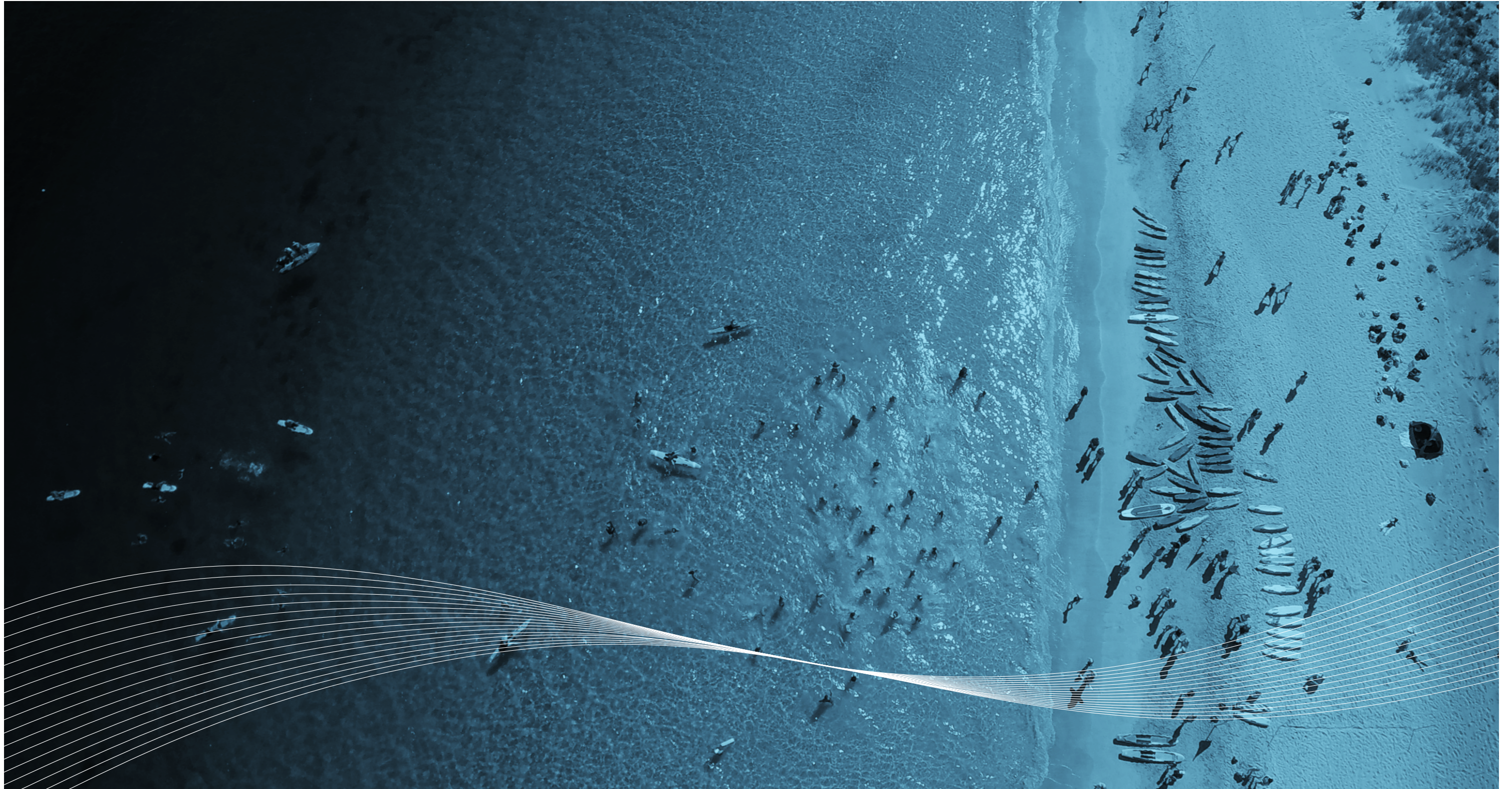


# 2022

## STATE OF COCKBURN SOUND MARINE AREA REPORT





# Purpose of this report

The Cockburn Sound Management Council (the Council) reports annually to the Minister for Environment and the community on the results of environmental monitoring of the Cockburn Sound marine area and the extent to which the monitoring results meet the environmental quality objectives and criteria set in the State Environmental (Cockburn Sound) Policy 2015. These reports are published on the [Council's website](#).

Every three years, the Council reports on the overall state of the Cockburn Sound marine area, including trends in water quality and associated environmental values. This report is the second of the series and represents the Council's assessment of the overall state of the Cockburn Sound marine area in 2022. The water quality indices in this report refer to summer seasons 2017–18 to 2021–22, while other sections on environmental monitoring and management activities include information to 31 December 2022.



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# Cockburn Sound

Cockburn Sound is a sheltered marine embayment located south of the Swan–Canning river mouth at Fremantle (Figure 1). It is 22 kilometres long and ranges from 15 kilometres wide in the north to 9 kilometres wide in the south, with an area of about 124 square kilometres. It has a relatively large, low-gradient, deep central basin (17–22 metres in depth) flanked by the relatively steep slopes of the surrounding banks, shoals and shoreline to the north, south and west, with a lower gradient bank to the east. Garden Island extends along the western side of Cockburn Sound, providing protection from prevailing winds and ocean swells.

In terms of both its depth and degree of shelter from ocean swell, Cockburn Sound is unique along Perth's metropolitan coast and for several hundred kilometres to the north and south. These physical features are responsible for the regional significance of Cockburn Sound in ecological terms, including extensive areas of seagrass (*Posidonia* spp.) and organic-rich silts in the deeper basin. Cockburn Sound is also a major spawning ground and nursery area for pink snapper (*Pagrus auratus*), an important foraging area for little penguins (*Eudyptula minor*), and a nursery and feeding area for resident Indo-Pacific bottlenose dolphins (*Tursiops aduncus*).

Cockburn Sound is the most intensively used multiple-use marine embayment in Western Australia and considerable human alteration of Cockburn Sound has occurred since European settlement of the area during the 1800s.

It provides a safe anchorage and maritime facilities adjacent to the state's major industrial complex at Kwinana and the HMAS *Stirling* naval base on Garden Island. It supports recreational and commercial fisheries and aquaculture operations. Cockburn Sound is also highly valued by the community for its ecological, recreational and aesthetic attributes (including dolphins, fishing, swimming, diving and boating) and is used extensively for tourism.

Cockburn Sound is of vital economic and social importance to the Western Australian community and supports significant environmental values. Ongoing protection of Cockburn Sound is an important priority for the Government of Western Australia (State Government) to ensure that it continues to support the multiple values for which it is renowned.

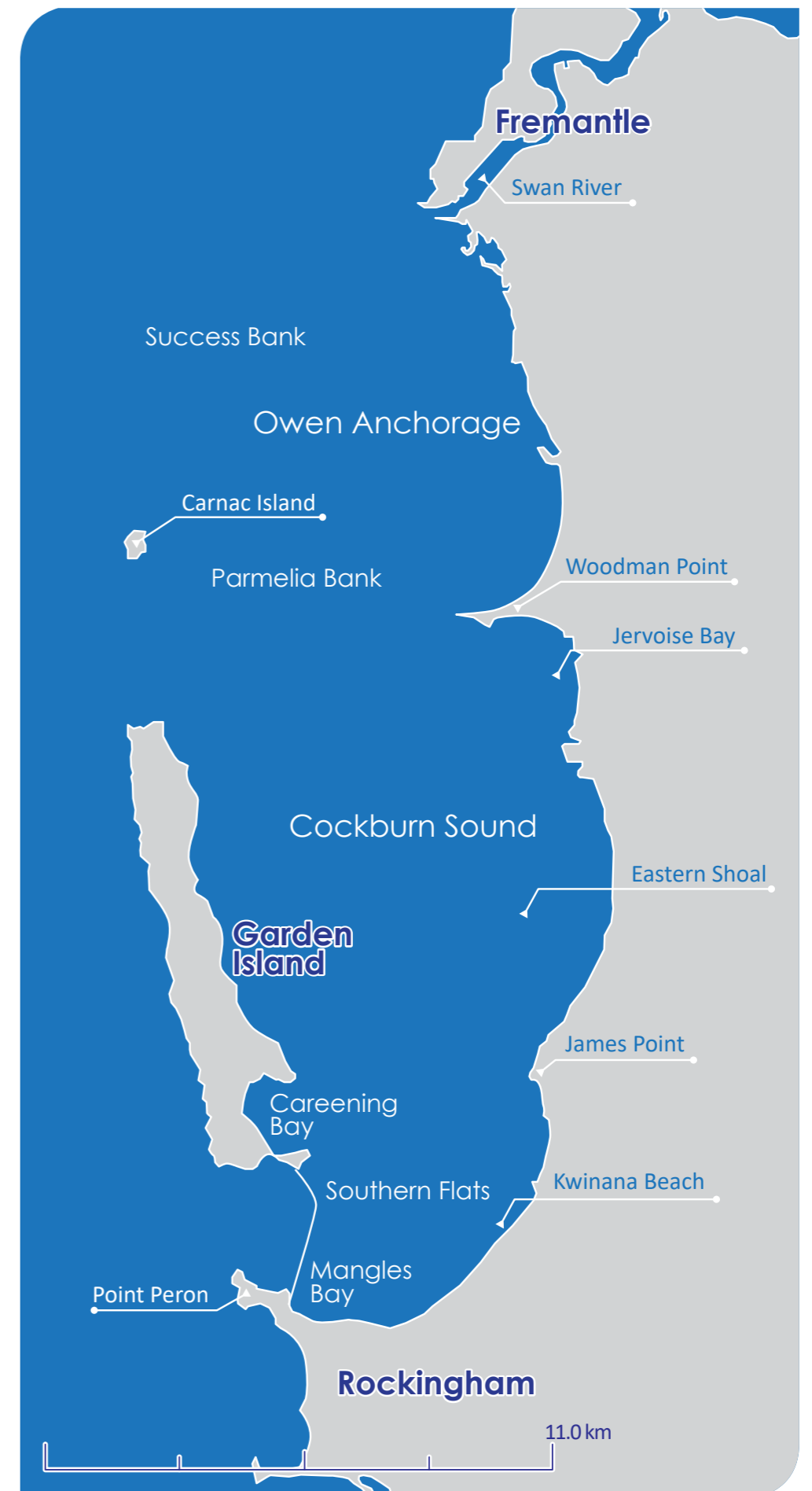


Figure 1: Cockburn Sound

# An environmental policy for Cockburn Sound

One of the main objectives of the *Southern Metropolitan Coastal Waters Study* (Department of Environmental Protection, 1996) was to design a coordinated management approach for the protection of Perth's coastal waters from pollution. This approach involved:

1. identification of environmental values for coastal waters
2. identification of environmental quality objectives to support these values and to determine where the objectives would apply
3. the development of environmental quality criteria to help ensure environmental quality objectives would be met.

