Ecological Protection Area
Revised SEP	Revised *State Environmental (Cockburn Sound) Policy 2013*
SDOOL	Sepia Depression Ocean Outfall Landline
SEP	*State Environmental (Cockburn Sound) Policy 2005*
SOP	*Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality* Criteria
TBT	Tributyltin (ingredient in anti-fouling paint)
TSS	Total suspended solids

Preface

It is with pleasure that I submit this State of Cockburn Sound report to the Minister for Environment on behalf of the Cockburn Sound Management Council (CSMC). Since its foundation in 2000 the CSMC has worked with the community, government and industry to keep Cockburn Sound healthy and sustainable for its multiple uses and for the people of Western Australia.

During 2013, the CSMC participated in a scheduled review, initiated in 2012 by the Office of the Environmental Protection Authority (OEPA), to update and revise the State Environmental (Cockburn Sound) Policy 2005 (SEP) and its associated technical reports. The SEP is a policy that all Western Australians have reason to be proud of in that it has established world class standards and processes for monitoring the environmental health of the state's most heavily and diversely used embayment.

The CSMC welcomed this review and has been updating its governance documents in preparation for the finalisation of the new SEP. In addition, the CSMC has taken the first steps towards reviewing its Environmental Management Plan 2005. The CSMC is committed to continuous improvement and it is envisaged that the revised SEP and EMP will further strengthen the CSMC's capacity to coordinate the environmental management of Cockburn Sound in collaboration with its partner organisations.

I am pleased to note the inclusion of nutrient enrichment in CSMC reporting. Nutrient enrichment is a key parameter for measuring ecosystem health that incorporates data for chlorophyll 'a', light attenuation coefficient and seagrass shoot density. This means that the CSMC reporting now aligns closely with the requirements of the Environmental Quality Criteria Reference Document for Cockburn Sound and reflects recommendations made by the Office of the Auditor General in 2010.

Within this State of Cockburn Sound report the Report Cards summarise in graphic form the monitoring results over the range of monitoring programs undertaken in 2013. Analysis of results suggests that multiple use pressures generally remain at sustainable levels and the existing management framework the CSMC works within appears to be an effective barrier to detrimental environmental impacts.

I would like to acknowledge the many stakeholders who directly and indirectly support the CSMC in our work either financially or through collaboration and sharing of information.

Finally, I would like to acknowledge the hard work and dedication of the members of the CSMC. It is as a result of their generous input of time, energy and expertise that the CSMC has been able to establish its proud record of serving the varied and extensive community of users of Cockburn Sound.

Chair, Cockburn Sound Management Council

Executive Summary

The State Environmental (Cockburn Sound) Policy 2005 (SEP) provides the framework within which the Cockburn Sound Management Council (CSMC) operates. The implementation of this policy by the CSMC through the Environmental Management Plan for Cockburn Sound and its Catchments 2005 (EMP) requires a collaborative approach involving key stakeholders from government and the community.

The SEP has been reviewed during 2013 and a revised SEP was released for public comment by the Environmental Protection Authority on 20 November 2013. The public comment period ended on 24 January 2014.

In 2013, the CSMC has begun reporting on two separate areas within the existing High Ecological Protection Area (HEPA): the HEPA-Northern Sound (HEPA–NS) and the HEPA-Southern Sound (HEPA-SS) for ecosystem health parameters. The HEPA-SS includes extensive seagrass meadows and is heavily used by the community for swimming, snorkelling, fishing and aquaculture. It is also an important feeding area for seabirds and resident bottlenose dolphins (Tursiops aduncus).

This report now presents outcomes for the assessment of nutrient enrichment, a key parameter for measuring ecosystem health. Assessment of nutrient enrichment incorporates data for chlorophyll 'a', light attenuation coefficient (LAC) and seagrass shoot density. Reporting on this parameter aligns closely with the requirements of the Environmental Quality Criteria Reference Document for Cockburn Sound and reflects recommendations made by the Office of the Auditor General in 2010.

Analysis of nutrient enrichment data indicates that the Garden Island Settlement (GIS), Mangles Bay (MB) and Kwinana (KW) monitoring sites are a concern. The CSMC will continue to liaise with the Department of Defence in regard to responding to nutrient enrichment at the GIS site and will review the nutrient enrichment status of KW and MB in 2014 to identify if there is further decline that provides increase cause for concern.

Chlorophyll 'a' concentration has exceeded the environmental quality guideline (EQG) at three of six sites in the HEPA-NS and at three of four sites in the HEPA-SS. Chlorophyll 'a' has also exceeded the EQG at four of seven sites in the Moderate Ecological Protection Area - Outside Harbours (MEPA-OH). It continues to exceed the EQG at the northern harbour (NH) site adjacent the Cockburn Sound Power Boat Association and public boating facilities.

LAC measured through the water column appears to be relatively stable after some good improvements from earlier years of monitoring. There has, however, been a slight decline in overall LAC in 2013 meaning that light availability in the water column was reduced. Elevated chlorophyll 'a' concentrations in the water column, as seen at a number of sites in the HEPAs and MEPAs, may be responsible for a reduction in LAC.

Based on monitoring of only one site, the Northern Harbour of Jervoise Bay continues to have very high phytoplankton biomass levels as it has done for the past seven years due to the low exchange of oceanic waters. Phytoplankton biomass is not of concern at any other place in Cockburn Sound.

Sites 11, 13 and MB exceeded the EQG when dissolved oxygen saturation levels fell between 78% and 90%. While the exceedance is a concern, the saturation levels are similar to levels recorded in some previous years. Site 11, near Mangles Bay is of most concern and may indicate that there is little 'turnover' of waters at this deep water site in an area that has a low exchange rate with oceanic waters.

To improve government's ability to target appropriate management actions, the CSMC and the then Department of Environment and Conservation's Environmental Regulations Division (now Department of Environment Regulation) commissioned a review of historical and contemporary contaminant loads entering Cockburn Sound (GHD, 2013). Estimates indicate that the major contemporary pathway for contaminants to Cockburn Sound appears to be surface runoff that enters drains or the groundwater from all land uses in the catchment. Residential use is estimated to be the largest contributor of nitrogen (21-53 tonnes/year) and phosphorus (3-6 tonnes/year) in the Cockburn Sound catchment.

The long term trends in the condition of seagrass meadows in Cockburn and Warnbro sounds were investigated in 2013 (Mohring & Rule, 2013). The investigation noted a significant decline in seagrass density at almost all sites (including reference sites) in Cockburn and Warnbro sounds. The pressure of most concern to seagrass communities appears to be summer sea temperature which has shown an increase at all sites.

In order to determine if the decline in seagrass density represents a general, regional-scale trend or if it is confined to Cockburn and Warnbro sounds, the study recommended the health of seagrass sites should be monitored beyond the current study areas.

It is the intention of the CSMC to seek resources to map seagrass and make an estimate of coverage over the entire area of Cockburn Sound. The last map and estimate was made in 2004 and was confined to the eastern shelf of Cockburn Sound extending from Woodman Point to the BP Refinery where historical loss of seagrass has been most profound. There is a pressing need to assess the extent of seagrass coverage across the entire Sound as an overall indicator of seagrass health.

Seafood tested in commercial growing areas did not exceed the Western Australian Seafood Quality Assurance Program guidelines. Seafood sourced from seafood growers is considered safe to eat. Shellfish outside commercial growing areas are not monitored for safe eating and the general public should remain aware of the risk of eating seafood from jetties, piers, harbours and port related facilities. Mussels are the only species cultured in Cockburn Sound and are considered ecologically healthy.

Microbial water quality monitored near recreational beaches and boating areas in Cockburn Sound undertaken by the City of Rockingham, City of Kwinana and City of Cockburn and analysed by the Department of Health did not exceed guidelines. The improvement in stormwater drainage and waste water disposal introduced by local government in particular has resulted in much cleaner waters for swimmers and boaters.

The CSMC will begin reviewing the EMP for Cockburn Sound over the next 12 to 18 months as required by the existing and revised SEP. This process will involve an assessment of the implementation of the existing EMP and involve key stakeholders and extensive public consultation.

The CSMC meets regularly. The dedication of the members demonstrates the continued confidence that stakeholders have in the fundamental role of the CSMC to coordinate monitoring within Cockburn Sound and facilitate information exchange that contributes to an improvement in environmental and social values.

The Rockingham shop-front office of the CSMC continues to be a focus for community to seek information about the health of Cockburn Sound and as a place to discuss any concerns they may have. The CSMC office attracted more than 500 public telephone inquiries, approximately 300 office visitors and approximately 3000 window front display visitors in 2013.

Figure 1: A small number of CSMC members and their Department of Environment Regulation (DER) Executive support. Left to right: Ron Pease (Councillor, City of Rockingham), Glen Dibben (Operator, Blue Lagoon Mussels), Sue Stephen (DER), Vivienne Panizza (Planning Manager, Department for Planning), Professor Kateryna Longley (Chair), Barb Green (DER), Chris Oughton (Director, Kwinana Industries Council).

