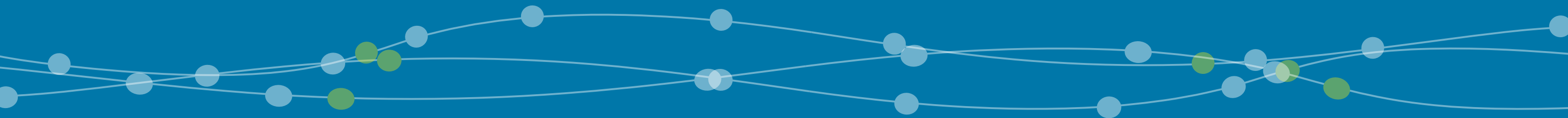




COCKBURN SOUND REPORT CARD

2015
- 2016



Cockburn Sound Management Council Membership as at 30 June 2016

Chair: Emeritus Professor Kateryna Longley

State Government	
Sarah McEvoy	Department of Environment Regulation
Dr Shaun Meredith	Department of Fisheries
Leon Brouwer	Department of Water
Jim Dodds	Department of Health
Gordon Groth	Water Corporation
Gino Valenti	Fremantle Ports
Local Government	
Deputy-Mayor Carol Reeve-Fowkes	City of Cockburn
Cr Ruth Alexander	City of Kwinana
Cr Chris Elliott	City of Rockingham
Federal Government	
Mark Sweetman	Department of Defence

Industry	
Chris Oughton	Kwinana Industries Council
Glenn Dibbin	WA Fishing Industry Council
Recreational Users	
Craig Bibra	Recfishwest
Desmond Kelly	Cockburn Power Boats Association
Conservation	
Prof. David Harries	Conservation Council of WA
Community Members	
Peter Green	
James Mumme	
John Polglaze	

Members were appointed by the Minister for Environment for a period of three years from 1 January 2016.

Cockburn Sound is the most intensively used marine embayment in Western Australia. It is highly valued by the community for recreation and is used for tourism. The Sound supports fisheries and aquaculture, as well as providing a safe anchorage and maritime facilities for industry and the Australian Defence Force. This Report Card provides a summary of the Cockburn Sound Management Council's assessment of the extent to which the environmental quality criteria and objectives for Cockburn Sound were met in 2015–16. This is based on the results of monitoring carried out during the 2015–16 reporting period.

Introduction

Cockburn Sound is the most intensively used marine embayment in Western Australia. It supports recreational and commercial fisheries and aquaculture operations, as well as a range of tourism and recreational activities. It is also valued for its ecological attributes; it is an important spawning ground and nursery area for Pink Snapper, an important foraging area for Little Penguins, and an important nursery and feeding area for resident Bottlenose Dolphins.

Cockburn Sound provides a safe anchorage and maritime facilities adjacent to a major industrial complex which represents a vital part of Western Australia's economy. The Sound is also important to the Australian Defence Force which has a base on Garden Island.

While there have been significant improvements in the ecological condition of Cockburn Sound since the 1970s, it is under ongoing environmental pressure from increasing industrial, urban and recreational use.

The State Environmental Policy for Cockburn Sound

The State Environmental Policy provides the framework for Cockburn Sound's environmental management. The objective of the State Environmental Policy is to ensure that water quality is maintained and, where possible, improved so that the Sound's values and uses are maintained.

The State Environmental Policy identifies the environmental values for the Cockburn Sound marine area, and the environmental quality objectives that are required to be met to protect and maintain these values. The environmental quality objectives guide decision-making and provide the common goals for management.

The State Environment Policy describes three levels of ecological protection and where they apply in the Cockburn Sound marine area so that overall ecological integrity can be maintained. Most of Cockburn Sound is assigned a high level of ecological protection (HPA-N and HPA-S). Careening Bay on Garden Island (MPA-CB) and the eastern margin of Cockburn Sound adjacent to the industrial area (MPA-ES) are assigned a moderate level of protection. MPA-ES includes the Jervoise Bay Northern Harbour (MPA-NH) which is assessed separately. A few small areas around outfalls are assigned a low level of ecological protection.

The Environmental Quality Management Framework

The Environmental Protection Authority has established an environmental quality management framework for Cockburn Sound. Implementation of the environmental quality management framework requires a cooperative approach that involves all stakeholders.

Environmental quality criteria (criteria) play an important role in the environmental quality management framework. The criteria represent the quantitative benchmarks for measuring success in achieving the environmental quality objectives. The goal of environmental management is to ensure that direct and indirect sources of contaminants are managed such that the criteria are met and the environmental quality objectives are achieved.

There are two types of environmental quality criteria:

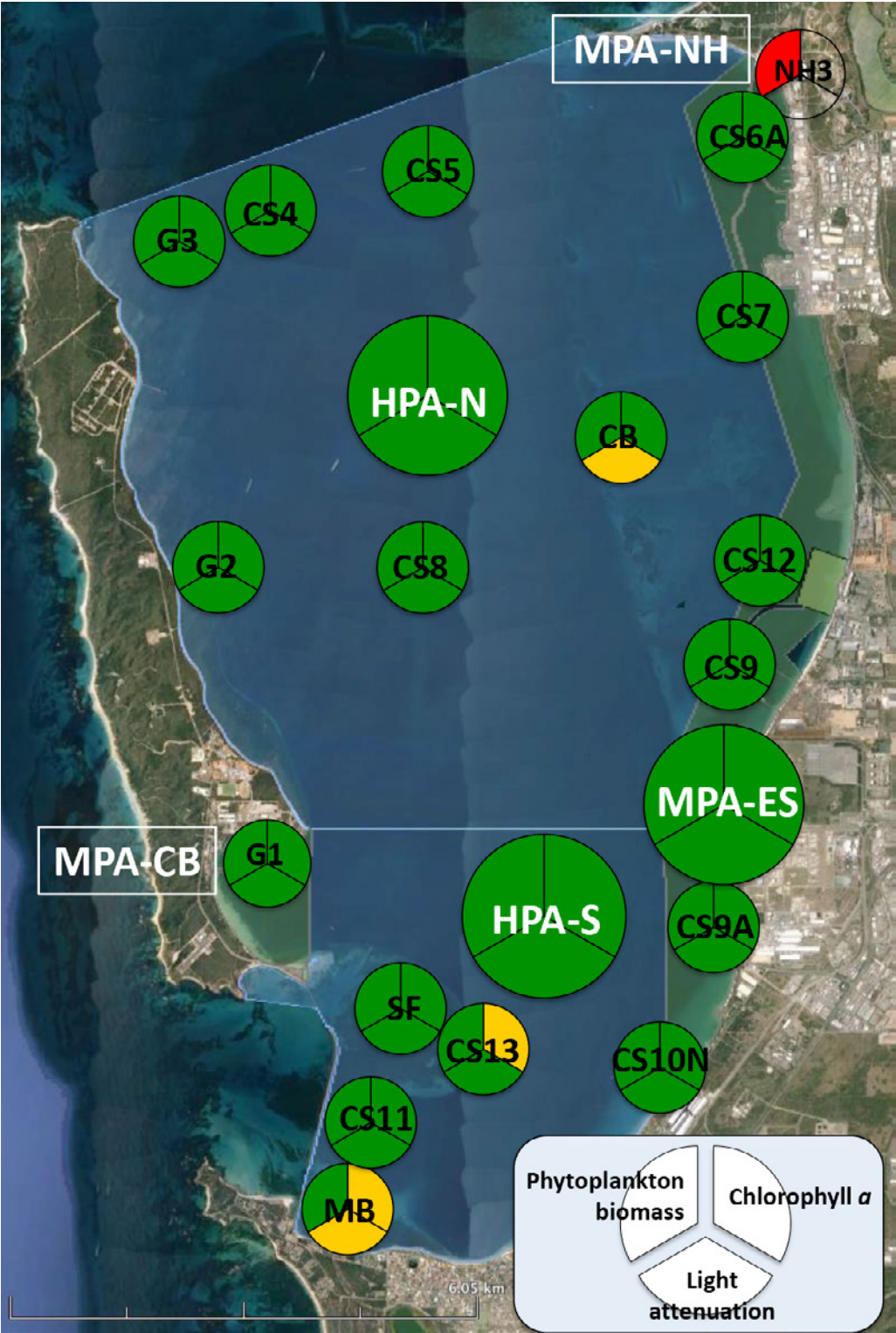
- **Environmental quality guidelines (guidelines)** – which, if met, indicate there is a high degree of certainty that the associated environmental quality objective has been achieved. If a guideline is not met, there is uncertainty whether the environmental quality objective has been achieved. This triggers a more detailed assessment against an environmental quality standard.
- **Environmental quality standards (standards)** – which indicate a level beyond which there is a significant risk that the associated environmental quality objective has not been achieved. This triggers an adaptive management response. The response would normally focus on identifying the cause (or source) and reducing loads of the contaminant of concern.