In 2000, the Environmental Protection Authority released a working document describing the environmental values and environmental quality objectives for Perth's coastal waters, including Cockburn Sound.

In 2005, the State Government released the first State Environmental Policy for the protection of environmental quality in Cockburn Sound. An updated policy was released in 2015. The policy identifies five environmental values for the Cockburn Sound marine area:

1. ecosystem health
2. fishing and aquaculture
3. recreation and aesthetics
4. cultural and spiritual values
5. industrial water supply.

The policy also sets out the environmental quality objectives that need to be met to ensure the protection and maintenance of these values. The overall objective of the policy is to ensure that water quality is maintained and, where possible, improved. This is to ensure that there is no further net loss – or preferably, there is a net gain – in seagrass areas, and that other values and uses are maintained.

## Ecosystem health environmental value: state and trends

Nutrient-related water quality in Cockburn Sound has been measured through surveys during the summer, when river flow is minimal. The surveys measured nutrient concentrations, chlorophyll *a* (as a measure of phytoplankton abundance) and light attenuation (as a measure of water clarity) since 1977.<sup>1</sup> A suite of other physical-chemical indicators (i.e. dissolved oxygen concentrations, salinity, temperature and pH) has also been routinely measured. Changes in these parameters beyond their normal range can have a harmful impact on the plants and animals in Cockburn Sound.

To summarise the monitoring data and provide information on status and trends in the water quality of Cockburn Sound, a water quality index has been calculated from five indicators:

- total nitrogen concentration

- total phosphorus concentration
- chlorophyll *a* concentrations
- light attenuation coefficients
- dissolved oxygen concentrations in the water just above the seafloor.

The index is an overall water quality score for each of the five ecological protection areas in Cockburn Sound<sup>2</sup> (Figure 2) relative to water quality at a reference site in Warnbro Sound. For further information on how the index is calculated, refer to 'Calculation of the Cockburn Sound Water Quality Index' on page 5.

<sup>1</sup> There have been several changes to the Cockburn Sound water quality monitoring program over the 40 years of the program. These include: (1) the inclusion of additional sites into the program and changes in the location of some sites; (2) changes in the frequency of monitoring (every 1–3 years to annually; monthly to about weekly); (3) changes in the sampling methodology (samples collected from surface, middle and bottom depths to depth-integrated samples); (4) changes in methods for measuring light attenuation; and (5) changes in sample processing and analytical methods.

<sup>2</sup> The State Environmental Policy describes three levels of ecological protection (high protection, moderate protection and low protection) that apply to Cockburn Sound and where they apply spatially in the protected area so that overall ecological integrity can be maintained. Most of Cockburn Sound is designated as having a high level of ecological protection. Areas where societal uses preclude a high level of ecological protection have been designated as having a moderate level of ecological protection. A few small areas around outfalls (less than 1 per cent of the protected area) have been designated as having a low level of ecological protection.

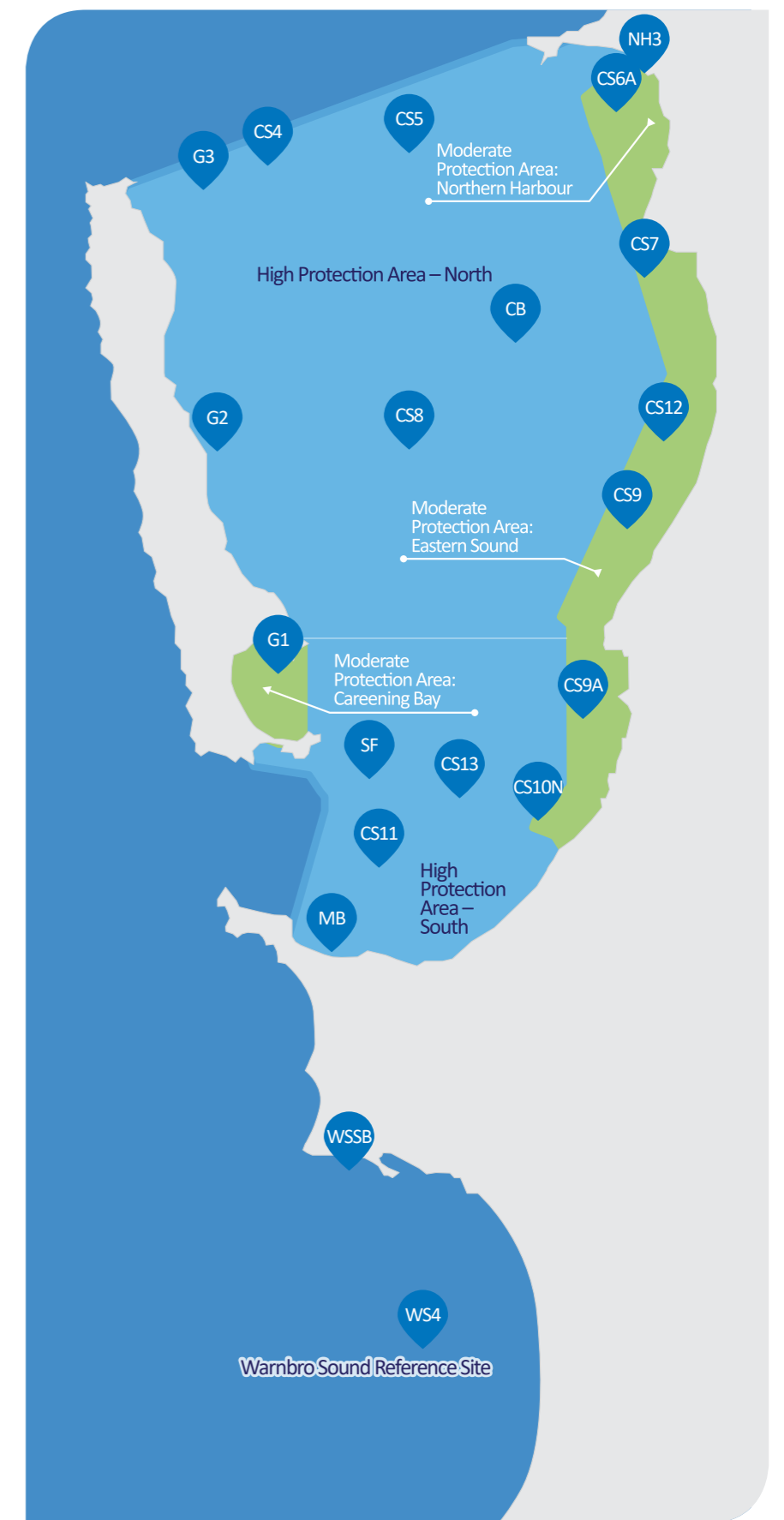


Figure 2: High and moderate ecological protection areas and the location of water quality monitoring sites in Cockburn Sound



# Calculation of the Cockburn Sound Water Quality Index

Indicators		Chlorophyll <i>a</i>	Light attenuation coefficient	Dissolved oxygen	Total nitrogen	Total phosphorus	Score	Grade
Monitored		Approximately monthly over the non river-flow period (December to March) at 18 sites in Cockburn Sound						
Assessed against guideline values calculated from the Warnbro Sound reference site to determine the percentage of times each ecological protection area met the guideline		<b>High protection areas</b>						
		≤ 1.1 µg/L	≤ 0.096 log <sub>10</sub> m <sup>-1</sup>	> 90% saturation	≤ 130 µg/L	≤ 14 µg/L		
		<b>Moderate protection areas</b>						
		≤ 1.8 µg/L	≤ 0.014 log <sub>10</sub> m <sup>-1</sup>	> 80% saturation	≤ 140 µg/L	≤ 15 µg/L		
2021–22 results	High Protection Area North (6 sites)	92%	96%	92%	100%	58%	88%	A
	High Protection Area South (4 sites)	88%	81%	63%	75%	13%	64%	B-
	Moderate Protection Area Eastern Sound (6 sites)	96%	88%	96%	96%	17%	79%	B
	Moderate Protection Area Careening Bay (1 site)	100%	100%	100%	100%	50%	90%	A
	Moderate Protection Area Northern Harbour (1 site)	25%	0%	75%	0%	0%	20%	D-