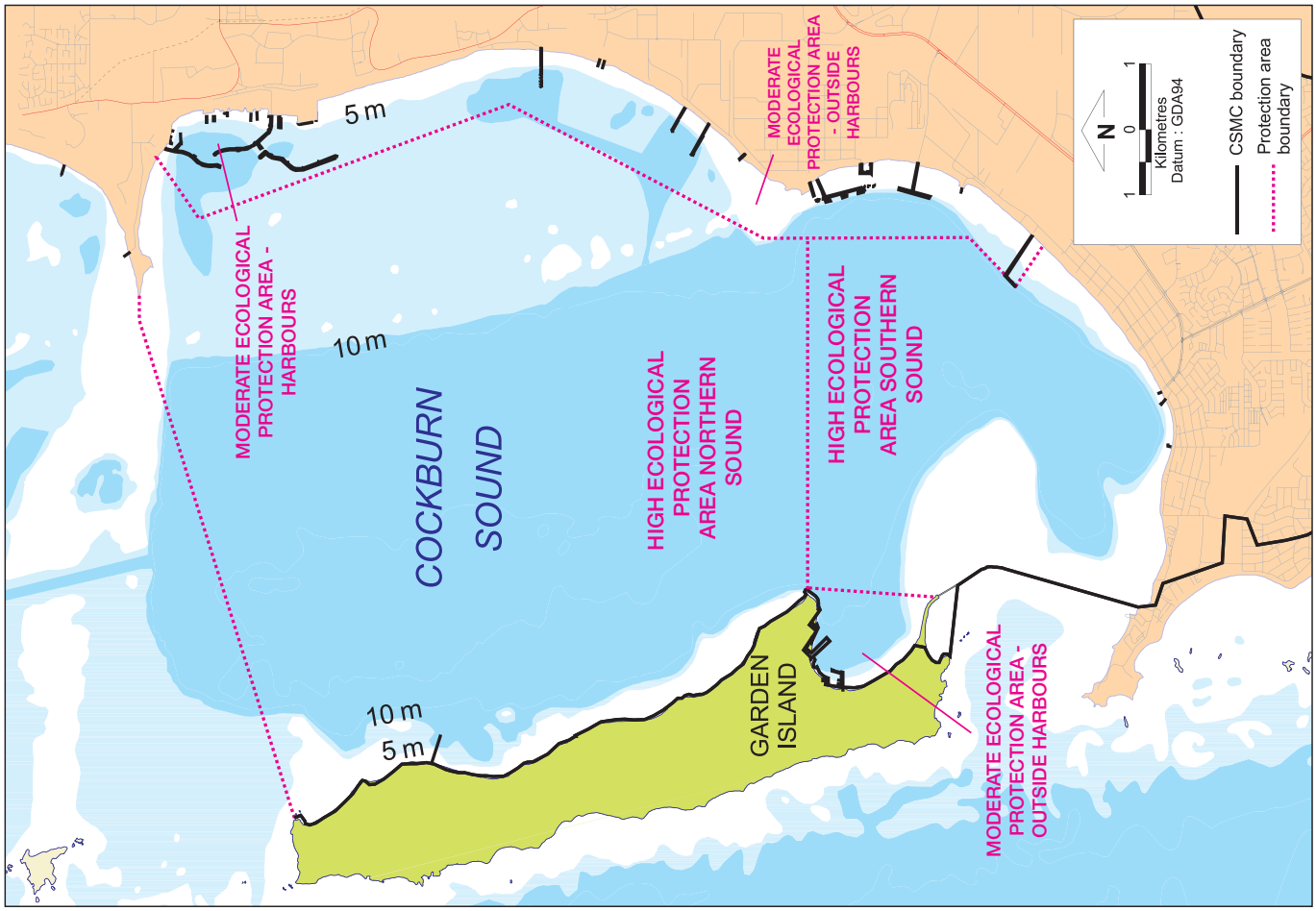


Figure 3: The High and Moderate Ecological Protection Areas in Cockburn Sound.

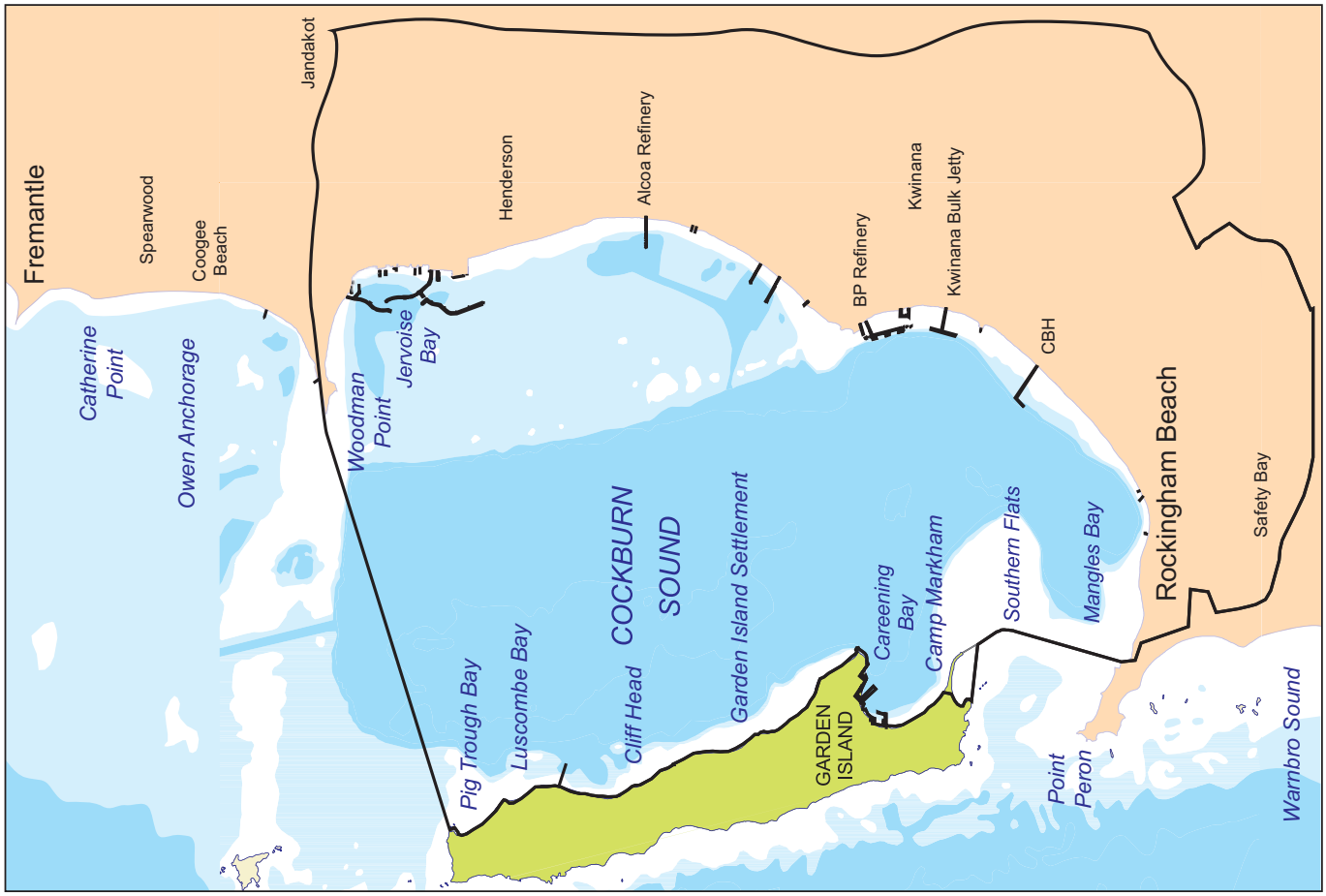


Figure 2: Geographic location of Cockburn Sound in the southern metropolitan waters of Perth.