The environmental quality management framework implements monitoring strategies to provide data for measuring environmental performance against the criteria. Responsibility for monitoring is shared across a number of public authorities. The Cockburn Sound Management Council (CSMC) coordinates environmental monitoring and reports annually to the Minister for Environment and the community.

This Report Card summarises the assessment of the extent to which the results from the 2015–16 monitoring period met the environmental quality criteria and environmental quality objectives for Cockburn Sound. For more detailed information refer to the *Cockburn Sound Annual Environmental Monitoring Report 2015–2016* which is available at: www.der.wa.gov.au/images/documents/about/csmc/2015-2016_Cockburn_Sound_Annual_Environmental_Monitoring_Report_FINAL.pdf.

Environmental Value: Ecosystem Health
Environmental Quality Objective: Maintenance of Ecosystem Integrity

Figure 1: Assessment against the nutrient enrichment-related environmental quality criteria



The achievement of this environmental quality objective is assessed, in accordance with the *Environmental Quality Criteria Reference Document for Cockburn Sound* (Environmental Protection Authority 2015), on the basis of results from monitoring of:

- the nutrient enrichment-related indicators chlorophyll *a*, light attenuation, seagrass shoot density and lower depth limit, and phytoplankton biomass;
- the physical-chemical stressors dissolved oxygen concentration, water temperature, salinity and pH;
- toxicants in marine waters; and
- toxicants in sediment.

The environmental quality criteria set a level of environmental quality so that the overall ecological integrity of Cockburn Sound can be maintained. The level of environmental quality considered acceptable varies according to the level of ecological protection assigned to the area.

Nutrients (Figure 1)

Background

Cockburn Sound has had a history of nutrient inputs from industrial and wastewater discharge, groundwater discharge and surface run-off from urban and rural areas. Nutrient enrichment resulted in poor water quality and the loss of seagrass meadows in the Sound in the late 1960s and early 1970s. The loss of seagrass was attributed to increased growth of phytoplankton and epiphytes¹ which reduced the availability of light reaching the seagrass.

Water quality monitoring in Cockburn Sound focuses on nutrient-related effects. Chlorophyll *a* concentration and water clarity (measured as light attenuation coefficient), which are affected by nutrient availability and water residence time, are used as indicators of nutrient enrichment. Chlorophyll *a* concentrations also provide a measure of phytoplankton biomass, which is an indicator of the occurrence of algal blooms in Cockburn Sound.

Measurements of chlorophyll *a* concentration and light attenuation were made at 18 sites in Cockburn Sound and two reference sites in Warnbro Sound on 16 occasions over the non river-flow period (December 2015–March 2016). The results were assessed against the nutrient-related guidelines for Cockburn Sound. Measurements of phytoplankton biomass (as chlorophyll *a*) were assessed against the phytoplankton biomass criteria.

Seagrass shoot densities were measured at 11 sites in Cockburn Sound, five sites outside Cockburn Sound and five reference sites in Warnbro Sound. Shoot densities were assessed against the ‘absolute minimum’ shoot densities² and the rolling four-year percentiles of shoot densities³ at the Warnbro Sound reference sites. The lower depth limit⁴ of seagrass distribution was recorded at two sites in Cockburn Sound, one site outside Cockburn Sound and one site in Warnbro Sound.

Result			
Assessment and Action	Environmental Quality Guidelines met—continue monitoring	Environmental Quality Guidelines not met—investigate against the Environmental Quality Standard	Environmental Quality Standard not met—management response triggered

¹ Algae that grow on seagrass leaves.
² A baseline condition at the Warnbro Sound reference sites during the first four years of monitoring prior to 2005.
³ Shoot density at each Warnbro Sound reference site is measured each year and the data added to the historical reference data set. The percentiles are re-calculated from the last four years (approximately 100 data points) for each reference site.
⁴ The maximum depth at which seagrass shoots are observed.

Key findings

Chlorophyll *a*

The chlorophyll *a* guidelines were met in the northern high ecological protection area (HPA-N) and the southern high ecological protection area (HPA-S), as well as in the Careening Bay (MPA-CB) and the eastern Sound (MPA-ES) moderate ecological protection areas.

2015–16 was the first monitoring period since 2007–08 that the chlorophyll *a* concentration in HPA-S met the high protection guideline.

Light attenuation

The light attenuation guidelines were met in the northern high ecological protection area (HPA-N) and the southern high ecological protection area (HPA-S), as well as in the Careening Bay (MPA-CB) and the eastern Sound (MPA-ES) moderate ecological protection areas.

2015–16 was the first monitoring period since 2010–11 that light attenuation in HPA-S met the high protection guideline.

Phytoplankton biomass

The phytoplankton biomass guidelines were met at all sites and in all ecological protection areas except Jervoise Bay Northern Harbour (MPA-NH).

The phytoplankton biomass guideline and standard were not met in Jervoise Bay Northern Harbour. The phytoplankton biomass standard in Jervoise Bay Northern Harbour has not been met since 2003 when reporting began. This is attributed to high levels of nitrogen in groundwater flowing into the Northern Harbour and increased residence times associated with the construction of the northern breakwater in the late 1990s. Previous mitigation strategies have included the removal of nitrogen point sources and the implementation of a groundwater recovery scheme.