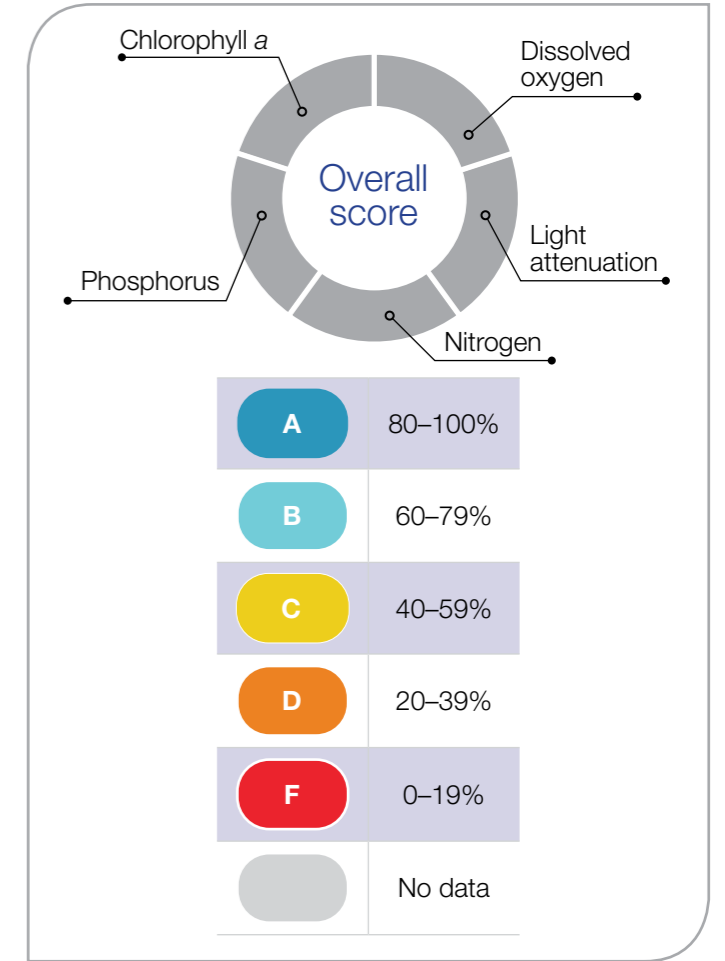
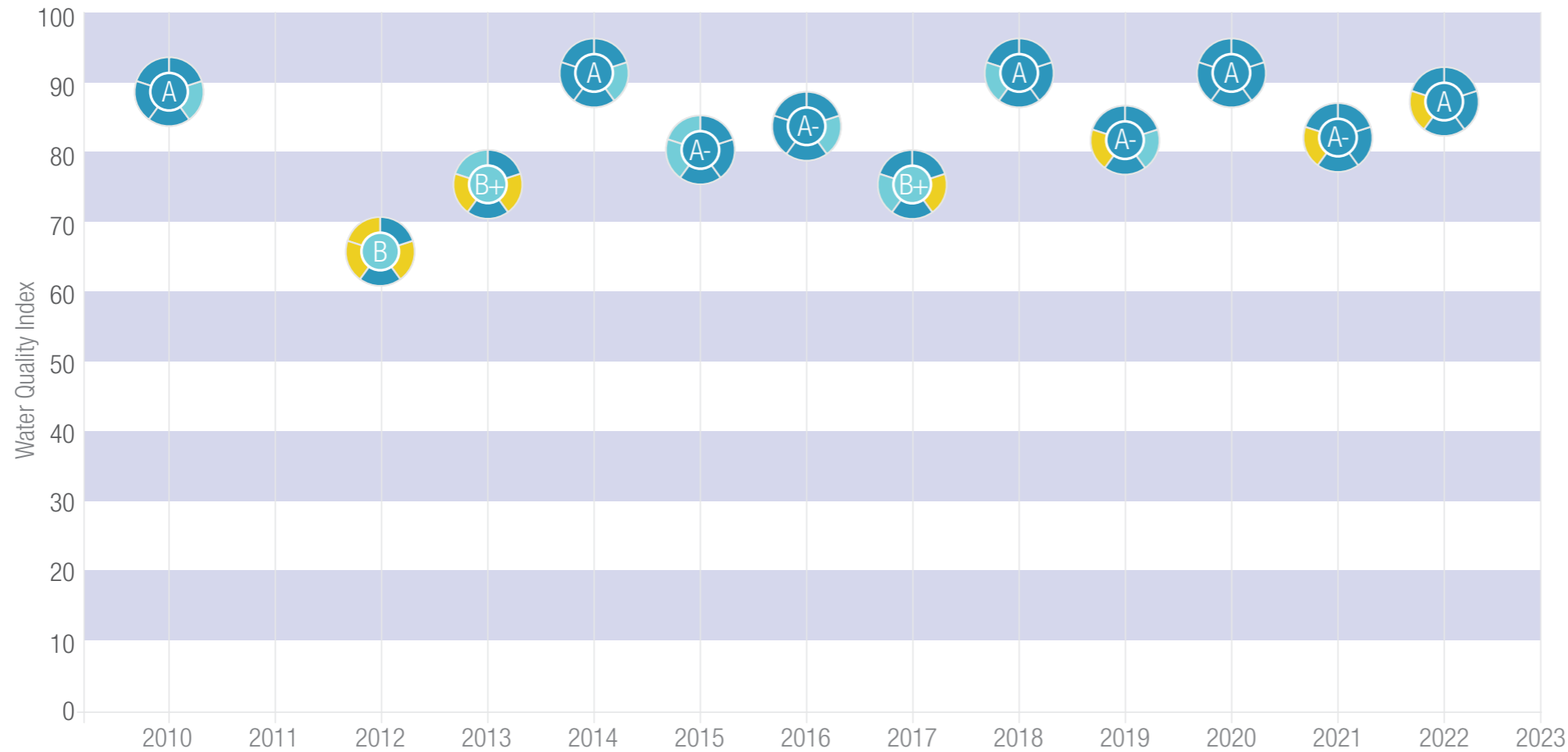
The five indicator scores within each ecological protection area are averaged to give each ecological protection area Water Quality Index score and grade.

The Water Quality Index is reported for the 2021–22 summer season (December 2021 to March 2022) for each of the ecological protection areas in Cockburn Sound. Changes in the Water Quality Index are based on the past three years of available information presented as:

- improving water quality is improving
- declining water quality is declining
- unchanging water quality has not changed (it is not getting better or worse)

The graphs overleaf show the trend in Water Quality Index in each of the ecological protection areas since 2010. Nutrient-related water quality was measured about weekly through summer surveys (December to March) from 2009–10 to 2019–20. There were no summer surveys in 2010–11. Since January 2021, water quality measurements have been taken about monthly throughout the year.

# State and trends in water quality in the High Protection Area North



**Water Quality Index**

A water quality index between 'A' and 'B' indicates that the water quality indicators usually meet the desired levels.

Variability between years may be because of factors such as weather events (e.g. above average rainfall).



**Nutrients**

Nutrient concentrations (total nitrogen and total phosphorus) usually meet the desired levels. Total phosphorus concentrations show high variability from year to year.



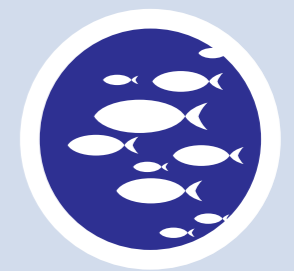
**Chlorophyll a / light attenuation**

Chlorophyll a concentrations and light attenuation coefficients have improved since 2017.



**Phytoplankton biomass**

Phytoplankton biomass (an indicator of phytoplankton blooms) has met the guideline since the summer season 2017–18.