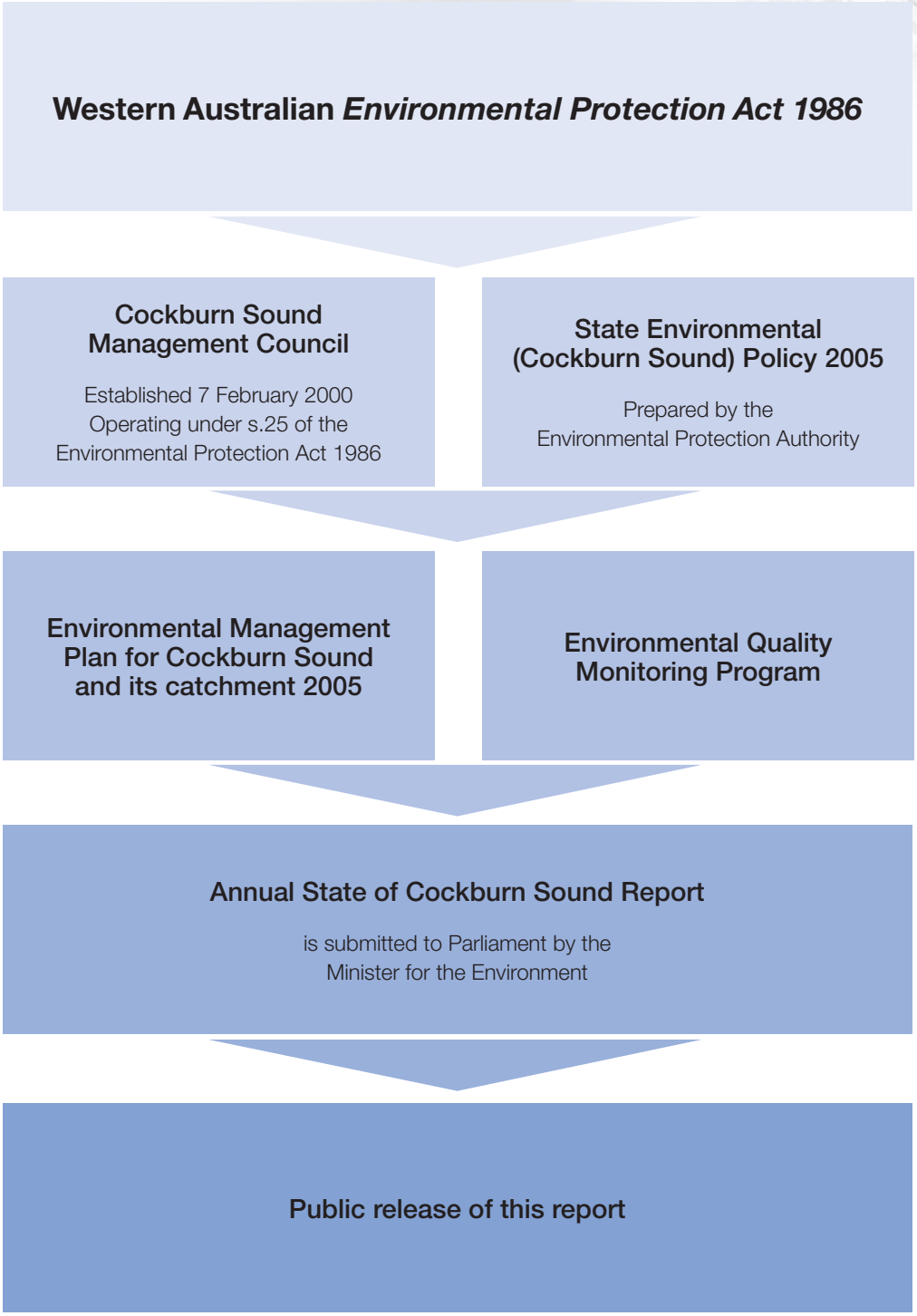


Figure 4: Process leading to the tabling of this report in Parliament and release to the public.

Cockburn Sound Management Council Membership 2013

Name	Membership Position*	Occupation
Kateryna Longley	Independent Chair	Emeritus Professor Murdoch University
Chris Oughton	Kwinana Industries Council	Director
Jim Dodds	Department of Health	Director, Environmental Health
Alan Sands	Department of Environment Regulation	Director, Environmental Regulation
Stefan De Haan	Department of Parks and Wildlife	Regional Manager
Ian Briggs	Department of Mines and Petroleum	General Manager
Jarrad Scott	Department of Defence	Senior Environmental Manager
Laurie Caporn	Department of Fisheries	Principal Management Officer
Gino Valenti	Fremantle Ports	General Manager
Vivienne Panizza	Department for Planning	Planning Manager
Gordon Groth	Water Corporation	Environmental Operations Manager
John Keesing	CSIRO	Principal Marine Research Scientist
Phil Jennings	Conservation Council of Western Australia	Emeritus Professor Murdoch University
Glenn Dibbin	WA Fishing Industry Council	Mussel producer
Carol Reeve-Fowkes	City of Cockburn	Councillor
Ruth Alexander	City of Kwinana	Councillor
Ron Pease	City of Rockingham	Councillor
John Polglaze	General community	Environmental Consultant
Bart Houwen	Community Networking Inc.	Business Manager
Ellen Smith	Recfishwest	Regional Policy Officer
John Smedley	Cockburn Powerboat Association	Builder
VACANT	Department of Water	
VACANT	Horticulture/Agriculture Industry	
VACANT	General community	
Barb Green	A/Coordinator	
Dr Tom Rose	Former Coordinator	
Geoff Botting	Senior Project Officer	
Sue Stephen	Executive Support and Administration	

*Nomination for membership of the CSMC is described in the Constitution for the Cockburn Sound Management Council (2004). The Constitution is currently under review by the CSMC in consultation with the Department of Environment Regulation.

Setting the Scene

Cockburn Sound (Figure 2) is the busiest marine embayment in southern Western Australia and supports a range of significant attractions and recreational and commercial activities including fishing, swimming, yachting, parasailing, diving, wind and kite surfing and aquaculture. Nature reserves, regional parks and the Shoalwater Islands Marine Park managed under the *Conservation and Land Management Act 1984* contribute to the environmental character of Cockburn Sound. Private industry and the Department of Defence have a high profile presence in the Sound, with high levels of commercial shipping managed by Fremantle Ports.

The *State Environmental (Cockburn Sound) Policy 2005* (SEP) provides the framework within which the Cockburn Sound Management Council (CSMC) operates. The implementation of this policy by the CSMC through the *Environmental Management Plan for Cockburn Sound and its Catchments 2005* (EMP) requires a collaborative approach involving key stakeholders from government and the community.

In addition to implementing the EMP, the CSMC coordinates an annual Environmental Quality Monitoring Program (EQMP) that addresses the requirements of the SEP in regard to the protection of the four values identified for Cockburn Sound:

- **Ecosystem health**
- **Fishing and aquaculture**
- **Recreation and aesthetics**
- **Industrial water supply**

Top – The Kwinana Industrial Area in the northern part of Cockburn Sound.
Bottom left – A diver recording seagrass health data.
Bottom right – Seahorses are commonly seen by divers in Cockburn Sound.

Maintenance and improvement of water and sediment quality and seagrass health are pivotal to the protection of all these values. The health of water, sediment and seagrass is assessed against predetermined Environmental Quality Guidelines (EQG) and Environmental Quality Standards (EQS) contained within the ***Environmental Quality Criteria Reference Document for Cockburn Sound*** (EQC document). If an EQG is exceeded (is not met), a more detailed assessment against an EQS is required. If an EQS is exceeded, an appropriate management response will be required. Report Cards in this document present the results of these assessments in a quick reference format.

Information in the report cards is presented in a traffic-light format of green, orange and red. The colour is determined by comparing monitoring data with relevant EQG and EQS contained within the the EQC document.

The presence of green on the report cards helps give the community confidence that their use of Cockburn Sound is occurring in a safe and sustainable manner. Conversely, the presence of red or orange can indicate that there is still effort required to improve the ecological health of Cockburn Sound.

Monitoring occurs in High Ecological Protection Areas (HEPA) and Moderate Ecological Protection Areas (MEPA) (Figure 3). The CSMC does not coordinate monitoring in the Low Ecological Protection Areas as the Department of Environment Regulation administers strict licence conditions to industries that discharge into these very small areas.

The CSMC meets regularly. The dedication of the members demonstrates the continued confidence that stakeholders have in the fundamental role of the CSMC to coordinate monitoring within Cockburn Sound and facilitate information exchange that contributes to an improvement in environmental and social values.

The Rockingham shop-front office of the CSMC continues to be a focus for community to seek information about the health of Cockburn Sound and as a place to discuss any concerns they may have. The CSMC office attracted more than 500 public telephone inquiries, approximately 300 office visitors and approximately 3000 window front display visitors in 2013.

Information provided by the CSMC to the public supports a comprehensive foundation for understanding this highly complex marine embayment and helps to quickly clarify areas of concern.

What's New?

Ecological protection area reporting

In 2013, the CSMC has begun reporting on two separate areas within the existing High Ecological Protection Area (HEPA): the HEPA-Northern Sound (HEPA–NS) and the HEPA-Southern Sound (HEPA-SS) for ecosystem health parameters. The HEPA-SS includes extensive seagrass meadows and is heavily used by the community for swimming, snorkelling, fishing and aquaculture. It is also an important feeding area for seabirds and resident bottlenose dolphins (*Tursiops aduncus*). Safeguarding these activities and wildlife is an important function of the CSMC. The CSMC already reports on two separate areas of the Moderate Ecological Protection Area (MEPA): MEPA-Outside Harbours (MEPA-OH) and MEPA-Harbours (MEPA-H) (see figure 3).

The recognition of the southern section of the HEPA as a separate area is expected to make reporting more informative across what is a large geographical area. It also recognises that the southern area of the Sound has different environmental characteristics than the northern, better flushed area of the Sound.

Introduction of reporting for nutrient enrichment

This report now presents outcomes of the CSMC assessment of nutrient enrichment, a key parameter for measuring ecosystem health. Assessment of nutrient enrichment incorporates data for chlorophyll 'a', light attenuation coefficient (LAC) and seagrass shoot density. Reporting on this parameter aligns closely with the requirements of the *Environmental Quality Criteria Reference Document for Cockburn Sound* and reflects recommendations made by the Office of the Auditor General in 2010. Scientists at the Office of Environmental Protection Authority have greatly assisted the CSMC in introducing this key parameter to the reporting framework.

2013 Research support

In collaboration with the Kwinana Industies Council, the CSMC extended its support for small-scale research projects including a population assessment of little penguins and dolphin health. In 2014, the CSMC will seek to provide support for larger-scale research projects where greater funding leverage can be achieved through stakeholder partnerships.