Changes over time

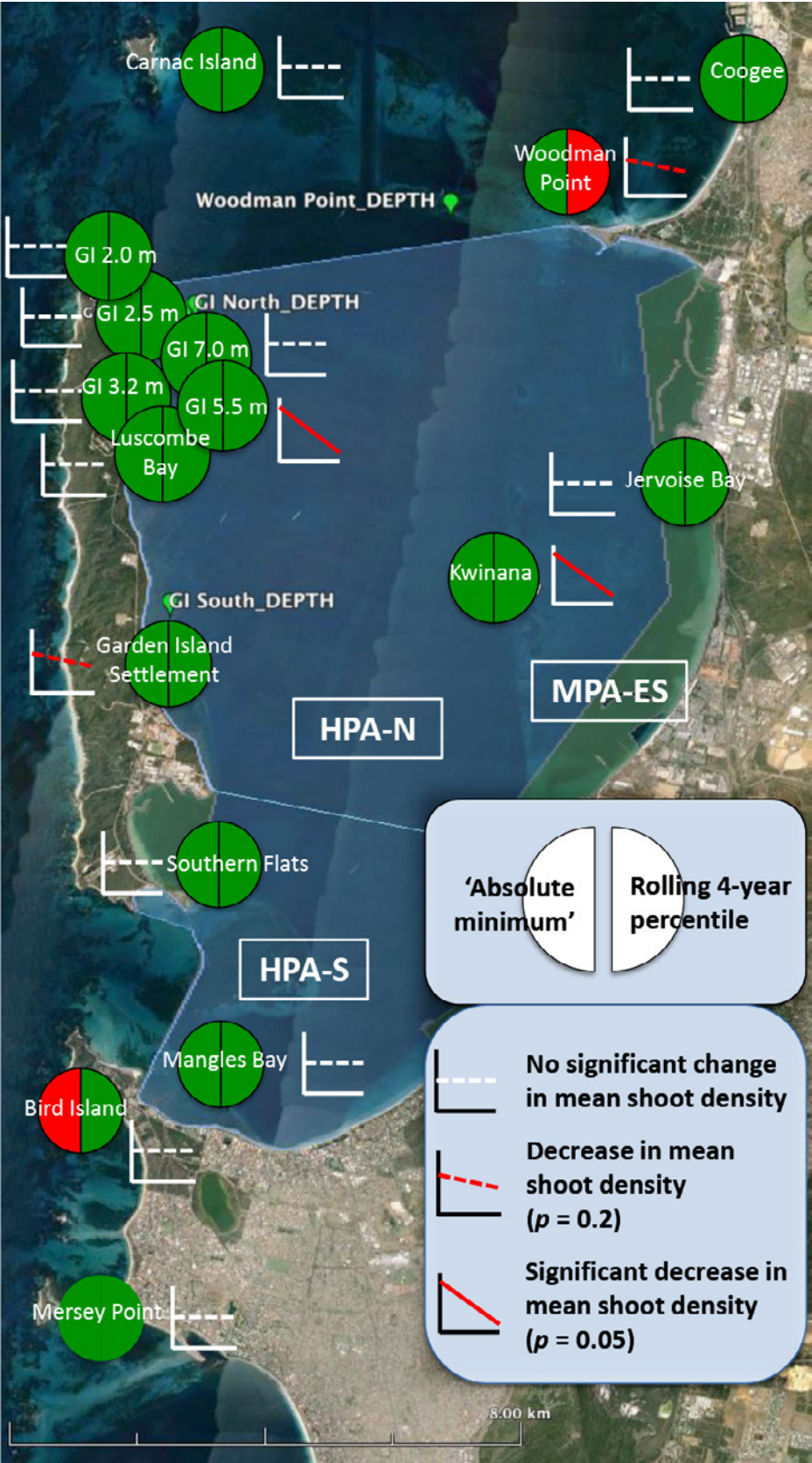
Nutrient-related water quality has been monitored through summer surveys of chlorophyll *a* levels since the late 1970s. Water quality in Cockburn Sound has improved markedly over the past 30 years. Significant downward trends in the concentrations of nutrients are attributable to a reduction in nutrient inputs from external sources (for example, diversion of industrial wastewater, improvements in groundwater and interception of stormwater).

Response

In response to concerns about the state of water and sediment quality and the environmental conditions in Jervoise Bay Northern Harbour and following extensive consultation with stakeholders, the CSMC prepared the *Jervoise Bay Northern Harbour Management Action Plan* (2012). The CSMC has recently reviewed the Management Action Plan in consultation with stakeholders. Noting it is anticipated that the nitrogen load into the harbour will continue to reduce slowly over time, the CSMC determined that it was not necessary to give further consideration to the recommendations in the Management Action Plan at that time.

The CSMC will continue to monitor water quality in Jervoise Bay Northern Harbour, to report against the phytoplankton biomass criteria and to provide advice to the Minister for Environment on appropriate management responses. The CSMC does not consider it appropriate to seek to modify the criteria for Jervoise Bay Northern Harbour.

Figure 2: Summary of the 2016 seagrass health monitoring results



Result	Assessment	Result	Assessment
<div></div>	Median seagrass shoot densities are higher than the: <ul style="list-style-type: none">• 'absolute minimum' criteria• rolling four-year percentiles of shoot densities	<div></div>	Median seagrass shoot densities are lower than the: <ul style="list-style-type: none">• 'absolute minimum' criteria• rolling four-year percentiles of shoot densities

Seagrass Health (Figure 2)

Key findings

Shoot density

Median seagrass shoot densities at all the seagrass monitoring sites in Cockburn Sound were higher than the 'absolute minimum' shoot densities. Median shoot densities were also higher than the annually updated rolling four-year percentiles of shoot densities at the Warnbro Sound reference sites.

At sites outside Cockburn Sound:

- median seagrass shoot density at Bird Island was below the 'absolute minimum' shoot density; and
- median shoot density at Woodman Point was below the rolling four-year 20th percentile shoot density.

Lower depth limit of seagrass

The lower depth limit of seagrass has increased significantly from around eight metres in 2001 to around 11 metres in 2016 at the GI South_Depth and Woodman Point_Depth sites.

The maximum depth of seagrass distribution has remained stable at around nine to 10 metres at the GI North_Depth and the Warnbro Sound_Depth sites.

The increase or stability in the distribution of seagrass in deeper waters suggests that water quality and light availability are generally adequate for seagrass growth as seagrass is growing near its depth limit in Cockburn Sound.

Changes over time

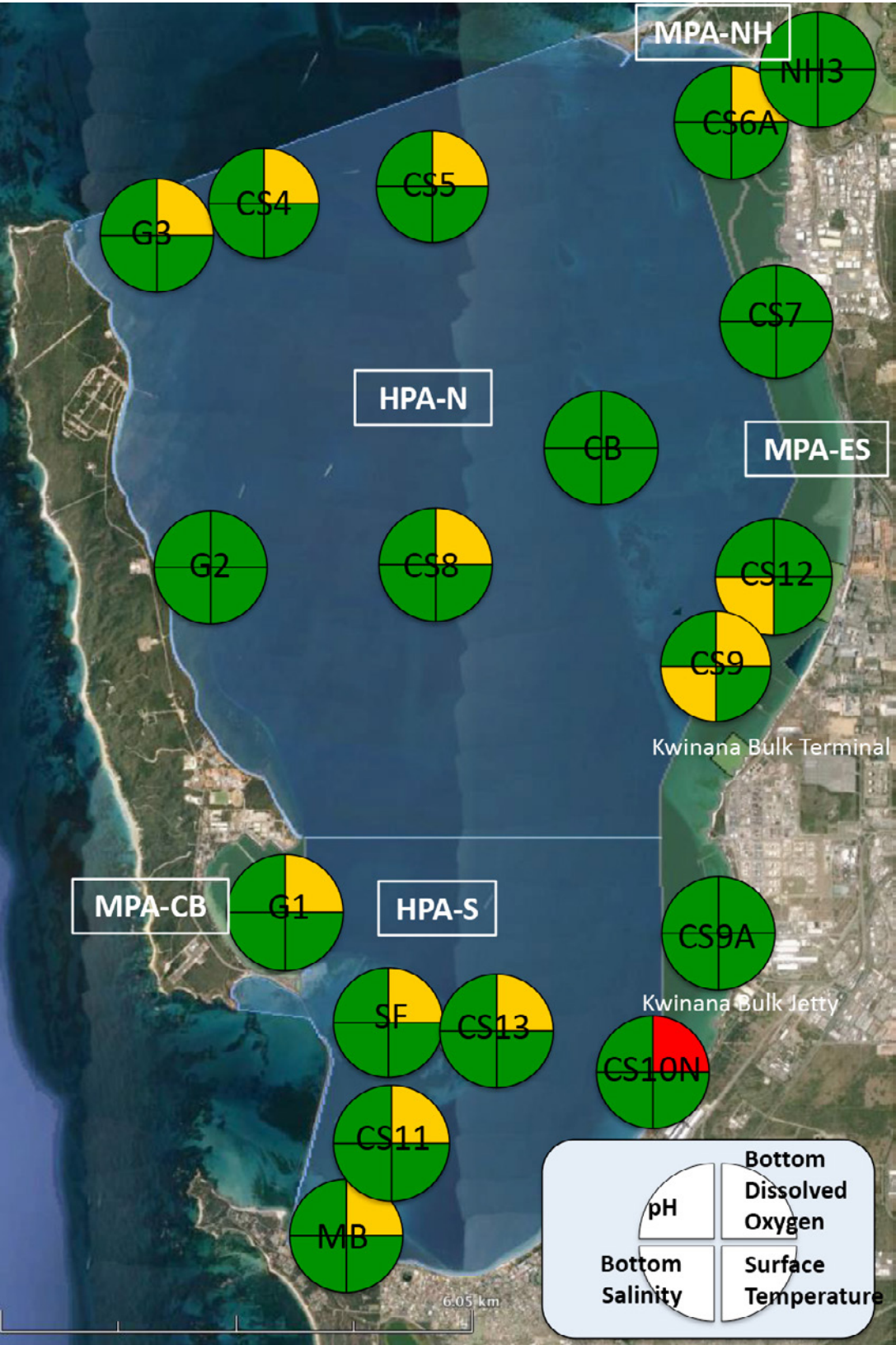
Higher shoot densities were recorded in 2016 than in the previous five to 10 years at eight of the monitoring sites in Cockburn Sound.