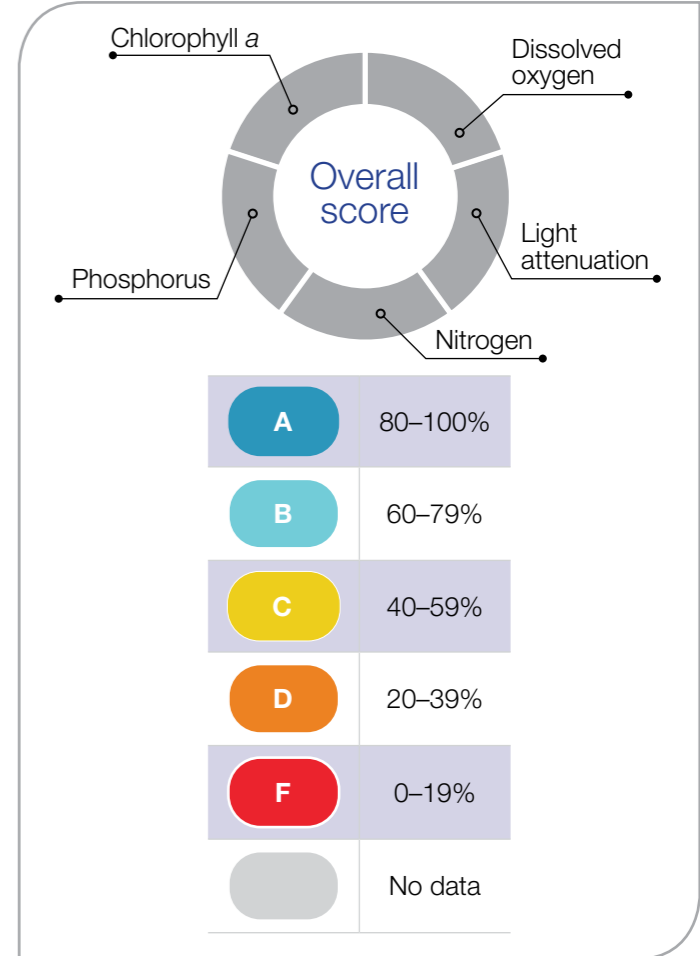
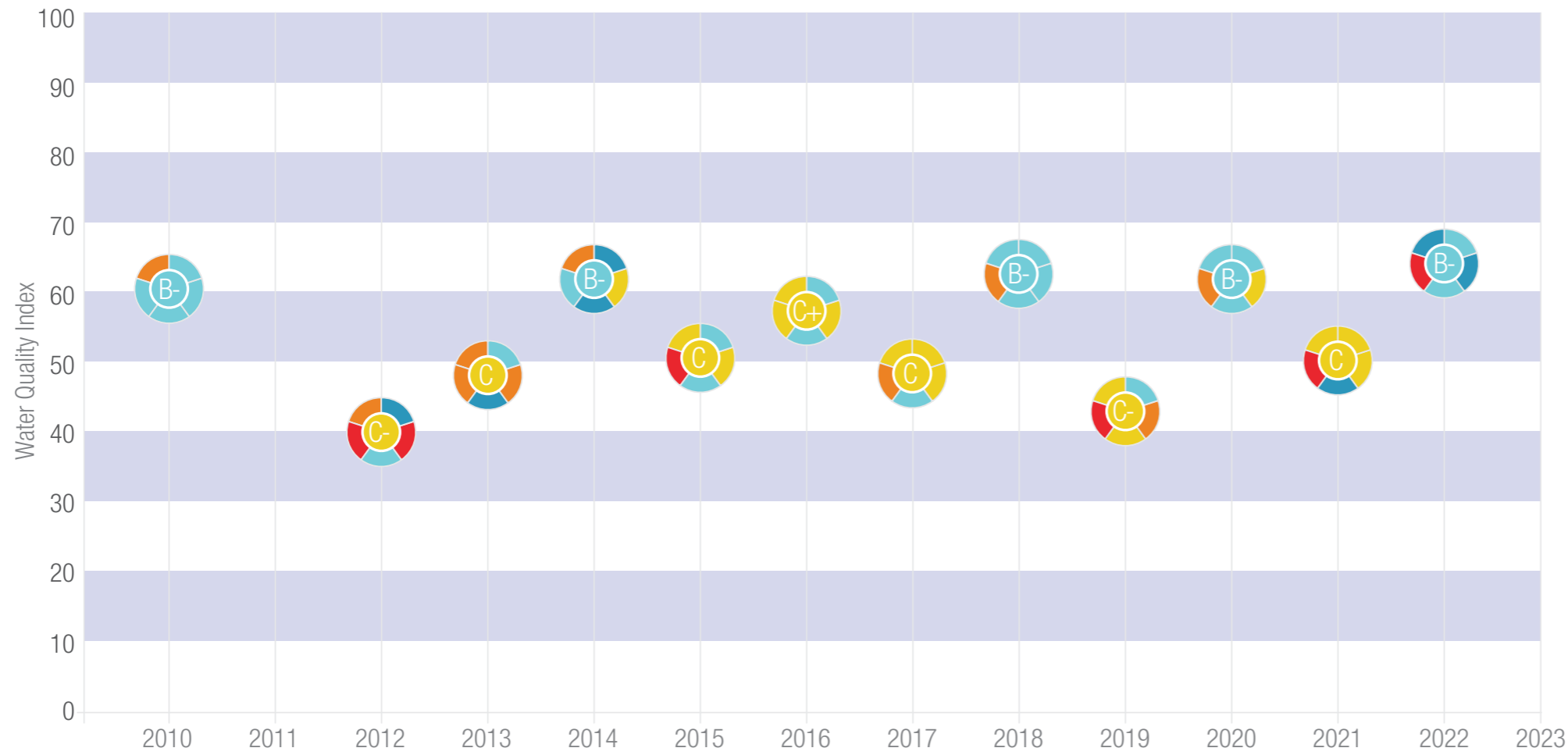


**Dissolved oxygen**

The waters are generally well mixed and well oxygenated. There are periods, mostly during late summer and autumn or associated with extreme weather events, when bottom waters become stratified and low dissolved oxygen concentrations may be experienced for short periods.



# State and trends in water quality in the High Protection Area South



Water Quality Index 2022

# B-



**Water Quality Index**

A water quality index between 'B' and 'C' indicates that some water quality indicators fail to meet the desired levels, signalling pressure on the ecosystem. Variability between years may be because of factors such as weather events (e.g. above average rainfall).



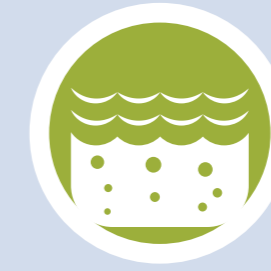
**Nutrients**

Nutrient concentrations (total nitrogen and total phosphorus) often fail to meet the desired levels. There is an indication that total nitrogen concentrations are improving, while total phosphorus concentrations continue to show little improvement.



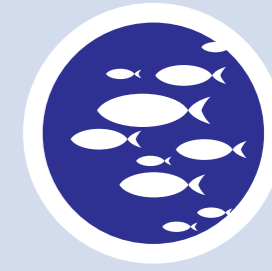
**Chlorophyll a / light attenuation**

While there is an indication that chlorophyll a concentrations are improving, variability is high from year to year. Light attenuation coefficients continue to show little improvement.



**Phytoplankton biomass**

Phytoplankton biomass (an indicator of phytoplankton blooms) has met the guideline since the summer season 2017-18, except during the summer season 2019-20.



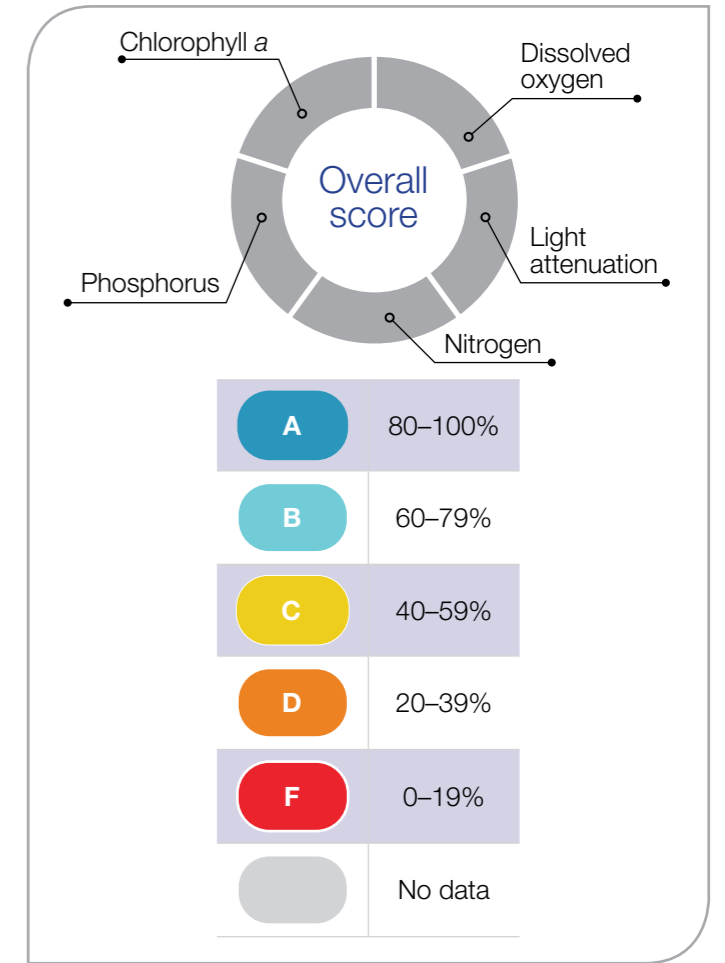
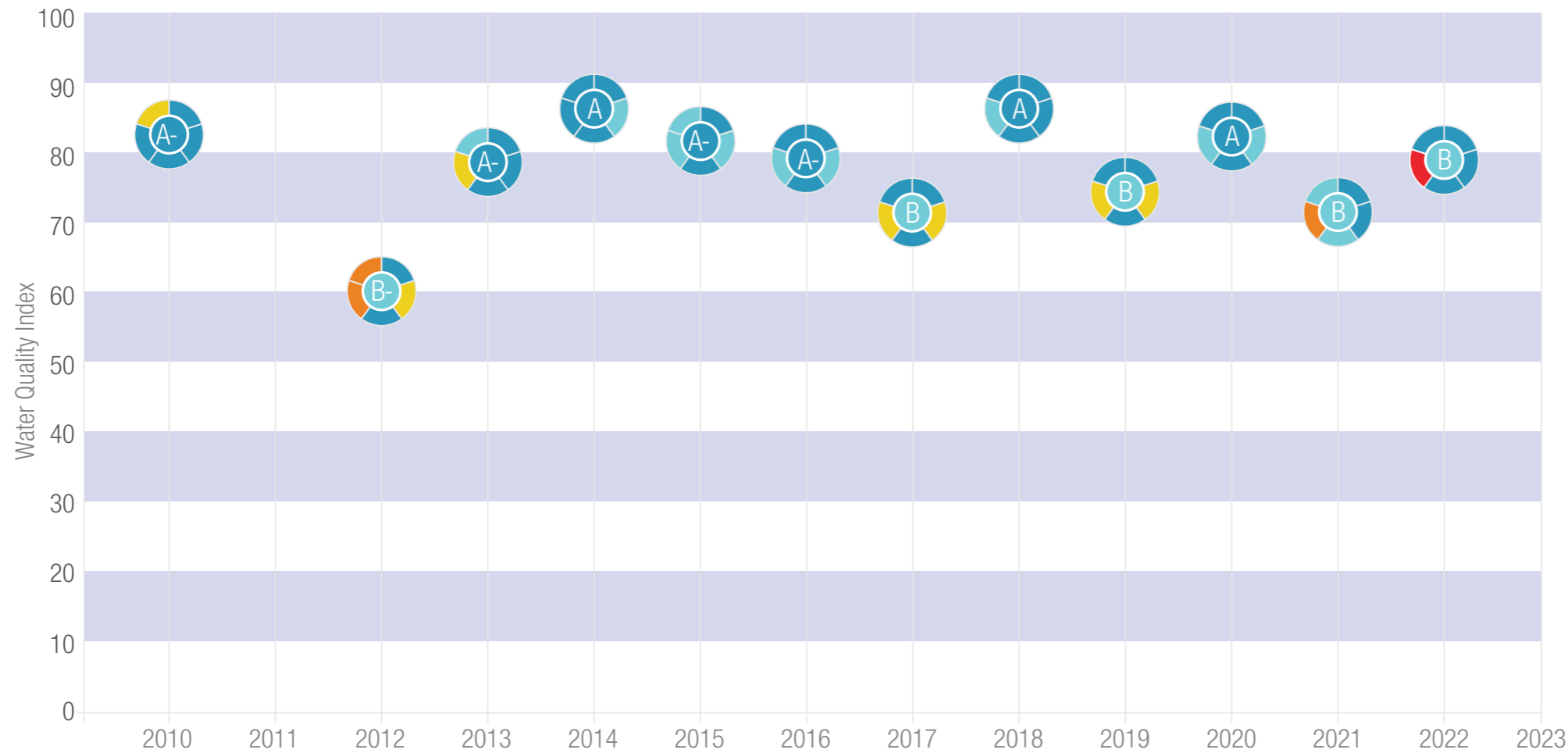
**Dissolved oxygen**