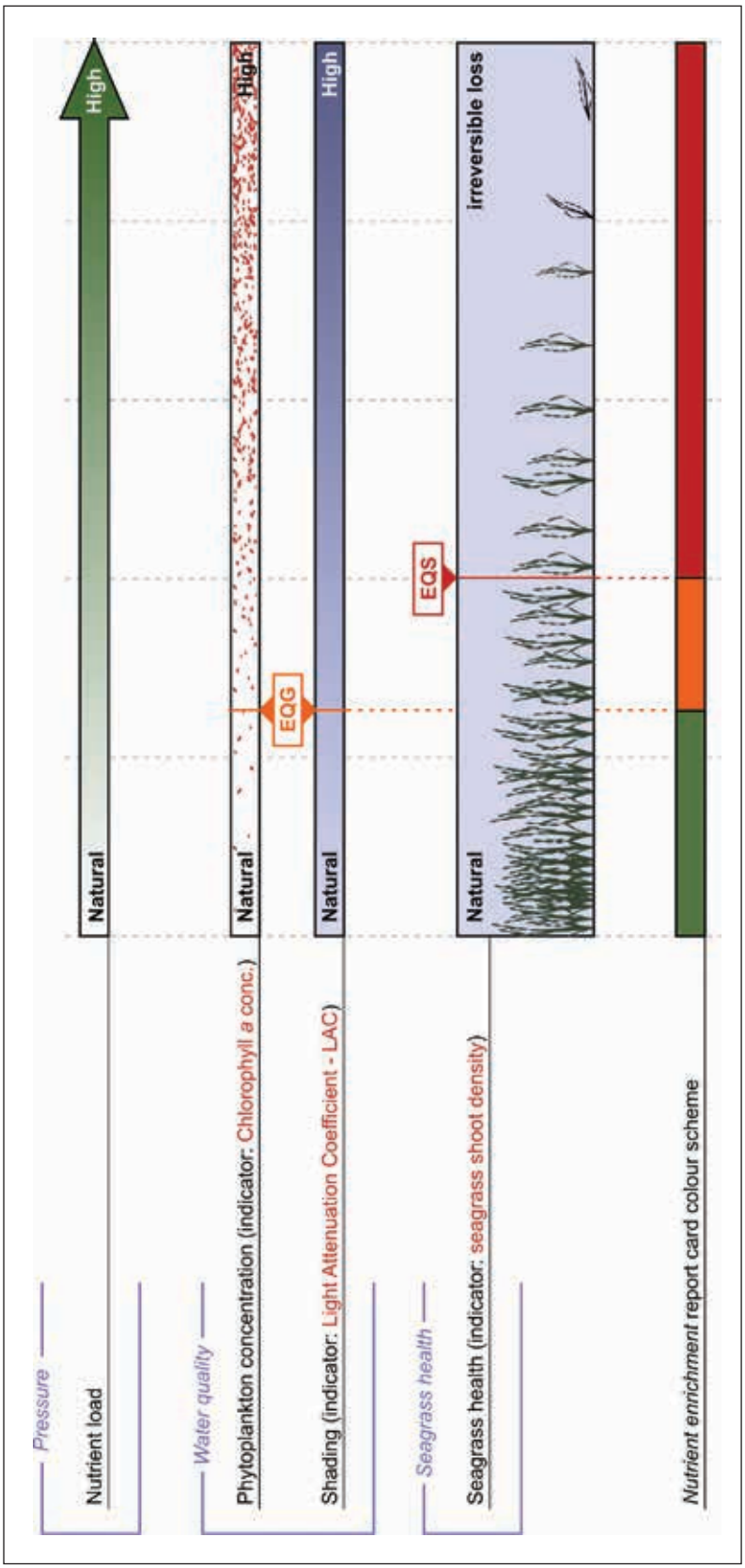
Revision of the State Environmental (Cockburn Sound) Policy 2005

The SEP has been reviewed during 2013 and a revised SEP was released for public comment by the Environmental Protection Authority on 20 November 2013. The public comment period ended on 24 January 2014. The document will be finalised in consultation with the Minister for Environment and once adopted will direct the work of the CSMC into the next decade.

Revision of the Environmental Management Plan for Cockburn Sound and its Catchment (2005)

The CSMC will begin reviewing the EMP for Cockburn Sound in 2014 as required by the existing and revised SEP. This process will involve an assessment of the implementation of the existing EMP and involve consultation with key stakeholders and extensive public consultation. The revised EMP will guide the day to day operational activities of the CSMC and its many partners in relation to the protection of the environmental and social values of Cockburn Sound.

Nutrient Enrichment



When nutrients are added to a system they stimulate the growth of microscopic phytoplankton, allowing this group of primary producers to rapidly increase in number. The increase in phytoplankton biomass reduces water clarity so that less light reaches the seabed. If light availability at the seabed falls below critical levels for prolonged periods, seagrass which rely on sunlight to photosynthesise can suffer and die. For seagrass species such as Posidonia sinuosa a loss in health tends to be first expressed as a thinning of the meadow which is measured as a reduction in seagrass shoot density.

Monitoring programs aimed at identifying and managing areas under pressure from nutrient enrichment measure water quality indicators such as Chlorophyll 'a' concentration (indicative of phytoplankton concentration) and light attenuation coefficient (i.e. a measure of the degree of shading in the water column) as early warning indicators, and seagrass shoot density as the indicator for seagrass health, which is 'further down' the pressure-response pathway. When these are assessed together (as 'multiple lines of evidence'), we can be confident about what is actually happening in the marine environment and increase our ability to make pre-emptive and informed management decisions to prevent unacceptable risk to seagrass and the marine environment.

Figure 5: A conceptual diagram of the nutrient enrichment pressure response pathway in Cockburn Sound.

2013 Monitoring Program Outcomes

ECOSYSTEM HEALTH

WATER QUALITY

Water quality was sampled throughout the water column between December 2012 and April 2013 at 20 sites (18 in Cockburn Sound and two in Warnbro Sound) (Figure 6). The Mangles Bay (MB) site in the HEPA-SS has been included since 2009. Only the surface and bottom waters were sampled at sites 13 and WS4 to give an indication of the potential difference in water quality.

The physical and chemical parameters of depth, temperature, salinity, dissolved oxygen, pH, turbidity, chlorophyll florescence and secchi depth are measured *in situ*. Water samples are collected for the analysis of ammonium, nitrate-nitrite, total nitrogen, phosphate, total phosphorus and chlorophyll 'a' in a laboratory setting. Samples for total suspended solids (TSS) were also collected from selected sites over a period of four weeks during February 2013. Light attenuation was measured utilising two underwater light sensors recording simultaneously against two depths to correct for changes in ambient conditions.

Nutrient enrichment

The analysis of the parameters of nutrient enrichment which includes chlorophyll 'a', LAC and seagrass shoot density is presented for the first time in this report (figure 6&7). Analysis indicates that the Garden Island Settlement (GIS), Mangles Bay (MB) and Kwinana (KW) monitoring sites are a concern. (Note: If a site does not have seagrass it cannot be assessed for nutrient enrichment).

The CSMC has discussed the issues affecting water quality at the GIS site with the Department of Defence (DoD). The DoD conducts routine annual ground water quality monitoring across Garden Island. Elevated nutrient levels in the vicinity of the island's wastewater treatment plant have been detected in the groundwater. However, there is no confirmed scientific evidence that this is impacting Cockburn Sound. In 2010, the DoD relined two of the saltwater wastewater ponds that were thought to be leaking. The DoD intends to upgrade the wastewater treatment plant as a priority action in a major base redevelopment scheduled within the next 5 years.

Mangles Bay receives discharge from the Lake Richmond stormwater drain and the general catchment groundwater flow. The Bay has a low exchange rate with oceanic waters resulting in the 'capture' of nutrients. Chlorophyll 'a' levels exceeded the EQG at MB. No data were collected for LAC in 2012 or 2013. Seagrass shoot density was found to be equal to the EQG which is an improvement on 2012 levels. It is unclear at present if proposed changes to drainage and the shoreline of this area by the proposed construction of the Mangles Bay Marina Tourist Precinct will assist in a correction of water quality as measured by nutrient enrichment. The Environmental Protection Authority has reported that predicted chlorophyll 'a' contributions from the proposal, although considered by the proponent to be minor, could increase the risk of the EQS being exceeded in the southern end of Mangles Bay. It is for this reason that the predicted impact on water quality in Mangles Bay is considered to be a residual risk for the proposal that requires an environmental offset. Accordingly, the EPA has recommended that the proponents contribute funding to the CSMC for the purpose of facilitating nutrient reduction strategies in the catchment of Mangles Bay (http://www.epa.wa.gov.au/EPADocLib/Rep%201471%20Mangles%20Bay%20PER%20290413.pdf). The details of this contribution have not been finalised. The EPA has also recommended that the portion of the Mangles Bay area associated with the marina be designated a MEPA.

The issues affecting the KW are less clear. Chlorophyll 'a' levels at KW exceeded the EQG for nutrient enrichment but LAC and seagrass shoot density did not. This indicates that seagrass health is not being affected by increased chlorophyll 'a' and that water clarity is still within an acceptable range.

The CSMC will continue to liaise with the DoD in regard to responding to nutrient enrichment at the GIS site and will review the nutrient enrichment status of KW and MB in 2014 to identify if there is further decline that provides increase cause for concern.

Chlorophyll 'a' and Light Attenuation Coefficient

Chlorophyll 'a' and LAC can also provide important information about water quality in their own right.

Chlorophyll 'a' concentration has exceeded the EQG at three of six sites in the HEPA-NS and at three of four sites in the HEPA-SS. Chlorophyll 'a' has also exceeded the EQG at four of seven sites in the MEPA-OH. It continues to exceed the EQG at the northern harbour (NH) site adjacent the Cockburn Sound Power Boat Association and public boating facilities. Chlorophyll 'a' levels in the HEPA-SS and MEPA-H are of most concern because of ongoing nutrient discharge from stormwater drains, and the low exchange of oceanic waters in these areas of Cockburn Sound.

Light availability to seagrasses can be a major factor affecting their growth and distribution. LAC measured through the water column appears to be relatively stable after some good improvements from earlier years of monitoring. There has, however, been a slight decline in overall LAC in 2013 meaning that light availability in the water column was reduced. Elevated chlorophyll 'a' concentrations in the water column, as seen at a number of sites in the HEPAs and MEPAs, may be responsible for a reduction in LAC.

Phytoplankton biomass

Phytoplankton biomass levels in the HEPA-NS and HEPA-SS did not exceed the EQG. Based on monitoring of only one site, the Northern Harbour of Jervoise Bay continues to have very high phytoplankton biomass levels as it has done for the past seven years. The reason for the high level is similar to that provided under *Chlorophyll 'a' and Light Attenuation Coefficient*.