There were no significant trends in mean shoot densities at most of the seagrass monitoring sites over the past 11–14 years. There were significant negative trends in mean shoot density at Garden Island 5.5 m and Kwinana. There were also negative trends in mean shoot density at Garden Island Settlement and Woodman Point but these were not significant.

There were negative trends in mean shoot density at four of the Warnbro Sound reference sites (Warnbro Sound 2.0 m, Warnbro Sound 3.2 m, Warnbro Sound 5.2 m and Warnbro Sound 7.0 m). The decreases in mean shoot densities at Warnbro Sound 2.0 m and Warnbro Sound 3.2 m were statistically significant.

Sediment erosion and the development of 'blow outs' has been identified as a potential cause of the decline in shoot densities at the Warnbro Sound reference sites. Relatively high levels of intrusion of potentially toxic sediment sulfides into seagrass tissues have also been reported at the reference sites, which may also be contributing to declines in shoot density.

Figure 3: Assessment against the physical and chemical stressors environmental quality criteria



Physical and Chemical Stressors (Figure 3)

Background

Changes in dissolved oxygen concentration, water temperature, salinity and pH can have a negative impact on marine organisms if the parameters extend beyond their normal range for Cockburn Sound.

Measurements of dissolved oxygen concentration, water temperature, salinity and pH were made at 18 sites in Cockburn Sound and two reference sites in Warnbro Sound on 16 occasions over the non river-flow period (December 2015–March 2016). The results were assessed against the criteria for physical-chemical stressors for Cockburn Sound.

Key findings

Dissolved oxygen

Dissolved oxygen concentrations in bottom waters at eight of the 10 monitoring sites in the high protection areas (HPA-N and HPA-S) did not meet the high protection guideline (90% saturation) on between two and nine of the sampling occasions. Dissolved oxygen concentrations in bottom waters at four of the eight monitoring sites in the moderate protection areas (MPA-ES, MPA-CB and MPA-NH) did not meet the moderate protection guideline (80% saturation) on between one and three occasions.

This triggered assessment against the dissolved oxygen concentration standard. With one exception, dissolved oxygen concentrations in bottom waters met the standard (60% saturation) at all the sites. A dissolved oxygen concentration of 45% saturation was reported at CS10N in MPA-ES on 29 February 2016.

There were no known reports of deaths of marine organisms that may have been attributable to deoxygenation during the periods when low dissolved oxygen concentrations were recorded over the 2015–16 non river-flow period.

Dissolved oxygen concentrations below 90% saturation were recorded on four occasions at one Warnbro Sound reference site and on six occasions at the other Warnbro Sound reference site.

Water temperature

At all the sites surface water temperatures met the guideline.

Salinity

The salinity of surface waters at CS4 and G3 in north-western Cockburn Sound was below the guideline. This is likely to reflect increased exchange and mixing with waters from outside Cockburn Sound.

The salinity of bottom waters at most sites met the guideline. The salinity of bottom waters at CS9 and CS12 in MPA-ES and of the surface water at CS12 was above the guideline. The higher salinities recorded at these sites are possibly associated with the saline water discharge from the Perth Seawater Desalination Plant.

This triggered assessment against the salinity standard. The salinities recorded at these sites were higher than the guideline by less than one practical salinity unit and were below the default salinity

Result			
Assessment and Action	Environmental Quality Guidelines met—continue monitoring	Environmental Quality Guidelines not met—investigate against the Environmental Quality Standard	Environmental Quality Standard not met—management response triggered

trigger value for Cockburn Sound. The risk of a persistent and significant change beyond natural variation in ecological or biological indicators that are affected by changing salinity is considered to be low. There were no known deaths of marine organisms from anthropogenically-sourced salinity stress.

pH

At all the sites pH met the guideline in surface and bottom waters.

Response

The CSMC will continue to monitor dissolved oxygen concentrations, water temperature, salinity and pH and to report against the criteria for physical-chemical stressors for Cockburn Sound.

The CSMC will review dissolved oxygen concentrations from each monitoring period in the context of previous year’s data to assess whether there is evidence of a downward trend in the oxygen status of Cockburn Sound.

Toxicants in Marine Waters and Sediments

Background

The concentrations of selected contaminants were measured in water samples collected at sites around the Kwinana Bulk Terminal and the Kwinana Bulk Jetty and at one site in Mangles Bay over the 2015–16 reporting period. Contaminant concentrations were assessed against the criteria for toxicants in marine waters.

The concentrations of selected contaminants in surface sediments collected at sites around the Kwinana Bulk Terminal and the Kwinana Bulk Jetty were measured and assessed against the criteria for toxicants in sediments.

Key findings

Marine waters
Concentrations of most contaminants were below the laboratory limits of reporting* or the guidelines: <ul style="list-style-type: none">Dissolved metalsBenzene-Toluene-Ethylbenzene-Xylene (BTEX)Petroleum hydrocarbonsPolycyclic Aromatic Hydrocarbons (PAHs)Organochlorine and organophosphorus pesticidesHerbicides
Concentrations of dissolved cadmium and zinc in a sample collected in Mangles Bay were slightly higher than the high protection guidelines, but were below the moderate protection guidelines
Sediments
Concentrations of metals, tributyltin (TBT) and Polycyclic Aromatic Hydrocarbons (PAHs) were below the guidelines
Concentrations of petroleum hydrocarbons were below the laboratory limits of reporting

* The lowest amount of a substance in a sample that can be determined with acceptable precision and accuracy under the stated analytical conditions.

Response

The CSMC will undertake further sampling and analysis of water quality in Mangles Bay.

Has the Environmental Quality Objective ‘Maintenance of Ecosystem Integrity’ been achieved?

Based on the results from the 2015–16 monitoring program it can be concluded that nutrient enrichment was not an issue in most of Cockburn Sound over the 2015–16 non river-flow period. There is a high degree of certainty that, in terms of nutrients, the environmental quality objective is being achieved in most of Cockburn Sound. Routine monitoring should be continued.

While there have been improvements in water quality in Cockburn Sound over the past 30 years, analysis of trends in seagrass shoot densities indicates there have been declines over the past 11–14 years at some sites in Cockburn Sound. This suggests that other environmental factors may be playing an important role in seagrass decline or lack of recovery in Cockburn Sound.

Similar to previous reporting periods, the phytoplankton biomass standard was not met in Jervoise Bay Northern Harbour. This indicates there is a high risk that the environmental quality objective has not been achieved in that harbour. Monitoring in Jervoise Bay Northern Harbour will continue.