The waters are generally well mixed and well oxygenated. There are periods, mostly during late summer and autumn or associated with extreme weather events, when bottom waters become stratified and low dissolved oxygen concentrations may be experienced for short periods in the southern end of Cockburn Sound.

Trend

Unchanging

# State and trends in water quality in the Moderate Protection Area Eastern Sound



**Water Quality Index**

A water quality index between 'A' and 'B' indicates that the water quality indicators usually meet the desired levels.

Variability between years may be because of factors such as weather events (e.g. above average rainfall).



**Nutrients**

Nutrient concentrations (total nitrogen and total phosphorus) at times fail to meet the desired levels. Total nitrogen concentrations generally meet the desired levels, while total phosphorus concentrations continue to show little improvement.



**Chlorophyll a / light attenuation**

Chlorophyll a concentrations generally meet the desired levels. While there is an indication that light attenuation coefficients are improving, variability is high from year to year.



**Phytoplankton biomass**

Phytoplankton biomass (an indicator of phytoplankton blooms) has met the guideline since the summer season 2017–18.



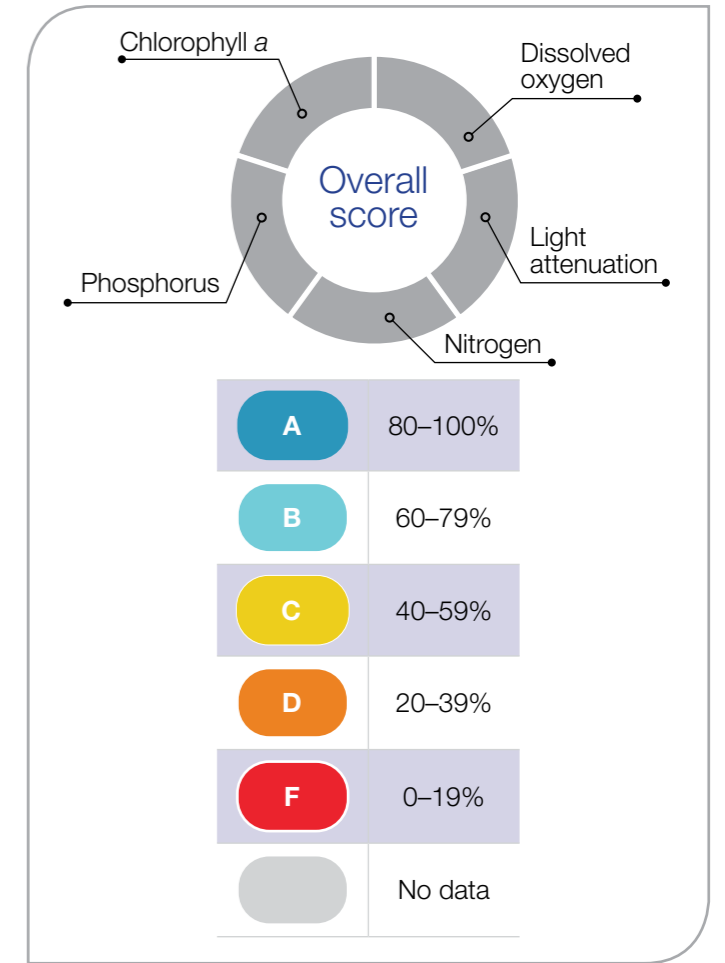
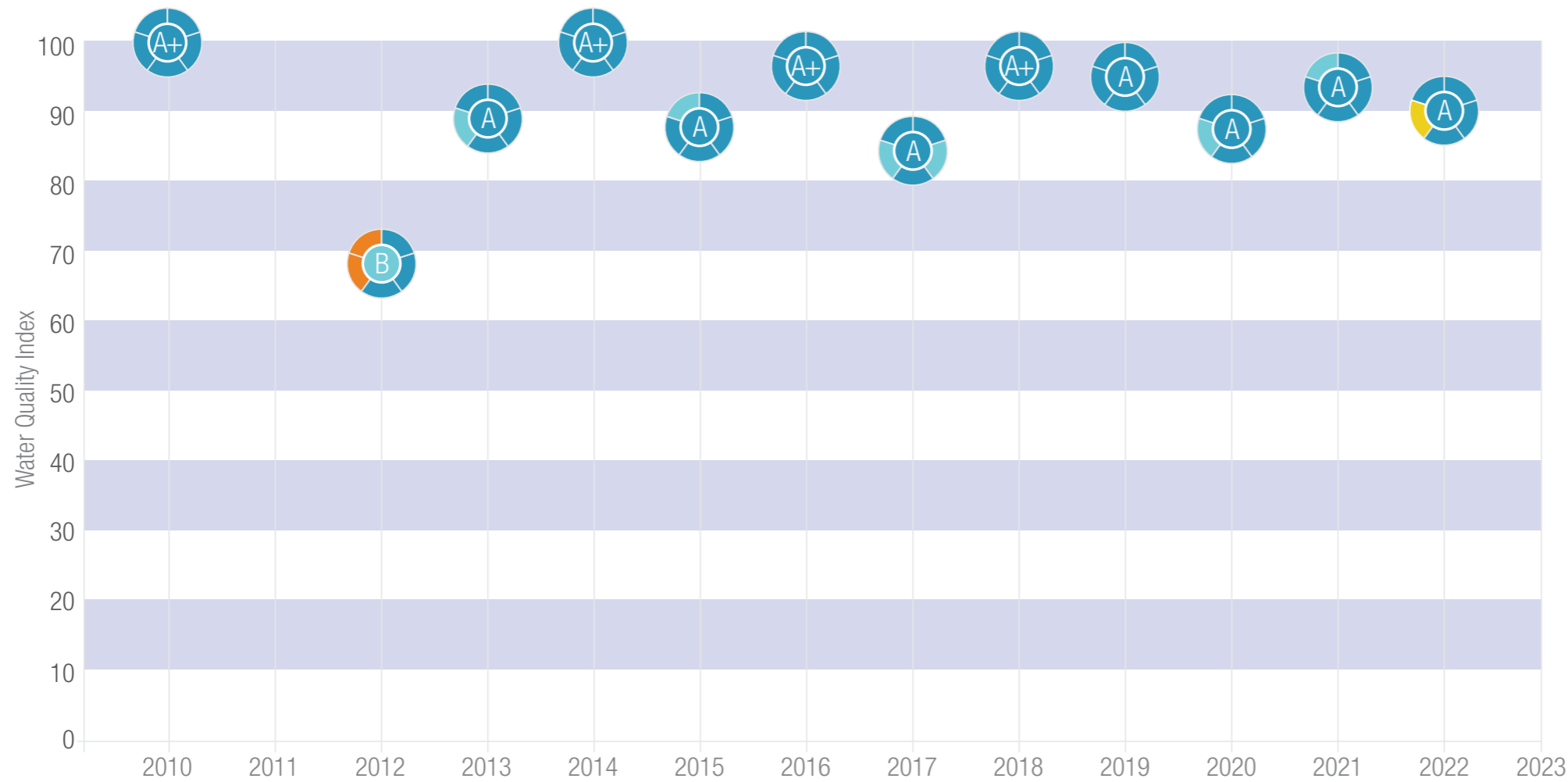
**Dissolved oxygen**

The waters are generally well mixed and well oxygenated. There are periods, mostly during late summer and autumn or associated with extreme weather events, when bottom waters become stratified and low dissolved oxygen concentrations may be experienced for short periods.





# State and Trends in Water Quality in the Moderate Protection Area Careening Bay



**Water Quality Index**

A water quality index between 'A' and 'B' indicates that the water quality indicators usually meet the desired levels.

Variability between years may be because of factors such as weather events (e.g. above average rainfall).



**Nutrients**

Water quality continues to be consistently high with no indication of significant trends in nutrient concentrations.



**Chlorophyll a / light attenuation**

Water quality continues to be consistently high with no indication of significant trends in chlorophyll a concentrations or light attenuation coefficients.