Dissolved oxygen

Sites 11, 13 and MB exceeded the EQG when saturation levels fell between 78% and 90%. While the exceedance is a concern, the saturation levels are similar to levels recorded in some previous years. Site 11, near Mangles Bay is of most concern and may indicate that there is little 'turnover' of waters at this deep water site in an area that has a low exchange rate with oceanic waters.

Other water quality indicators

Concentrations of dissolved inorganic nutrients (filterable reactive phosphorus, ammonium and nitrate-nitrite) were significantly lower than in the majority of other years sampled, and similar to those of reference sites located in Warnbro Sound. This is indicative of an overall improvement in water quality in regard to these indicators.

Contaminant review

An audit by the Western Australian Office of the Auditor General on the environmental management of Cockburn Sound (2010) made a key finding that total contaminant discharges into Cockburn Sound have not been monitored since 2001. The Office of the Auditor General felt this reduced government's ability to target appropriate management actions and weakened implementation of the SEP.

To improve government's ability to target appropriate management actions, the CSMC and the then Department of Environment and Conservation's Environmental Regulations Division (now Department of Environment Regulation) commissioned a review of historical and contemporary contaminant loads entering Cockburn Sound (GHD, 2013).

Historically, the major contaminant of concern has been direct input of nitrogen from industrial sources. Nitrogen is thought to be the main contributor to seagrass die-off through epiphytic algal growth on seagrass and high phytoplankton biomass observed in the 1970s and 1980s.

Industrial inputs to Cockburn Sound are significantly less now as industrial wastes have been reduced through improved treatment processes and diversion of many discharges from Cockburn Sound to the Sepia Depression Ocean Outfall Landline (commonly referred to as the SDOOL).

Estimates indicate that the major contemporary pathway for contaminants to Cockburn Sound appears to be surface runoff that enters drains or the groundwater from all land uses in the catchment. Residential use is estimated to be the largest contributor of nitrogen (21-53 tonnes/year) and phosphorus (3-6 tonnes/year) in the Cockburn Sound catchment. Nitrogen and phosphorus are known limiting factors for plant growth and when present stimulate growth. In Cockburn Sound, phytoplankton has a high uptake of nutrients. Dense phytoplankton in the water column can shade seagrass on the seafloor causing it to decline. Epiphytes on seagrass blades also increase when nutrients are available to them. High epiphyte loads can result in seagrass being smothered.

The review made several recommendations to the Environmental Regulation Division of government inclusive of:

- Undertake a detailed review of industrial inputs into Cockburn Sound and establish reporting frameworks that require licensees to report action discharge loads as part of their annual reporting requirement.
- Undertake an environmental risk assessment to determine the risk posed to environmental values by contaminant inputs to Cockburn Sound.
- Develop policies for local government to better identify, manage and assess the range of prescribed and informal premises that generate contaminant waste in a diffuse manner.
- Establish and maintain a contaminant database.

The CSMC will consider how it may be able to assist the Department of Environment Regulation to implement the recommendations.

SEAGRASS HEALTH

Seagrass health was assessed at 25 permanent sites over eight days between 21 January and 1 February 2013 (see figure 5). Twelve sites act as fixed seagrass monitoring quadrats, nine act as reference quadrats and four allow for the collection of seagrass depth limit information.

Seagrass shoot density

Seagrass shoot density is a measure of nutrient enrichment. In previous years, it has been assessed as a single indicator. This approach is not consistent with the EQC document and reporting for seagrass shoot density alone will no longer occur.

Seagrass depth limit

Seagrass depth limit is not a measure required by the EQC document. However, it provides information on the adaptability of seagrass to varying water quality. There were minor reductions in the lower depth limits that seagrass was recorded at three of the four depth transect sites: Garden Island north and south and Woodman Point. Despite the small decrease in the depth that seagrass was found, the lower depth limit of seagrass had actually extended at another three sites from earlier records dating back to 2008. Fluctuations may be a result of changes in water clarity and light availability sufficient to cause a change.

Long term seagrass trends

The long term trends in the condition of seagrass meadows in Cockburn and Warnbro sounds were investigated in 2013 (Mohring & Rule, 2013).

The investigation noted a significant decline in seagrass density at almost all sites (including reference sites) in Cockburn and Warnbro sounds. The pressure of most concern to seagrass communities appears to be summer sea temperature which has shown an increase at all sites.

The decline in seagrass density is in contrast to a general improvement in water quality across Cockburn and Warnbro sounds. The general decline in seagrass density across sites appears to most likely be a result of:

1) a concomitant increase in water temperature across the area;

2) repeated disturbance associated with measuring seagrass in permanent quadrats; and/ or

3) the study's inadequate characterisation of the pressure field.

In order to determine if the decline in seagrass density represents a general, regional-scale trend or if it is confined to Cockburn and Warnbro sounds, the study recommended the health of seagrass sites should be monitored beyond the current study areas. Moreover, the current seagrass monitoring program should be augmented by broader local scale assessments of changes in seagrass extent and area through meso-scale (i.e. large-scale) assessments.

The report made several recommendations for the CSMC to consider in 2014:

- Fund an experimental study to determine the impact of repeated sampling of fixed seagrass quadrats on seagrass condition based on the question *"Is annual sampling reducing seagrass shoot density?"*.
- Incorporate temperature and light data loggers at several sites to help determine if these factors are affecting seagrass density.
- Investigate the impact of wave climate, vessel use, anchoring and other pressures on seagrass.

Localised seagrass observations

On the western side of Cockburn Sound around Garden Island the seagrass appears healthy. However, high levels of wrack (dead seagrass) had accumulated on the shore of some parts of Garden Island. Considerable wrack accumulation and exposed rhizome mat was observed on the beach at Garden Island Settlement (GIS). Wrack is not necessarily an issue in itself, but the increase may be an indication of seabed erosion.

Large seagrass blow outs (loss of seagrass and exposure of seabed) may encroach into the survey area over time and affect analysis. For example, the Southern Flats (SF) site was inundated by sand to the point that very few of the pins which mark permanent monitoring quadrats could be relocated. Maintenance to this site, and all others, will be undertaken in 2014 to ensure the markers are not lost.

The seagrass at Mangles Bay appears stressed, with fragile shoots and high levels of filamentous epiphyte (algal growth on leaves) coverage. There was also fine sediment smothering some shoots.

At Woodman Point, one depth transect was found to be located within a blow out in the meadow. Nearly all seagrass depth transects are impacted by blow outs in some way. Blowouts can commonly occur on the edge of seagrass meadows and are an indicator of the dynamic nature of sand movement across the seafloor. They may or may not indicate net seagrass loss from the system.

It is the intention of the CSMC to seek resources to map seagrass and make an estimate of coverage over the entire area of Cockburn Sound. The last map and estimate was made in 2004 and was confined to the eastern shelf of Cockburn Sound extending from Woodman Point to the BP Refinery where historical loss of seagrass has been most profound. There is a pressing need to assess the extent of seagrass coverage across the entire Sound as an overall indicator of seagrass health.

References

GHD (2013). *Cockburn Sound Contaminant Review*. Prepared for the Cockburn Sound Management Council and the Department of Environment and Conservation (Environmental Regulation Division). Perth WA.

Mohring, M. & Rule, M. (2013). *Long-term trends in the condition of seagrass meadows in Cockburn and Warnbro Sounds*. Prepared for the Cockburn Sound Management Council. Department of Parks and Wildlife, Kensington WA.

FISHING AND AQUACULTURE

SAFE SEAFOOD FOR EATING AND PROTECTING THE HEALTH OF AQUACULTURE SPECIES

Concentrations in water of several potentially toxic phytoplankton species exceeded the EQG, but no species tested in previous studies have been shown to produce biotoxins when present in seafood in Cockburn Sound. Toxicity test were not completed in 2013 because the risk of toxins is considered low.

Seafood tested in commercial growing areas did not exceed the *Western Australian Shellfish Quality Assurance Program* guidelines and seafood sourced from seafood growers is considered safe to eat.

It should be noted, however, that shellfish outside commercial growing areas are not monitored for safe eating and the general public should remain aware of the risk of eating seafood from jetties, piers, harbours and port related facilities.

Mussels are the only species cultured in Cockburn Sound. They are considered safe for eating.

RECREATION AND AESTHETICS

CLEAN WATERS FOR SWIMMING AND BOATING

Microbial water quality monitored near recreational beaches and boating areas in Cockburn Sound undertaken by the City of Rockingham, City of Kwinana and City of Cockburn and analysed by the Department of Health did not exceed human health guidelines. The improvement in stormwater drainage and waste water disposal methods introduced by local government in particular has resulted in much cleaner waters for swimmers and boaters.

INDUSTRIAL WATER SUPPLY

Water sourced by industry from Cockburn Sound continues to be suitable for use.