The dissolved oxygen concentration guidelines were not met in the bottom waters at 12 of the 18 monitoring sites in Cockburn Sound on one or more occasions over the 2015–16 non river-flow period. The standard was met at all sites with the exception of one site (CS10N) in MPA-ES on one occasion. With the exception of localised elevated surface or bottom water salinities at two sites (CS9 and CS12) in MPA-ES, the criteria for protecting the marine ecosystem from the effects of the other physical and chemical stressors were met. The results from the 2015–16 monitoring program in Cockburn Sound indicate that there is a low risk that the environmental quality objective is not being achieved in most of Cockburn Sound. Routine monitoring should be continued.

The guidelines for toxicants in sediments and marine waters were met around the Kwinana Bulk Terminal and the Kwinana Bulk Jetty in MPA-ES. There is a high level of confidence that in these areas the environmental quality objective is being achieved. Routine monitoring should be continued.

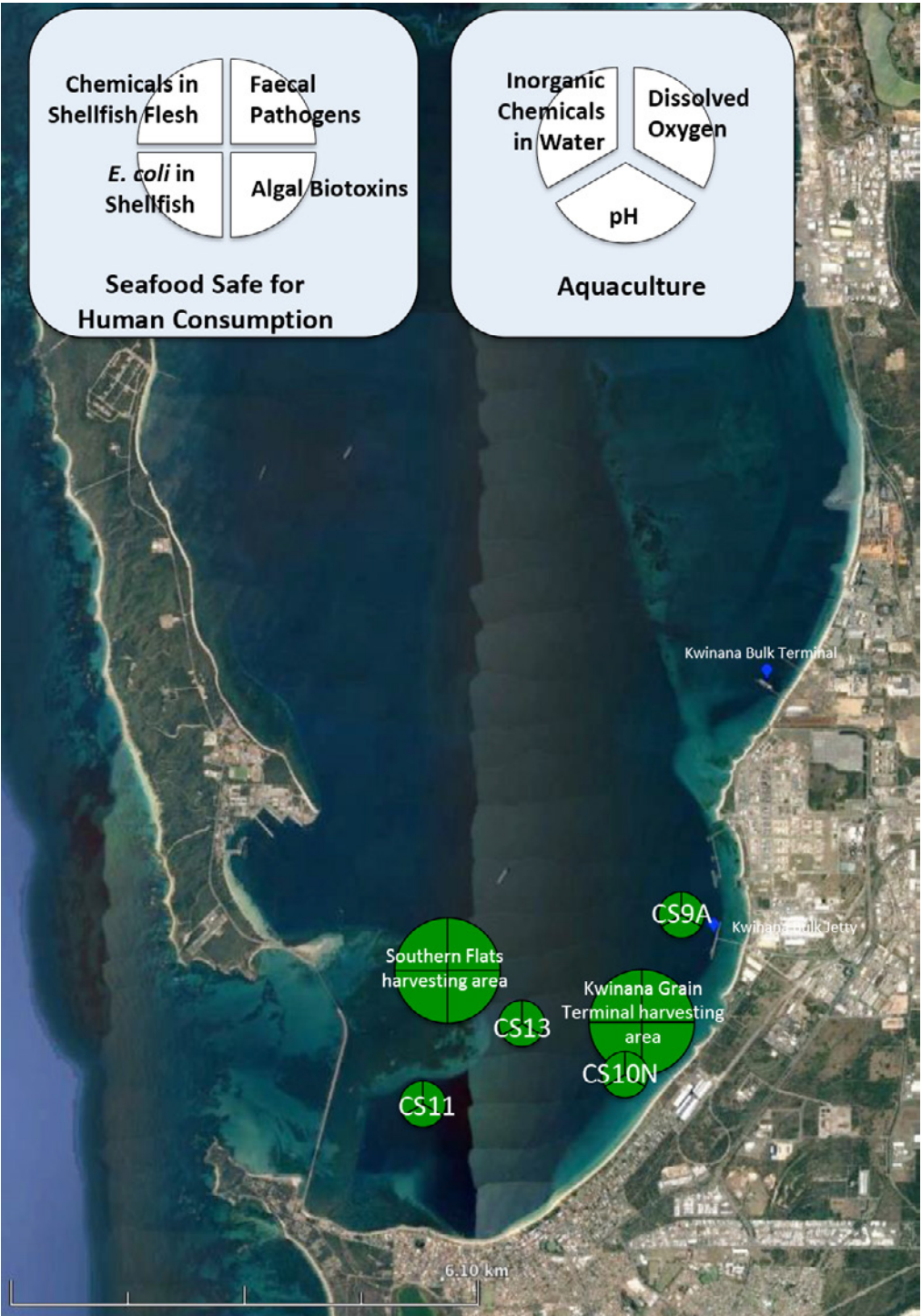
In November–December 2015, there was a fish kill in Cockburn Sound with an estimated 2,000 fish and invertebrates (representing 15 species) affected, including more than 250 large Pink Snapper (*Pagrus auratus*) which congregate in Cockburn Sound for spawning at that time of the year.⁵ The most likely cause of the event was attributed to a combination of a spike in the densities of the diatom *Chaetoceros* (a potentially harmful phytoplankton taxon) coupled with other contributory factors such as low dissolved oxygen concentrations and unseasonably high water temperatures. Routine water quality monitoring in Cockburn Sound commenced on 1 December 2015 and the data do not provide information as to the potential cause of the fish kill.

There were no other known reports of deaths of marine organisms over the 2015–16 reporting period that may have been attributable to deoxygenation or anthropogenically-sourced stress.

⁵ Department of Fisheries (2016). *Fish Kill Incident. Cockburn Sound, Western Australia, November–December 2015.*

Environmental Value: Fishing and Aquaculture
Environmental Quality Objective: Maintenance of Seafood Safe for Human Consumption

Figure 4: Assessment against the environmental quality criteria for the maintenance of seafood safe for human consumption and the maintenance of aquaculture



The achievement of this environmental quality objective is assessed, in accordance with the *Environmental Quality Criteria Reference Document for Cockburn Sound* (Environmental Protection Authority 2015), on the basis of results from monitoring of:

- biological contaminants; and
- chemical concentrations in seafood flesh.

The environmental quality criteria set a level of environmental quality that will ensure there is a low risk of any effect on the health of human consumers of seafood.

Biological Contaminants (Figure 4)

Background

The primary threats to human consumers of seafood relate to contamination of filter feeding shellfish by faecal pathogens (for example bacteria), the accumulation of biotoxins for toxic algae and/or the accumulation of toxic chemicals in the flesh of shellfish.

The *Western Australian Shellfish Quality Assurance Program* (WASQAP) sets out the requirements for bacteriological monitoring (water and shellfish), phytoplankton and shellfish biotoxin monitoring in shellfish growing areas in Cockburn Sound.

The results were assessed against the criteria for the maintenance of seafood safe for human consumption.

Key findings

Faecal pathogens

The guideline for faecal pathogens in water was met at all sites with the exception of one site in the Kwinana Grain Terminal harvesting area. This triggered investigation against the faecal pathogens in water standard. The standard was met.

Under its conditional approval, the water quality in the Kwinana Grain Terminal harvesting area must meet the WASQAP criteria for faecal pathogens except on occasions when pre-determined and predictable environmental conditions prevail. Under these specific environmental conditions, harvesting in the Kwinana Grain Terminal harvesting area is stopped. Harvesting recommences once the WASQAP criteria for water and shellfish samples are met.

Escherichia coli (E. coli) in shellfish flesh

The standard for *Escherichia coli* (*E. coli*) in shellfish flesh was met in the Southern Flats and Kwinana Grain Terminal harvesting areas.