**Phytoplankton biomass**

Phytoplankton biomass (an indicator of phytoplankton blooms) has met the guideline in all years since 2005–06.

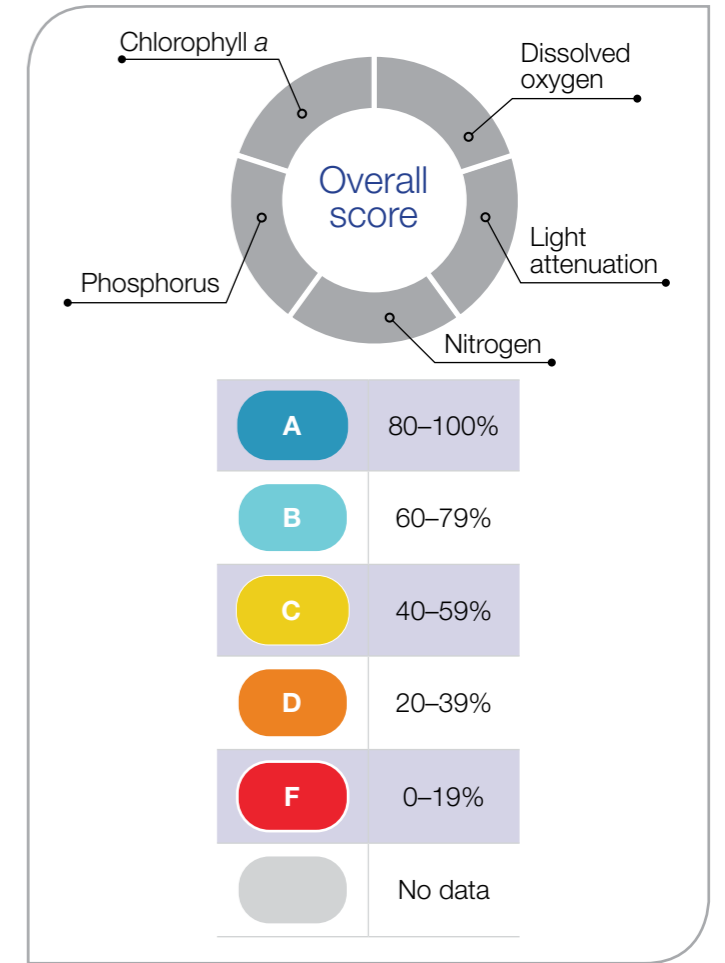
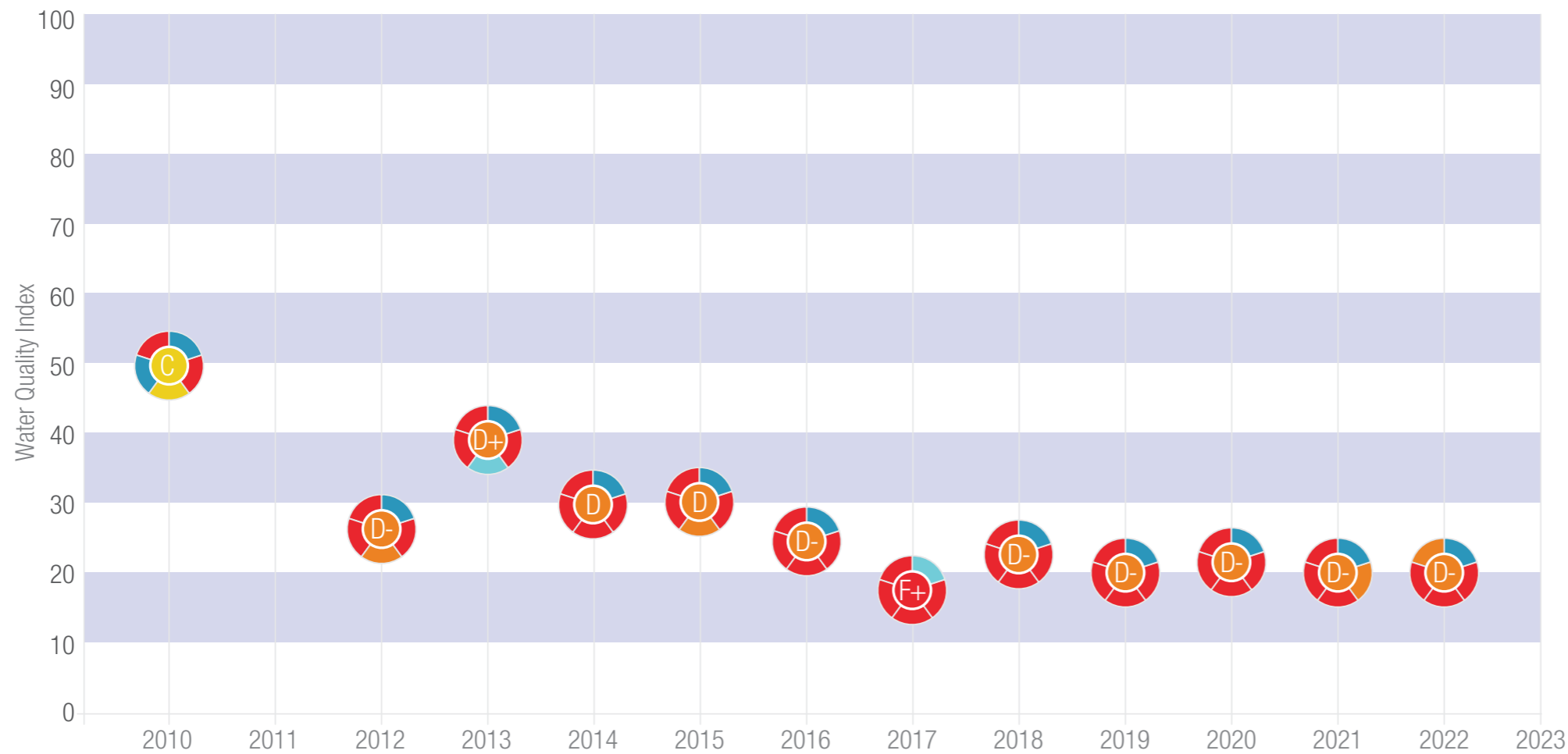


**Dissolved oxygen**

The waters are generally well mixed and well oxygenated.



# State and Trends in Water Quality in the Moderate Protection Area Northern Harbour



**Water Quality Index**

A water quality index 'D' and 'F' indicates some water quality indicators consistently fail to meet the desired levels. Variability between years may be because of factors such as weather events (e.g. above average rainfall).



**Nutrients**

Nutrient concentrations (total nitrogen and total phosphorus) generally fail to meet the desired levels. The poor water quality has been attributed to high levels of nitrogen in groundwater flowing into the harbour and reduced flushing in the harbour.



**Chlorophyll a / light attenuation**

Chlorophyll a concentrations and light attenuation coefficients continue to remain elevated.



**Phytoplankton biomass**

Phytoplankton biomass (an indicator of phytoplankton blooms) was not met since the summer season 2017-18.



**Dissolved oxygen**

The waters are generally well mixed (vertically) and well oxygenated. There are periods, mostly during late summer and autumn or associated with extreme weather events, when bottom waters become stratified and low dissolved oxygen concentrations may be experienced for short periods.







# Seagrass in Cockburn Sound

Seagrass meadows are an important benthic (seafloor) habitat providing critical ecosystem functions and services in Cockburn Sound. Seagrasses provide habitat for fish and other aquatic organisms, contribute to improving water quality through nutrient recycling and sediment retention, and represent an important source of organic matter. Seagrasses respond rapidly to changes in environmental conditions, such as light and nutrient availability, making them good indicators of the state of the marine environment.

Annual monitoring of seagrass shoot density has been undertaken at sites in Cockburn Sound since 1998. The monitoring has found no significant increasing trends in shoot densities in Cockburn Sound that would indicate widespread recovery of seagrass meadows at the ecosystem level.<sup>3</sup>

Historical declines in seagrass shoot densities continue at sites at Jervoise Bay, Woodman Point and northern Garden Island. The decline in shoot density suggests thinning in parts of seagrass meadows which could lead to reduced resilience. The remainder of the seagrass sites in Cockburn Sound show no trends, potentially indicating that seagrass shoot densities have become more stable at these sites.

<sup>3</sup> RPS Group (2022). *Long-term monitoring seagrass survey 2022, Cockburn Sound*. Report prepared for the Department of Water and Environmental Regulation on behalf the Cockburn Sound Management Council.