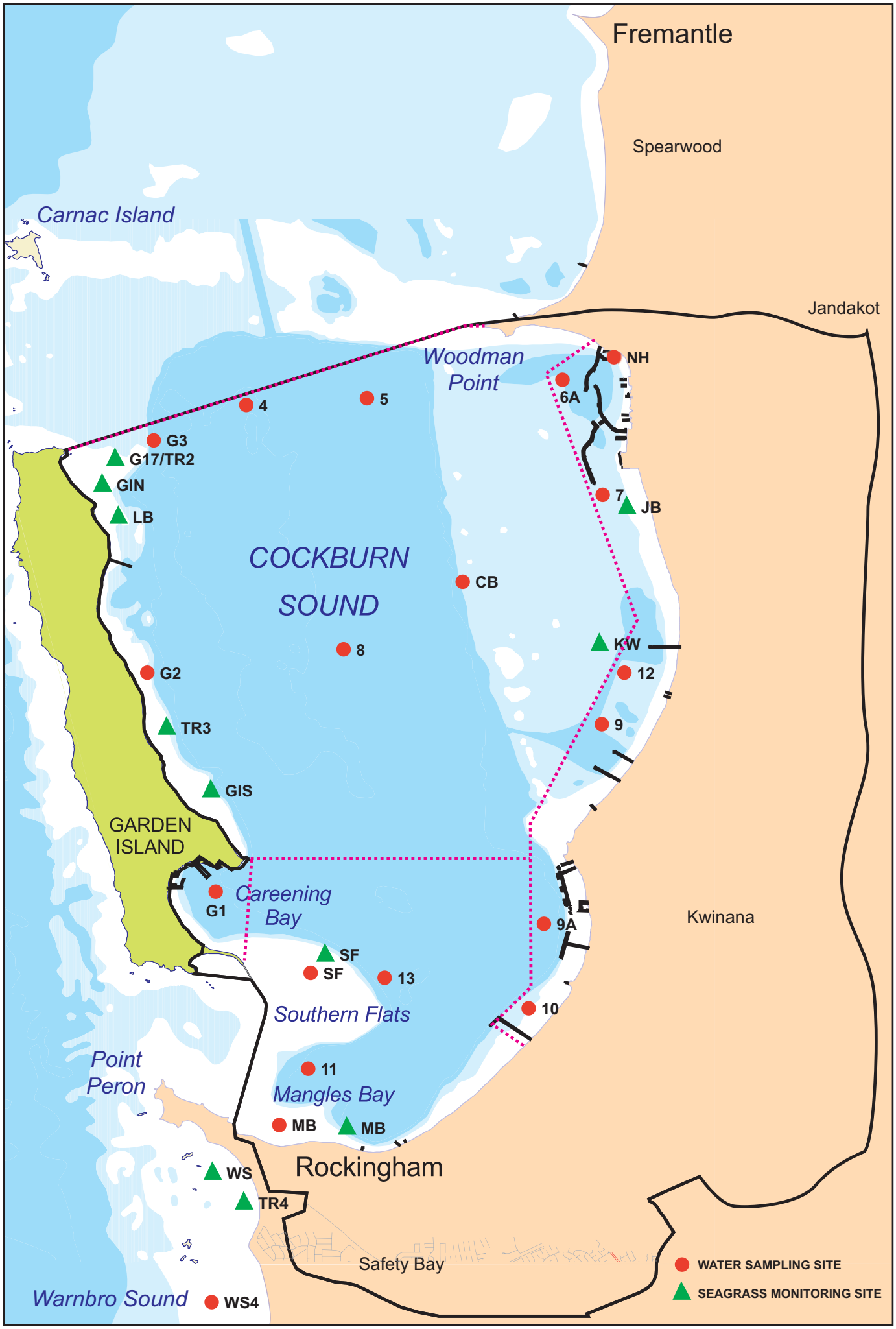


Figure 6: Annual seagrass monitoring sites and annual water quality sampling sites.

Cockburn Sound Report Cards 2013

LEGEND

Status	Action
M	**Monitor** Below EQG, continue monitoring
I	**Investigate** Above EQG, investigate and where necessary take precautionary action
A	**Act** Above EQS, facilitate a management response if practicable
M	**Monitor** Data greater than one year old but met EQG when last measured
I	**Investigate** Data greater than one year old but exceeded EQG when last measured
A	**Act** Data greater than one year old but exceeded EQS when last measured
	Monitoring did not occur, data results were not available or data is too old to report on

High Ecological Protection Area - Northern Sound

Environmental Quality Indicator	Management Response	Comments
Nutrient enrichment (assessed across 5 sites)		
Data for chlorophyll 'a', light attenuation coefficient (LAC) and seagrass shoot density is collectively assessed against the EQG for nutrient enrichment. Outcomes for individual sites are shown on figure 7.		
Garden Island North (GI7/TR2)	M	
Garden Island North (GIN)	M	
Garden Island North (LB)	M	
Kwinana (KW)	I	Nutrient enrichment coding for this site was determined using chlorophyll 'a' and LAC data from site 12 (MEPA-OH) and seagrass shoot density for site KW. Chlorophyll 'a' at site 12 exceeded the EQG.
Garden Island Settlement (GIS)	A	Nutrient enrichment coding for this site was determined using chlorophyll 'a' and LAC data from site G2 (HEPA-NS) and seagrass shoot density for site GIS. LAC exceeded the EQG for two consecutive years at site G2. Seagrass shoot density exceeded the EQS at GIS.
Physical and chemical measures		
Chorophyll 'a'	M	
Light attenuation coefficient	M	
Phytoplankton biomass (using chlorophyll 'a' levels to determine the EQG).	M	
Seagrass depth limits	M	Stability at the lower depth limit suggests that there has not been a decline in water clarity and light availability sufficient to cause a loss of seagrass.
Dissolved oxygen	M	
Temperature	M	
Salinity	M	
pH	M	
Contaminants in Water		
Metals and metalloids; Non-metallic inorganics; Organics; Pesticides; Herbicides and fungicides; Surfactants; and Hydrocarbons.	No sampling in 2013	Data was last collected for these indicators in 2008. All sites met the EQG or were below normal laboratory reporting limits.
Contaminants in Sediments		
Organometallics (e.g. Tributyltin); Metals and metalloids and Organics.	No sampling in 2013	Tributyltin levels were found to be well below the EQG in 2007. Studies undertaken by Curtin University in 2011 indicate that the occurrence of shellfish imposex caused by tributyltin uptake is declining. Eighty-six sites sampled in 2006 met the EQG for organics.

High Ecological Protection Area - Southern Sound

Environmental Quality Indicators	Management Response	Comments
Nutrient enrichment (assessed across 2 sites)		
Data for chlorophyll 'a', light attenuation coefficient (LAC) and seagrass shoot density is collectively assessed against the EQG for nutrient enrichment. Outcomes for individual sites are shown on figure 7.		
Southern Flats (SF)	M	Nutrient enrichment coding for this site was determined using chlorophyll 'a' and LAC data from site SF and seagrass shoot density for site SF (all HEPA-SS).
Mangles Bay (MB)	I	Nutrient enrichment coding for this site was determined using chlorophyll 'a' and LAC data from site MB and seagrass shoot density for site MB (all HEPA-SS). Chlorophyll 'a' exceeded the EQG at MB and seagrass shoot density has not met the EQG for two consecutive years.
Physical and Chemical measures		
Chorophyll 'a'	I	Chlorophyll 'a' concentrations remain relatively high in the HEPA-SS due to a low exchange rate with oceanic waters.
Light attenuation coefficient	I	LAC remains relatively high in the HEPA-SS due to a low exchange rate with oceanic waters.
Phytoplankton biomass (using chlorophyll 'a' levels to determine the EQG).	M	Phytoplankton biomass was a concern in 2012. This indicator has improved significantly in 2013 with all sites meeting the EQG on most occasions.
Seagrass depth limits	M	
Dissolved oxygen	I	Sites 11, 13 and MB exceeded the EQG when saturation levels fell between 78% and 90%. While the exceedance is a concern, the saturation levels are similar to levels recorded in some previous years. Site 11, a deep water site near Mangles Bay, is of most concern.
Temperature	M	
Salinity	M	
pH	M	
Contaminants in Water		
Metals and metalloids; Non-metallic inorganics; Organics; Pesticides; Herbicides and fungicides; Surfactants; and Hydrocarbons.	No sampling in 2013	Data was last collected for these indicators in 2008. All sites met the EQG or were below normal laboratory reporting limits.
Contaminants in Sediments		
Organometallics (e.g. Tributyltin); Metals and metalloids and Organics.	No sampling in 2013	Tributyltin levels were found to be well below the EQG in 2007. Studies undertaken by Curtin University in 2011 indicate that the occurrence of shellfish imposex caused by tributyltin uptake is declining. Eighty-six sites sampled in 2006 met the EQG for organics.

Moderate Ecological Protection Area - Harbours

There is no seagrass in the Northern & Southern harbours.

Environmental Quality Indicators	Management Response	Comments
Physical and chemical measures		
Chlorophyll 'a'	I	
Light attenuation coefficient	I	Water clarity in the harbour is compromised by high levels of chlorophyll 'a' in the water column.
Phytoplankton biomass (using chlorophyll 'a' levels to determine the EQG).	A	Phytoplankton biomass has been a concern in the Northern Harbour (the only site assessed in 2013) since 2003. Seawater exchange with the open waters of Cockburn Sound is limited resulting in nutrients from groundwater flow and stormwater run- off being 'captured' in the harbour. No sampling occurred in the Southern Harbour.
Dissolved oxygen	M	
Temperature	M	
Salinity	M	
pH	M	
Contaminants in water		
Metals and metalloids; Non-metallic inorganics; Organics; Pesticides; Herbicides and fungicides; Surfactants; and Hydrocarbons.	No sampling in 2013	Data was last collected for these indicators in 2008. All sites met the EQG or were below normal laboratory reporting limits.
Contaminants in Sediments		
Organometallics (e.g. Tributyltin); Metals and metalloids and Organics.	No sampling in 2013	Tributyltin levels were found to be well below the EQG in 2007. Studies undertaken by Curtin University in 2011 indicate that the occurrence of shellfish imposex caused by tributyltin uptake is declining. Eighty-six sites sampled in 2006 met the EQG for organics.