Result			
Assessment and Action	Environmental Quality Guidelines met—continue monitoring	Environmental Quality Guidelines not met—investigate against the Environmental Quality Standard	Environmental Quality Standard not met—management response triggered

Note: Under the conditions of the Kwinana Grain Terminal harvesting area, while in the open status, all the guidelines and standards were met.

Environmental Quality Objective: Maintenance of Aquaculture Production

Algal biotoxins

The algal biotoxin guidelines for *Pseudo-nitzschia*⁶ were not met in the Southern Flats and Kwinana Grain Terminal harvesting areas on one occasion in February 2016. This triggered shellfish flesh testing for amnesic shellfish poisoning (ASP) biotoxin. The results of screening for ASP were negative.

The results of routine biotoxin screening for both harvesting areas were negative for ASP, diarrhetic shellfish poisoning (DSP) and paralytic shellfish poisoning (PSP) biotoxins.

Biotoxin concentrations in mussel and fish samples tested during the November–December 2015 fish kill in Cockburn Sound were negative for PSP, DSP and ASP biotoxins and the neurotoxic shellfish poisoning (NSP) biotoxin.

Chemical Concentrations in Seafood Flesh (Figure 4)

Background

WASQAP sets out the requirement for testing for chemical contaminants in shellfish from shellfish growing areas in Cockburn Sound. Shellfish were analysed for metals, organochlorine and organophosphate pesticides and polychlorinated biphenyls (PCBs).

Sentinel mussels were also deployed on mussel lines at the Kwinana Bulk Terminal and Kwinana Bulk Jetty for approximately six weeks in February/March 2016. Mussels were analysed for metals, organotins and polycyclic aromatic hydrocarbons (PAHs).

The results were assessed against the criteria for the maintenance of seafood safe for human consumption.

Key findings

The concentrations of chemicals (metals, organochlorine and organophosphate pesticides and PCBs) in mussel flesh from the Kwinana Grain Terminal and Southern Flats harvesting areas were below the criteria.

The concentrations of metals in sentinel mussels deployed at the Kwinana Bulk Terminal and the Kwinana Bulk Jetty were below the criteria. The concentrations of tributyltin (TBT) and PAHs were below the limits of reporting.

The concentrations of metals in fish flesh tested during the investigation into the November–December 2015 fish kill in Cockburn Sound were below the criteria. The concentrations of pesticides in fish flesh were below the limits of reporting.

The maintenance of aquaculture production is assessed, in accordance with the *Environmental Quality Criteria Reference Document for Cockburn Sound* (Environmental Protection Authority 2015), on the basis of results from monitoring of:

- physico-chemical stressors; and
- toxicants.

The environmental quality criteria set a level of environmental quality to maintain the health and productivity of aquaculture species.

Physico-chemical Stressors (Figure 4)

Background

Dissolved oxygen, pH and non-metallic inorganic chemicals (ammonia and nitrate–nitrite) were measured at four water quality monitoring sites close to the shellfish growing areas in Cockburn Sound on 16 occasions over the 2015–16 non river-flow period (December to March). The results were assessed against the guidelines for the maintenance of aquaculture production.

Key findings

The guidelines for dissolved oxygen concentration and pH in surface waters and at the approximate depth of the mussel lines were met at the four sites on all sampling occasions.

Toxicants (Figure 4)

Key findings

The concentrations of the non-metallic inorganic chemicals at the four sites were below the guidelines.

Have the Environmental Quality Objectives 'Maintenance of Seafood Safe for Human Consumption' and 'Maintenance of Aquaculture' been achieved?

Based on the results of the 2015–16 monitoring programs there is a high degree of certainty that the environmental quality objectives have been achieved in the shellfish harvesting areas in southern Cockburn Sound.

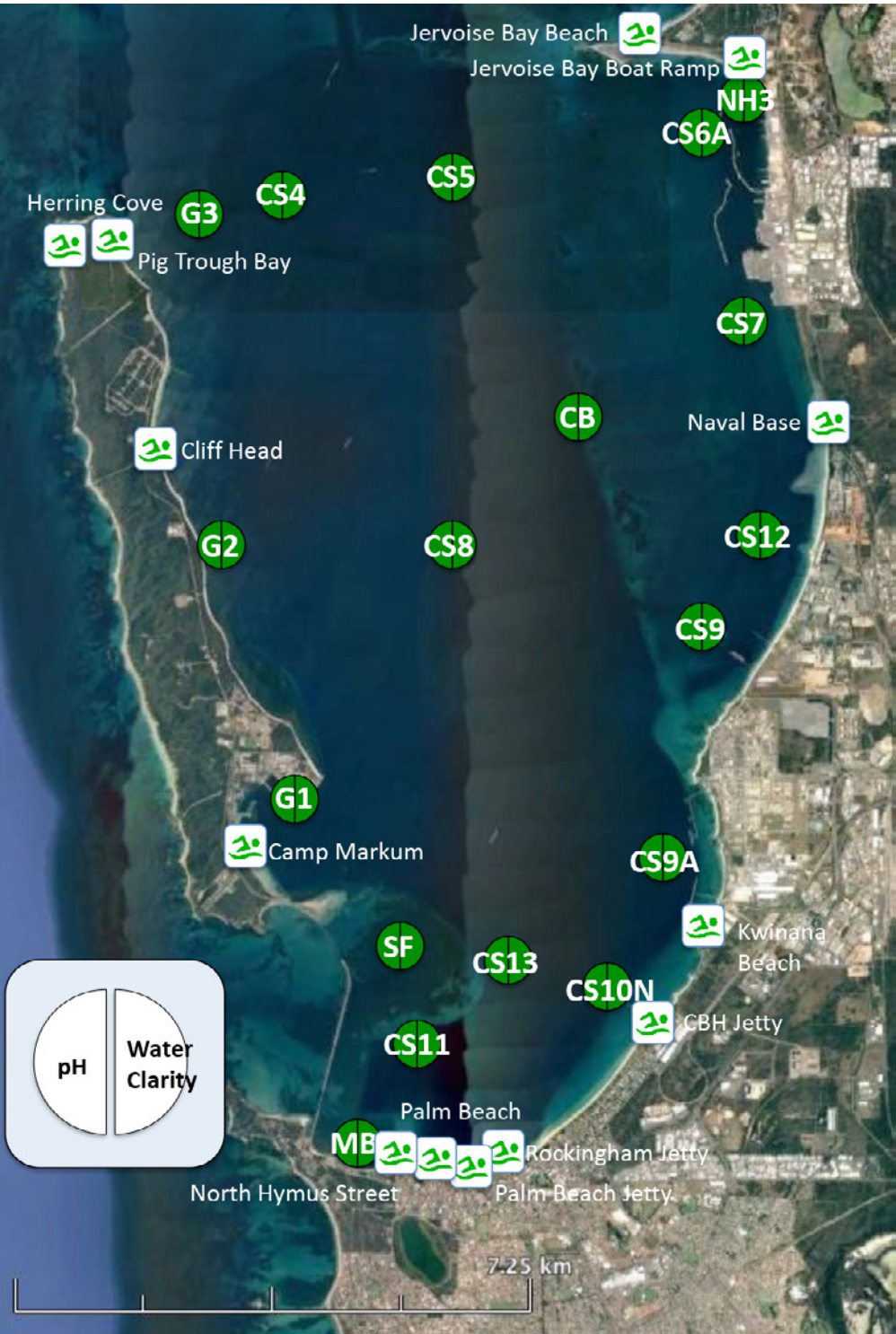
Accredited quality assurance monitoring programs, based on the requirements of WASQAP, are currently conducted for shellfish harvesting areas in southern Cockburn Sound where shellfish are grown commercially for the food market. The same level of monitoring is not conducted outside of the shellfish harvesting areas. The Department of Health advises that people who collect and eat wild shellfish may be putting their health at risk and recommends only eating shellfish harvested commercially under strict quality assurance monitoring programs.⁷

⁶ Marine phytoplankton containing some species which produce the neurotoxin domoic acid which is responsible for the neurological disorder amnesic shellfish poisoning.