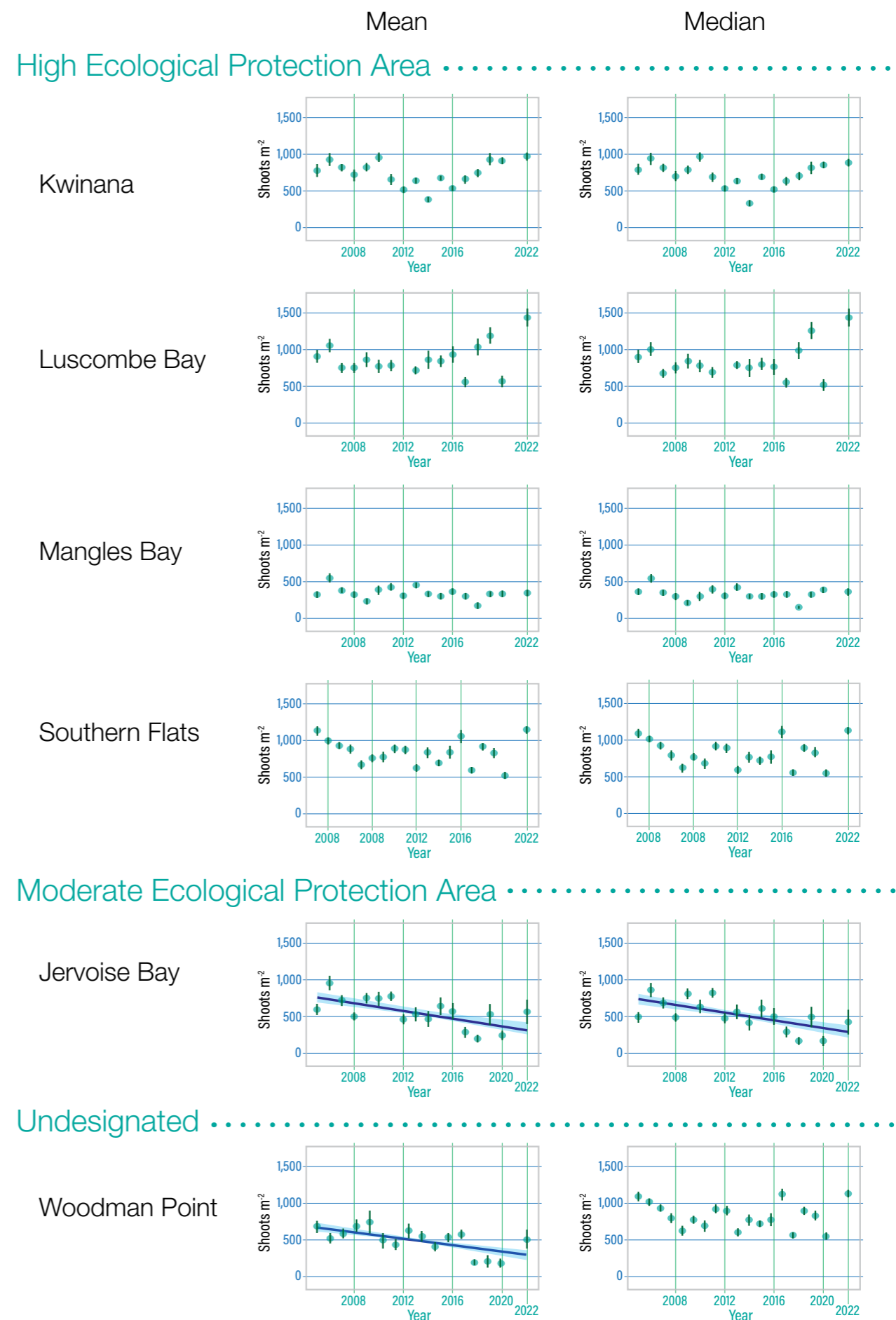


Figure 3: Trends in seagrass shoot densities in Cockburn Sound



## Contaminants in marine waters and sediments

### Marine waters

Monitoring of contaminants (e.g. metals, organometallics, non-metallic inorganics, organics and pesticides) in marine waters is not routinely undertaken in Cockburn Sound. Concentrations of potential contaminants were last comprehensively assessed in 2008; some site-specific targeted surveys have been undertaken since that time.

Based on the available information, the marine waters of Cockburn Sound are generally of good quality. Contaminant concentrations were below the guidelines, below their respective detection limits or the Limits of Reporting<sup>4</sup> where no guidelines were available, or present in low concentrations.<sup>5</sup> Contaminants at concentrations above the Limits of Reporting but with no guidelines were within accepted international standards where these are available.

### Sediments

Concentrations of sediment contaminants in Cockburn Sound were last comprehensively assessed in 2006; some site-specific targeted surveys have been undertaken since that time.

Based on the available information, concentrations of most contaminants (e.g. metals, hydrocarbons, organochlorine pesticides) were generally below the guidelines, where these were available, or the Limits of Reporting.<sup>4</sup> Concentrations of most metals (i.e. copper, zinc, aluminium, cobalt, lead, mercury, nickel) are generally higher in the southern area of Cockburn Sound. This is most likely because of the higher silt and clay content of the sediments (smaller particles have higher surface areas for adsorption of contaminants), rather than a local contaminant source.

Tributyltin (TBT) was once commonly used in antifouling paint for oceangoing vessels. TBT and its breakdown products (dibutyltin [DBT] and monobutyltin [MBT]) are consistently present in Cockburn Sound sediments, particularly in localised areas around port infrastructure, jetties and boat mooring areas. This suggests that recreational and commercial vessels were a major source of contamination.<sup>5</sup> Once in sediments, TBT is resilient – ‘hot spots’ of TBT contamination around infrastructure are expected to persist for some time, while new introductions of TBT would be expected to be non-existent or minimal.

Copper-based compounds have replaced organotins as the active ingredient in antifouling paints. Copper concentrations are occasionally elevated in sediments at individual sites around shipping-related infrastructure, with concentrations highly variable between sites.<sup>5</sup>

<sup>4</sup> The lowest amount of a substance in a sample that can be determined with acceptable precision and accuracy under the stated analytical conditions.

<sup>5</sup> Source: BMT (2018). *Cockburn Sound – Drivers, Pressures, State, Impacts, Responses Assessment 2017 Final Report*. Report prepared for Department of Water and Environmental Regulation, the Kwinana Industries Council, the City of Rockingham and the City of Kwinana on behalf of the Cockburn Sound Management Council.



## Marine pests in Cockburn Sound

The introduction and spread of new species into Western Australian waters poses a significant threat to the state’s aquatic environment and can have widespread effects on both the economy and public health. A targeted surveillance program provides early detection of marine pest species within the Swan River and Cockburn Sound.<sup>6</sup>

**Table 1: Introduced and pest species detected in Cockburn Sound and Fremantle Port waters.**

Common name	Scientific name	Type of organism	Pest status	Year first detected	Subsequent detection
	<i>Alexandrium catanella</i>	Dinoflagellate	Pest-like if in bloom	2012–13	N
	<i>Alexandrium sp.</i>	Dinoflagellate	Pest-like if in bloom	2014–15	N
Mediterranean fanworm	<i>Sabella spallanzanii</i>	Polychaete	Pest	2012–13	Y
Aeolid nudibranch	<i>Godiva quadricolor</i>	Mollusc	Introduced species	2013–14	Y
Scallop	<i>Scaechlamys livida</i>	Mollusc	Introduced species	2012–13	Y
Asian green mussel	<i>Perna viridis*</i>	Mollusc	Pest	2011–12	Y*
Asian date mussel	<i>Arcuatula senhousia</i>	Mollusc	Pest	2012–13	Y
Ivory barnacle	<i>Balanus improvisus*</i>	Barnacle	Pest	2013–14*	N
	<i>Balanus pulchellus*</i>	Barnacle	Introduced species	2013–14*	N
	<i>Amphibalanus amphitrite</i>	Barnacle	Introduced species	2014–15	N
Asian paddle crab	<i>Charybdis japonica</i>	Crab	Pest	2013–14	Y
Ciona	<i>Ciona intestinalis</i>	Ascidian	Introduced species	2013–14	Y
	<i>Didemnum perlucidum</i>	Ascidian	Introduced species, pest-like characteristics	2012–13	Y
	<i>Didemnum vexillum</i>	Ascidian	Introduced species	2020–22	Y
Codium	<i>Codium fragile fragile</i>	Algae	Introduced species	2019–22	Y
Striped sandgoby	<i>Acentrogobius pflaumi</i>	Fish	Introduced species	2014–15	Y

### Key

- \* species detected on vessel and is not known to be established in the wild
- Y/N species previously detected in the region and detected again in recent surveillance (previous two years)

<sup>6</sup> Source: Department of Primary Industries and Regional Development (personal communication, 15 March 2022).





# Cockburn Sound fisheries

Cockburn Sound has historically been a popular area for both commercial and recreational fishing because of its proximity to the Perth metropolitan area. There are currently four managed fisheries operating in Cockburn Sound: Cockburn Sound Crab Fishery, Cockburn Sound (Line and Pot) Fishery (octopus), Cockburn Sound Fish Net Fishery and Cockburn Sound Mussel Fishery.<sup>7</sup> Thirty-five fishers are licensed to operate in one or more of these fisheries. Recreational fishers target some of the same resources as exploited by these commercial fisheries, as well as other species.

## Cockburn Sound Crab Fishery

Commercial trap catches for blue swimmer crab (*Portunus armatus*) peaked in the late 1990s at over 350 tonnes and declined to 25 tonnes in 2014 (Figure 4). The Cockburn Sound Crab Fishery has been closed to commercial and recreational fishing since 2014 because of low recruitment and stock levels.

From 2014 to 2019, the annual standardised index of juvenile blue swimmer crabs in Cockburn Sound, which is a measure of juvenile crab abundance, has remained very low (0.03-0.11 juveniles/100m<sup>2</sup>), below the limit established in the preliminary harvest strategy.<sup>8</sup> Despite a significant increase in 2020 (0.25 juveniles/100m<sup>2</sup>), recruitment remains at unacceptable levels, with the juvenile index below the harvest strategy limit of 0.4 juveniles/100m<sup>2</sup> trawled.<sup>8</sup> The egg production index of 6.1 x 10<sup>6</sup> eggs/traplift is about half the limit reference value of 12 x 10<sup>6</sup> eggs/traplift. This indicates that breeding stock levels are unacceptable, and the status of the blue swimmer crab stocks in Cockburn Sound is classified 'environmentally limited'.<sup>8</sup>

Potential reasons for the stock decline include the combined effects of reduced levels of primary productivity (chlorophyll *a*) within Cockburn Sound, changes in water temperature, a low abundance of mature females and/or low proportion of berried females. The recent declines in abundance are believed to be primarily attributable to environmental changes, rather than fishing. It is considered unlikely that crab stock levels will recover to historical levels while productivity in the system remains low.