Moderate Ecological Protection Area - Outside Harbours

Environmental Quality Indicators	Management Response	Comments
Nutrient enrichment (assessed for 1 site)		
Data for chlorophyll 'a', light attenuation coefficient (LAC) and seagrass shoot density is collectively assessed against the EQG for nutrient enrichment. Outcomes for individual sites are shown on figure 7.		
Jervoise Bay (JB)	M	Nutrient enrichment coding for this site was determined using chlorophyll 'a' and LAC data from site 7 and seagrass shoot density for site JB (both MEPA-OH).
Physical and chemical measures		
Chlorophyll 'a'	M	
Light attenuation coefficient	M	
Phytoplankton biomass (using chlorophyll 'a' levels to determine the EQG).	M	Phytoplankton biomass was a concern in 2012. This indicator has improved significantly in 2013 with all sites meeting the EQG on most occasions.
Seagrass depth limits	M	Stability at the lower depth limit suggests that there has not been a decline in water clarity and light availability sufficient to cause a loss of seagrass.
Dissolved oxygen	M	
Temperature	M	
Salinity	M	
pH	M	
Contaminants in water		
Metals and metalloids; Non-metallic inorganics; Organics; Pesticides; Herbicides and fungicides; Surfactants; and Hydrocarbons.	No sampling in 2013	Data was last collected for these indicators in 2008. All sites met the EQG or were below normal laboratory reporting limits.
Contaminants in Sediments		
Organometallics (e.g. Tributyltin); Metals and metalloids and Organics.	No sampling in 2013	Tributyltin levels were found to be well below the EQG in 2007. Studies undertaken by Curtin University in 2011 indicate that the occurrence of shellfish imposex caused by tributyltin uptake is declining. Eighty-six sites sampled in 2006 met the EQG for organics.

Safe Seafood for Eating

Environmental Quality Indicators	Management Response	Comments
Biological contaminants in water		
Thermo-tolerant faecal coliform	M	
Algal biotoxins	I	Concentrations (in water) of several potentially toxic phytoplankton species exceeded the EQG, no species tested in previous studies have been shown to produce biotoxins when present in seafood in Cockburn Sound. Toxicity tests were not completed in 2013. Seafood tested in commercial growing areas did not exceed the Western Australian Seafood Quality Assurance Program guidelines. Seafood sourced from seafood growers is considered safe to eat. **IMPORTANT NOTE:** Shellfish outside commercial growing areas is not monitored for safe eating and the general public should remain aware of the risk of eating seafood from jetties, piers, harbours and port related facilities.
Biological contaminants in seafood flesh		
Presence of toxic algae in mussel flesh	Not sampled in 2013	All sites met the guidelines in 2012.
Thermo-tolerant faecal coliform in seafood flesh	M	A low number of samples of seafood flesh were sourced from the north and south of the Kwinana Grain Terminal and at Southern Flats. These samples met the guidelines but may be too few in number to provide a high level of confidence.
Metals in mussel flesh	M	
Organic chemicals in mussel flesh	Not sampled in 2013	Monitoring in previous years found that organic chemicals in mussel flesh were below laboratory reporting limits and were therefore safe to eat.

Protecting the Health of Aquaculture Species

Mussels are the only species cultured in Cockburn Sound and are considered ecologically healthy.

Environmental Quality Indicators	Management Response	Comments
	Physical and chemical measures	
Dissolved oxygen	M	
pH	M	
	Contaminants in Water	
Metals and metalloids	M	
Non-metallic inorganic chemicals Organic chemicals Pesticides	M	

Clean Waters for Swimming and Boating

Microbial water quality monitored near recreational beaches and boating areas in Cockburn Sound undertaken by the City of Rockingham, City of Kwinana and City of Cockburn and analysed by the Department of Health did not exceed guidelines. The improvement in stormwater drainage and waste water disposal introduced by local government in particular has resulted in much cleaner waters for swimmers and boaters.

Environmental Quality Indicators	Management Response	Comments
	Physical and biological measures	
Bacterial Enterococci (as it relates to swimming)	M	Beach sites have greatly improved in relation to bacteria contamination. No site has exceeded the EQG since 2010.
Toxic algae (as it relates to swimming)	M	The EQG for toxic algae was exceeded at one site near the Kwinana Grain Terminal. No reports of skin or eye irritations caused by toxic algae or algal poisoning were reported in 2012 or 2013.
Bacterial Enterococci (as it relates to boating)	M	
pH	M	
Water clarity (as measured by secchi disk)	M	All sites except Mangles Bay met the EQG for water clarity.
Inorganic chemicals	M	
Organic chemicals	M	
Pesticides	M	