⁷ Department of Health (2010). *Wild shellfish collection*.

Environmental Value: Recreation and Aesthetics
Environmental Quality Objective: Maintenance of Primary Contact and Secondary Contact Recreation Values

Figure 5: Assessment against the environmental quality criteria for the maintenance of primary and secondary contact recreation



The achievement of these environmental quality objectives is assessed, in accordance with the *Environmental Quality Criteria Reference Document for Cockburn Sound* (Environmental Protection Authority 2015), on the basis of results from monitoring of:

- faecal pathogens;
- physical indicators; and
- toxic chemicals.

The environmental quality criteria set a level of environmental quality to protect people undertaking primary contact recreation activities (for example, swimming, water skiing, wind surfing and diving) or secondary contact recreation activities (for example, boating, canoeing and fishing) from ill effects caused by poor water quality.

Faecal Pathogens (Figure 5)

Background

Bacterial water quality sampling was undertaken at popular recreational beaches around Cockburn Sound between November 2015 and May 2016. This is the time when most people participate in recreational activities.

The results were assessed against the criteria for the maintenance of primary and secondary contact recreation.

Key findings

The guidelines for faecal pathogens for primary and secondary contact recreation were met at all the beaches monitored.

Physical Indicators (Figure 5)




Key findings

Water clarity and pH met the criteria for primary and secondary contact recreation at the 18 water quality monitoring sites in Cockburn Sound over the 2015–16 non river-flow period (December to March).

Toxic Chemicals

Key findings

In general, the levels of toxicants required to impact on the health of people recreating in marine waters are greater than the levels necessary to protect ecosystem health. The toxicant concentrations met the ecosystem health criteria and the waters of Cockburn Sound can therefore also be considered safe for human recreation.

Result			
Assessment and Action	Environmental Quality Guidelines met—continue monitoring	Environmental Quality Guidelines not met—investigate against the Environmental Quality Standard	Environmental Quality Standard not met—management response triggered

Aesthetics

Observations of aesthetic quality over the 2015–16 non river-flow period (December to March) included:

- Reports of dead fish in south-western Cockburn Sound, in Careening Bay and on the eastern side of Garden Island in early December 2015. One dead Northwest Blowfish was observed at the Mangles Bay monitoring site on 25 January 2016.
- Algal blooms were observed at two sites in Cockburn Sound on 7 March 2016, 11 sites on 15 February and 14 March 2016 and at 13 sites on 29 March 2016.
- Grain was observed on the water surface at CS10N adjacent to the Kwinana Grain Jetty on 11 occasions.
- Odours were reported at sites adjacent to the industrial area on the eastern margin of Cockburn Sound on six occasions.

Have the Environmental Quality Objectives 'Maintenance of Primary Contact Recreation Values' and 'Maintenance of Secondary Contact Recreation Values' been achieved?

Based on the results of the 2015–16 monitoring programs there is a high degree of certainty that the environmental quality objectives have been achieved and the waters are safe for recreational activities.

Environmental Value: Industrial Water Supply Environmental Quality Objective: Maintenance of Water Quality for Industrial Use

The Perth Seawater Desalination Plant is an important source of potable water for the Perth metropolitan region and is located in the industrial zone along the eastern shore of Cockburn Sound. The environmental quality criteria set a level of environmental quality for the intake water that will ensure the efficacy of the desalination process is maintained and the potability of the desalinated water is protected.

Key findings

The results from the 2015–16 monitoring of the intake seawater from Cockburn Sound into the Perth Seawater Desalination Plant indicate that concentrations of boron were slightly higher than the guideline on two occasions. Boron is removed by the reverse osmosis process.

All the other parameters monitored met the guidelines or Water Corporation limits.

Has the Environmental Quality Objective 'Maintenance of Water Quality for Industrial Use' been achieved?

The Water Corporation advised that it did not report a significant reduction in efficiency of the desalination process or a significant increase in the maintenance requirements caused by the reported variance in intake seawater quality. There is therefore a high degree of certainty that the environmental quality objective has been achieved.

What Have We Done?

A Nitrogen Budget for Cockburn Sound

The CSMC and the Department of Water are supporting a project by CSIRO to assess spatial and temporal trends in water column nitrogen concentrations and to develop a nitrogen budget for Cockburn Sound. The nitrogen budget will assist with increasing understanding of the importance of different sources of nitrogen (for example, submarine groundwater discharge) and how these are used for primary production by phytoplankton, seagrass and epibenthic microalgae.⁸

The nitrogen budget developed by CSIRO is more detailed than the budgets that have previously been available for Cockburn Sound. The budget uses updated estimates of groundwater nitrogen input, explicitly includes nitrogen recycling and considers losses of nitrogen at the seafloor and via exchange with the shelf. The nitrogen budget will inform assessment of the health of the Cockburn Sound ecosystem and how the ecosystem has responded to reduced anthropogenic nitrogen inputs and improved water quality over the past 30 years.

CSIRO concluded that submarine groundwater discharge inputs represent between 13 and 27% of the total nitrogen used by photosynthetic plants in Cockburn Sound, with the remainder being supported by recycled nutrients. This suggests that Cockburn Sound is primarily a recycling system, with a small relative contribution from groundwater nitrogen. This reliance on recycled nitrogen may help to explain why chlorophyll biomass in Cockburn Sound has been slow to respond to reductions in external submarine groundwater discharge nitrogen load. This suggests that the pelagic ecosystem will be more sensitive to changes in recycling efficiency within the water column or the sediment, than it will to relatively small proportional changes in the external supply.

The nitrogen budget will assist in informing and understanding the risks associated with potential nitrogen additions to Cockburn Sound as a result of the infiltration of treated wastewater to the Superficial Aquifer. Managed Aquifer Recharge has been proposed for the Kwinana Industrial Area adjacent to the Sound as a source of non-potable water for heavy industry, horticulture and local government, and to help wetlands recover from the impacts of a drying climate. An understanding of the relative contribution of submarine groundwater discharge to the nitrogen budget of Cockburn Sound is necessary to determine possible impacts of Managed Aquifer Recharge on the Cockburn Sound ecosystem.

The [full report](#) is available on the CSMC's website. The report on the [spatial and temporal analysis of water quality monitoring data](#) is also available on the CSMC's website.

Information on monitoring programs and research studies being undertaken in Cockburn Sound

One of the roles of the CSMC is the oversight and coordination of environmental monitoring and research studies in Cockburn Sound. The CSMC has collated [summary information](#) on monitoring programs and research studies that are being undertaken in Cockburn Sound.

The CSMC is using this information to assist in identifying important information gaps and research priorities for the Cockburn Sound marine area.

This information will also address one of the recommendations following the November–December 2015 fish kill in Cockburn Sound. This identified the need for greater alignment of monitoring and research efforts in Cockburn Sound and improved sharing of information.

⁸ Microscopic algae found on the surface of sediments.

Update on monitoring programs and research studies supported by members of the CSMC

Murdoch University: Annual monitoring of Little Penguins on Garden Island (Dr Belinda Cannell)

Cockburn Sound is an important foraging area for the Little Penguin (Figure 6) colony on Garden Island and for a portion of the nearby colony on Penguin Island. The colony on Garden Island is important in the long-term conservation of Little Penguins in the Perth metropolitan area.

Dr Belinda Cannell (Murdoch University and University of Western Australia) undertakes annual monitoring of Little Penguins on Garden Island with the support of the Department of Defence. Fremantle Ports and the City of Rockingham currently support Dr Cannell's Little Penguin research on Penguin Island.⁹ Some of the penguins from this colony utilise Cockburn Sound.