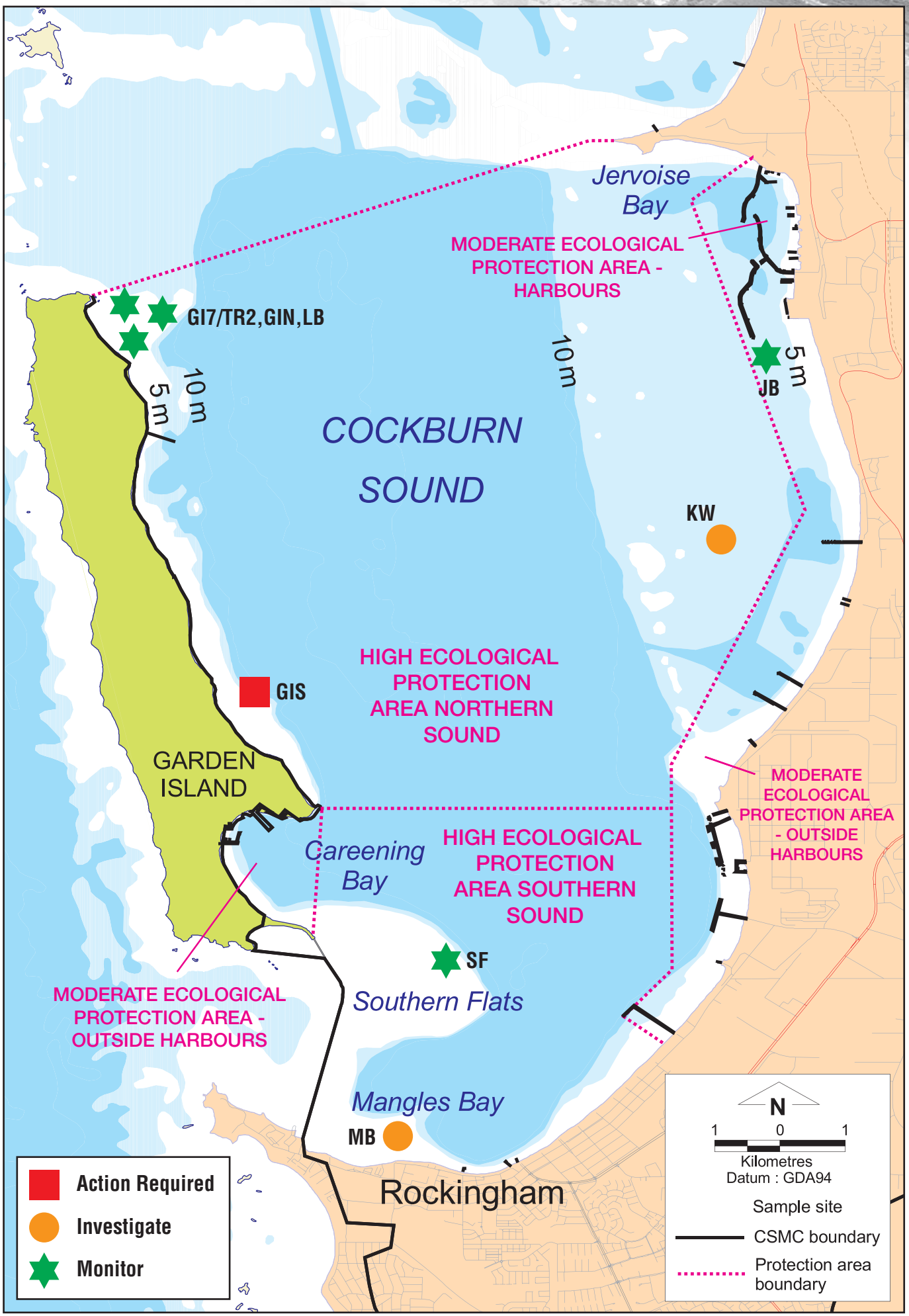


Figure 7: ECOSYSTEM HEALTH - Nutrient Enrichment

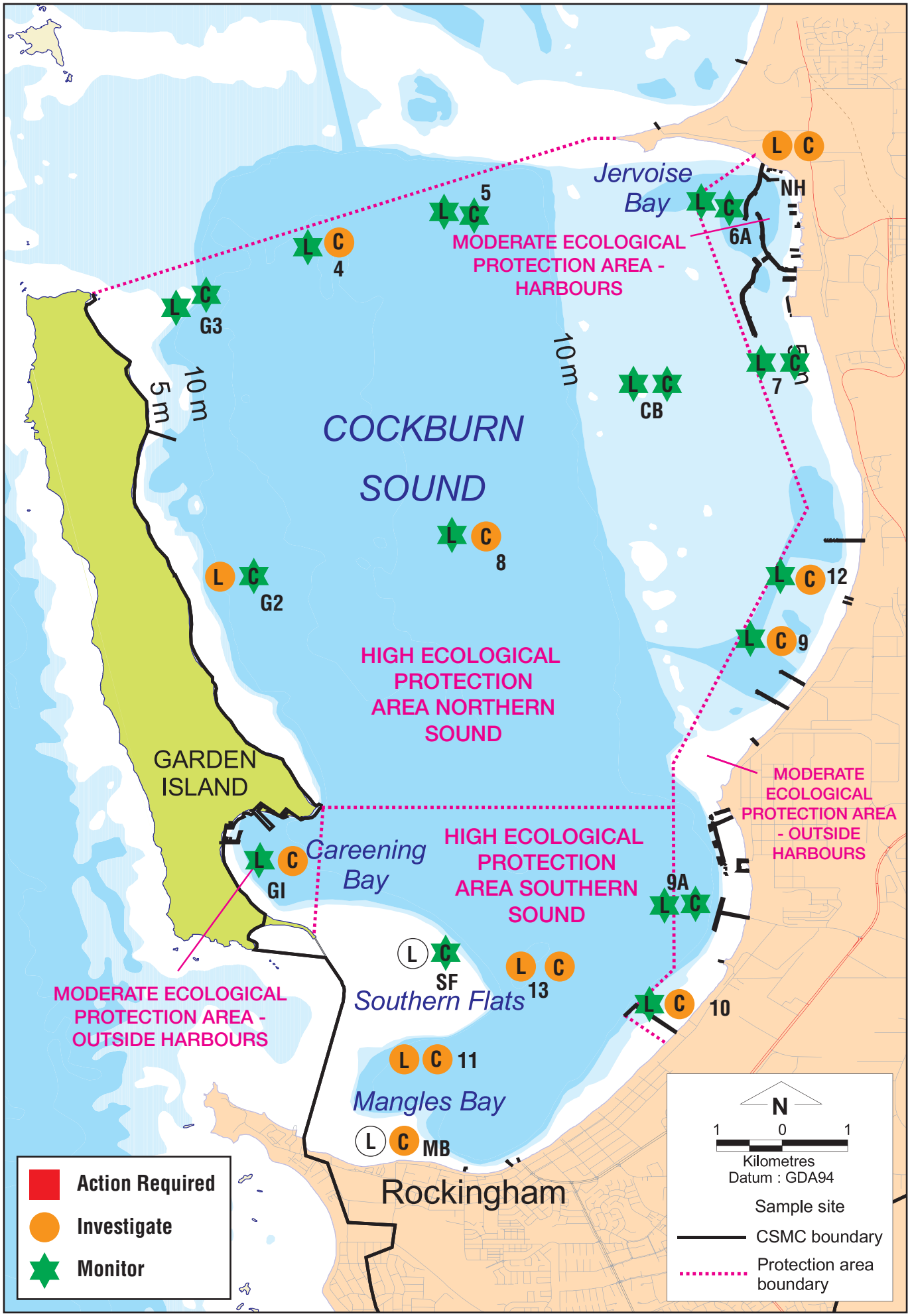


Figure 8: ECOSYSTEM HEALTH - Light attenuation coefficient (L) and chlorophyll 'a' (C)

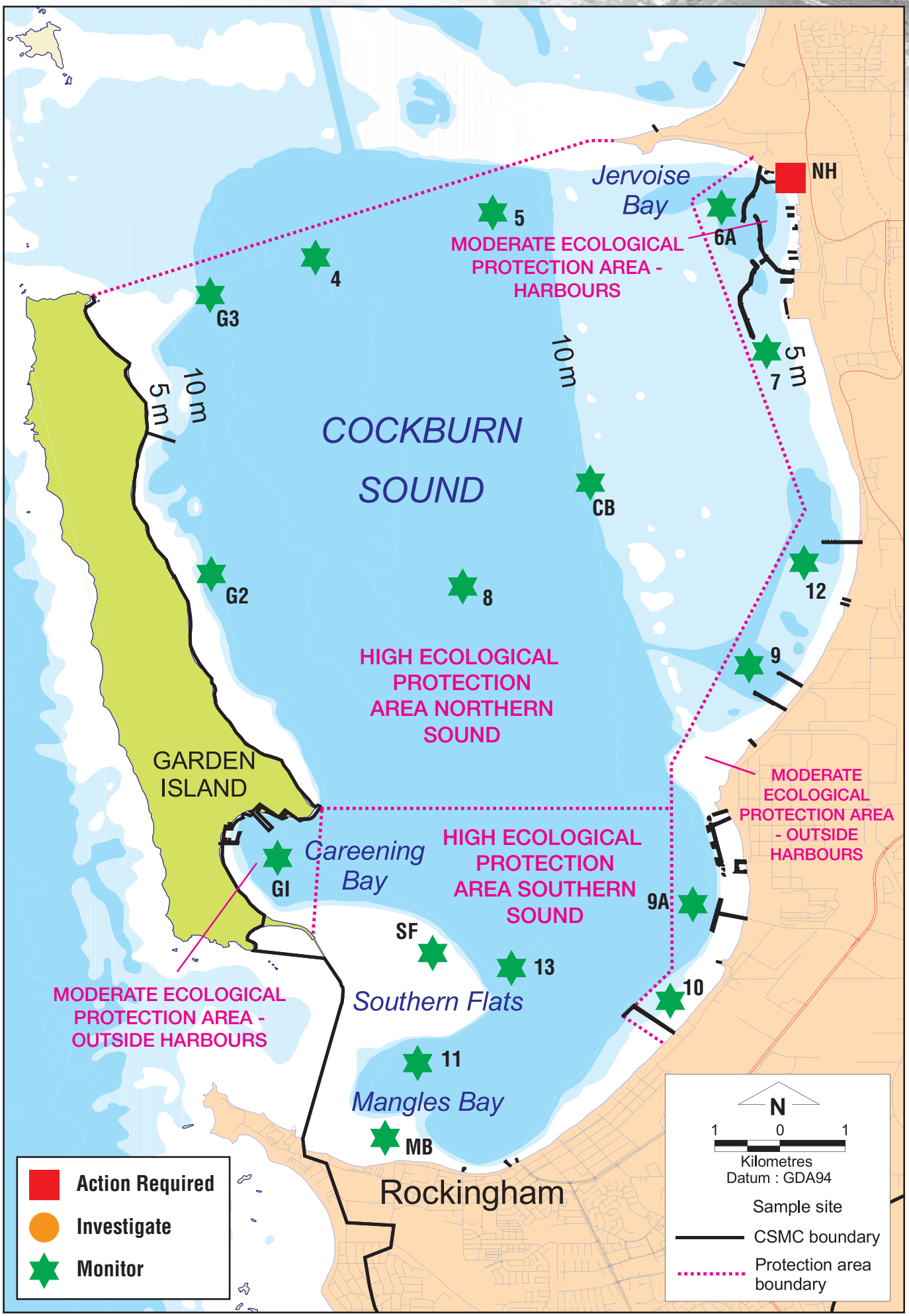


Figure 9: ECOSYSTEM HEALTH - Phytoplankton Biomass

Report Card Comparison 2003 - 2013

The CSMC reports exceedance of EQG of EQS to the EPA and Minister for Environment. If a responsible public authority can be identified as having responsibility for the exceedance, the CSMC will refer the exceedance to that authority for investigation (I) or action (A). If the CSMC identifies that there is no relevant public authority responsible for the exceedance, it will initiate an investigation or action taking into the account the cost and practicalities of such investigations or acts.

Area	Indicators	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013 N	2013 S
HEPA	**Nutrient Enrichment**	No assessment for nutrient enrichment prior to 2013 for the HEPA or MEPA											
Southern Sound	Southern Flats (SF)												M
	Mangles Bay (MB)												I
Northern Sound	Garden Island North (G17/TR2)											M	
	Garden Island North (GIN)											M	
	Garden Island North (LB)											M	
	Kwinana (KW)											I	
	Garden Island Settlement (GIS)											A	
MEPA Outside Harbours	Jervoise Bay (JB)											M	
HEPA	Light attenuation	I	I	M	I		I	M	M	I	I	M	I
	Chlorophyll 'a'	M	M	M	M	M	M	M	M	I	I	M	I
	Dissolved oxygen	M	M	M	M	M	M	I	M	M	M	M	I
	Seagrass shoot density	I	I	I	M	M	M	I	I	I	A	#	#
	Phytoplankton biomass										M	M	M
	Safe seafood for eating Algal biotoxins	M	M	I	I	I	M	I	M	M	I	I	I
	Clean waters for swimming Toxic Algae	M	M	M	M	I	I	I	M	M	M	M	M
	Clean waters for swimming Bacterial Enterococci	M	M	A	A	I	I	I	M	M	M	M	M
	Imposex & TBT (All areas)				A	A	A	A	A				
MEPA - HARBOURS Outside Harbours	TBT sediment	A	I	M	A	I	M	M	M	M	M		
MEPA - HARBOURS Northern Harbours	Light attentuation			I	I		I	I	I	I	I	I	I
	Chlorophyll 'a'	I	I	I	I	I	I	I	I	I	I	I	I
	Phytoplankton biomass	A	A	A	A	A	A	A	A	A	A	A	A
	TBT Sediment	A	I	I	A	I	I	I	I	I	I	I	
MEPA - HARBOURS Southern Harbours	TBT Sediment	A	I	I	A	I	M	M	M	M	M	M	

[1] N = High Ecological Protection Area - Northern Sound
S = High Ecological Protection Area - Southern Sound
(2013 represents the first year that the HEPA - Southern Sound data has been analysed separately from all HEPA data).

Under the EQC document, seagrass shoot density is a measure of nutrient enrichment. It is no longer assessed as a stand-alone indicator.

Bottlenose dolphins are resident in Cockburn Sound and use the area to raise their young. They are mammalian indicators of the health of Cockburn Sound. (Photo by Rockingham Wild Encounters)

Cockburn Sound Management Council

State of Cockburn Sound Report 2013

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