In 2015, the Garden Island population of Little Penguins was estimated to be a minimum of 200 breeding penguins. There has been no increase in the number of penguins breeding on Garden Island since 2011. This is attributed to the impact of the “marine heat wave” during the 2010–11 summer¹⁰ and continued above average sea surface temperatures in the region. While participation in breeding and overall breeding success has been low at the nearby colony on Penguin Island since 2011, this has not been observed on Garden Island where the burrows are found within cavities in limestone rocks or in nest-boxes which are shaded throughout the day. The lower overall participation and breeding success is attributed to reduced prey abundance in local waters south of Penguin Island.

The 2015–16 monitoring of Little Penguins on Garden Island found:

- Eggs were laid from March to November, with the highest numbers laid in July.
- Just over half the breeding penguins laid a single clutch, 75% of which were successful in raising one chick. The other breeding pairs laid two clutches and one pair laid three clutches, with almost two-thirds successfully raising at least one chick from each clutch.
- All the clutches laid in March were successful, with a decline in success through to October with 50% of the eggs laid successful.
- The higher success rate of breeding in 2015, in particular the proportion raising two clutches, indicates that local food resources were adequate for the number of breeding penguins.
- The November–December 2015 fish kill in Cockburn Sound did not impact the penguins, with well-fed chicks observed in the colony at the time of the fish kill.

On Garden Island the timing of peak egg lay, breeding success and the proportion of pairs laying two clutches varies annually, and is related to fish abundance in Cockburn Sound.

Figure 6: Two almost completely fledged Little Penguin chicks



Source: Dr Belinda Cannell, Murdoch University

⁹ Dr Cannell's research on Penguin Island was also supported in 2013 by the Australian Geographic Society.

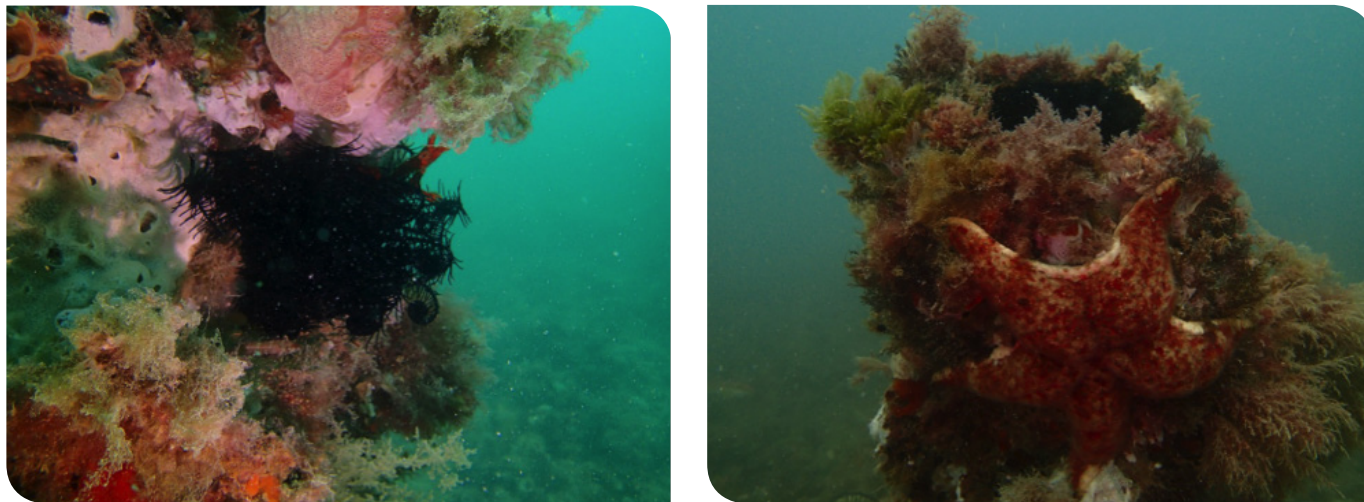
¹⁰ Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. (2011). *The “marine heat wave” off Western Australia during the summer of 2010/11*. Department of Fisheries, Fisheries Research Report No. 222.

Water Corporation: Assessing and mitigating environmental impacts of seawater reverse osmosis outfalls on key benthic marine organisms (National Centre for Excellence in Desalination, Australia)

The Water Corporation supported a study by Deakin University and the University of Western Australia which looked at the potential environmental impacts of the hypersaline (40–70 practical salinity units) discharge from desalination plants on marine ecosystems. This included a survey of the benthic communities associated with the Perth Seawater Desalination Plant's outfall in Cockburn Sound.

The 40 diffuser ports, which provide structure and stability in an otherwise sandy seafloor, were found to support a diverse and abundant biofouling community¹¹ indicating that environmental conditions at the discharge points were suitable for settlement and growth by plants and animals (Figure 7).

Figure 7: Biofouling communities associated with the Perth Seawater Desalination Plant's diffuser ports



Source: Fremantle Commercial Diving and Water Corporation

The biofouling community associated with the diffuser ports was predominantly sessile filter and suspension feeders, including ascidians (sea squirts), sponges, hard and soft corals, hydroids, polychaetes (marine worms), bryozoans (moss animals), barnacles and bivalve molluscs. Fish, echinoids (sea urchins), asteroids (sea stars), holothurians (sea cucumbers), crinoids (feather stars), nudibranchs (sea slugs), Blue Swimmer crabs and octopus were also observed around the ports. Of particular interest was the presence of asteroids and echinoids in and around the diffuser system as echinoderms could be sensitive to changes in salinity and water quality.

The full report is available on the National Centre of Excellence in Desalination Australia's website: desalination.edu.au/research/projects/social-environmental-economic-issues/evaluating-environmental-impact-of-brine-discharge/.

About the Cockburn Sound Management Council

Since the 1970s, the Western Australian State Government, in partnership with industry, local government and the community, has worked to improve the environmental health of Cockburn Sound. The partnerships formed over a number of years, and strong community support and concern for the state of the marine environment resulted in the formation of the CSMC. The CSMC was formed in 2000 for the purpose of maintaining the value of Cockburn Sound as a multiple-use marine area.

The CSMC was originally established as a Committee of the Board of the Water and Rivers Commission under the *Water and Rivers Commission Act 1995*. Since 2007, the CSMC has been an advisory council to the Minister for Environment established under the *Environmental Protection Act 1986*. The CSMC is composed of an independent Chair, and representatives from local, State and Federal Government and industry, as well as recreational user groups, conservation interests and the community.

In September 2015, the Minister for Environment agreed to new [Terms of Reference](#) for the CSMC. Under its Terms of Reference the CSMC is responsible for:

- facilitating and coordinating stakeholder and community input into the environmental management of Cockburn Sound;
- providing advice to the Minister for Environment on the environmental management of Cockburn Sound; and
- reporting to the Minister for Environment and the community on the state of the environment Cockburn Sound

particularly with respect to the protection and maintenance of water quality and the associated environmental values for the Cockburn Sound marine area.

The CSMC also has a role in the oversight and coordination of environmental monitoring and research studies in Cockburn Sound.

Between July 2015 and June 2016, the full Council met four times and the Executive met twice. At its meeting in February 2016, the CSMC held a strategic planning workshop to develop its 2016–2018 Strategic Plan.

The CSMC has established two working groups to progress key projects:

- the Communications Plan Working Group to develop the CSMC Communications Plan; and
- the Research Priorities Working Group to identify priority research and investigative studies for the Cockburn Sound marine area.

¹¹ Communities of plants and animals found on artificial surfaces.



For more information please contact the Cockburn Sound Management Council:

Phone: 6467 5000

Email: CSMC@DER.wa.gov.au

Or visit the Cockburn Sound Management Council's website
www.der.wa.gov.au/about-us/cockburn-sound-management-council