<sup>7</sup> Source: Department of Primary Industries and Regional Development (personal communication, 15 March 2022).

<sup>8</sup> Source: Johnston, D, Harris, D, Yeoh, D. and Blay, N. (2021). 'West Coast Blue Swimmer Crab Resource Status Report 2021'. In: *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2020/21: The State of the Fisheries*. eds Newman, S.J., Wise, B.S., Santoro, K.G and Gaughan, D.J Department of Primary Industries and Regional Development, Western Australia. pp40-48.

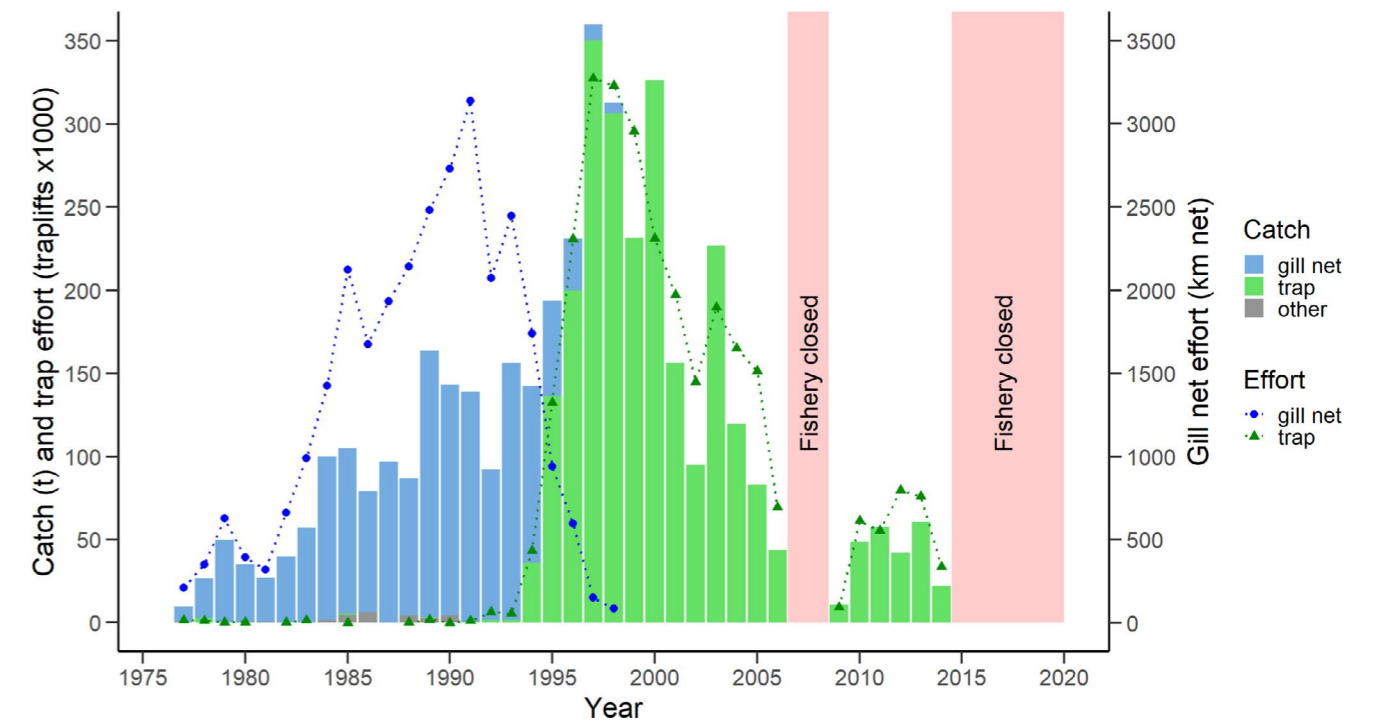


Figure 4: Annual commercial catch (tonnes) by season, for each fishing method in the Cockburn Sound Crab Fishery. The fishing season in Cockburn Sound runs from December to September inclusive, although management changes shortened the season considerably following the first closure in 2006–09 and the fishery has remained closed since 2014. The fishery operated with gill nets from 1977–78, transitioning to traps from 1994–95 to 1998–99, after which it was a trap only fishery.

# Cockburn Sound fisheries



## Cockburn Sound Octopus Fishery

The Cockburn Sound (Line and Pot) Fishery commenced in March 1995 and 34 of the 35 licensed fishers are permitted to operate in this fishery. Since 2005, a total of 13 licence holders have been active within the fishery, although only a small number of these have focused specifically on capturing the gloomy octopus (*Octopus tetricus*). Fishing is allowed with both baited and unbaited pots; however, longline-set shelter pots have been the gear type historically used in the fishery. Octopus are also caught as a by-product in rock lobster pots. A maximum of 47 tonnes of octopus was caught in 2013; since 2005, the catch has generally fluctuated between 20 and 30 tonnes.<sup>9</sup>

While there is no evidence to suggest that over-exploitation has occurred, the potential for localised depletion of octopus in Cockburn Sound has resulted in a highly precautionary management approach. Historically, in addition to limited entry, effort was regulated through restrictions on vessel size. Effort has been further constrained since 2015 with the introduction of a fixed octopus entitlement of 13,000 shelter pots.<sup>9</sup>

## Cockburn Sound Mussel Fishery

Black mussels (*Mytilus* spp.) are aquacultured in the southern region of Cockburn Sound. Black mussel production in Cockburn Sound increased from its first year in the early 1990s where it produced around 400 tonnes, to producing more than 700 tonnes in the early 2000s. Since this peak, production has fallen significantly to below 200 tonnes in early 2010s and has continued to decline, where in some recent years there has been no recorded production. Mussels are filter feeders and their growth rates are directly affected by the productivity of the ecosystem. The reported decline in aquaculture productivity may be attributed to a decline in phytoplankton primary productivity (chlorophyll *a*) and potentially an increase in snapper and crab predation, thereby reducing the economic viability of black mussel aquaculture.

## Cockburn Sound Finfish Fisheries

A range of finfish species is caught by commercial fishers (e.g. Cockburn Sound [Line and Pot] Fishery and Cockburn Sound Fish Net Fishery) and recreational fishers in the waters of Cockburn Sound.

Cockburn Sound and the adjacent embayments of Owen Anchorage and Warnbro Sound are the only locations on the lower west coast where snapper (*Chrysophrys auratus*) aggregate to spawn.<sup>7</sup> An annual fishing closure is in place to protect these aggregations during the spawning period. Current management arrangements for snapper are designed to rebuild the west coast stock, following evidence of overfishing in the early 2000s. A stock assessment in 2021 indicated that stocks were not recovering at the expected rate. Further management action was undertaken via a consultation process in 2022. There is no evidence of any long-term negative effects of environmental changes on these aggregations and subsequent recruitment of juveniles into Cockburn Sound.

Cockburn Sound was historically the main commercial and recreational fishing area for southern garfish (*Hyporhamphus melanochir*) in Western Australia and is regarded as a key location for this species. Garfish have declined in the Metropolitan Zone (area between Lancelin and north of Bunbury) since the late 1990s, because of a combination of overfishing and environmental factors. The 2011 marine heatwave<sup>10</sup> accelerated stock decline. A total fishing ban for southern garfish was implemented in the Metropolitan Zone in 2017 to allow recovery of the stock. Garfish are seagrass dependent for spawning and a decline in seagrass biomass is likely to negatively affect garfish.

The 2011 marine heatwave had major impacts on fish and fisheries along the west coast, including Cockburn Sound. There were marked changes in the composition of the fish fauna on the west coast after this event because of range shifts, increased mortality and recruitment failures.

New measures were introduced on 6 December 2022 to boost the recovery of demersal scalefish stocks in the West Coast Bioregion from Kalbarri to Augusta, following extensive community and industry consultation. The new measures are part of the West Coast Demersal Scalefish Recovery Plan which was established in 2010 in response to overfishing in the early 2000s. Common demersal species include dhufish, baldchin groper, breaksea cod and pink snapper.
















<sup>9</sup> Source: Hart, A, Murphy, D and Wiberg, L (2021). 'West Coast Octopus Resource Status Report 2017'. In S J Newman, Wise, BS, Santoro KG, and Gaughan D (eds), *Status reports of the Fisheries and Aquatic Resources of Western Australia 2020/21: The State of the Fisheries*. Report prepared by the Department of Primary Industries and Regional Development, Western Australia.

<sup>10</sup> Source: Smith, K, Holtz, M, Bunbury, E, O'Malley, J and Yerman, M (2018). 'West Coast Nearshore and Estuarine Finfish Resource Status Report 2017'. In DJ Gaughan and K Santoro (eds), *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries*. Report prepared by the Department of Primary Industries and Regional Development.



# Social environmental values: state and trends

Assessment of the state and trends in the Cockburn Sound marine area for the four social environmental values identified for protection: 'fishing and aquaculture', 'recreation and aesthetics', 'cultural and spiritual' and 'industrial water supply'.

Environmental value	Environmental quality objective	State in 2022	Trend	At a glance
<b>Fishing and aquaculture</b>	Maintenance of seafood safe for human consumption			Shellfish harvested from the 'approved' and 'conditionally approved' shellfish harvesting areas in southern Cockburn Sound are safe for human consumption.  Limited information is available from other areas in Cockburn Sound or for wild shellfish or fish. Accredited quality assurance monitoring programs based on the requirements of the <i>Western Australia Shellfish Quality Assurance Program (WASQAP) Sampler Manual 2021</i> are currently conducted for 'approved' and 'conditionally approved' shellfish harvesting areas in southern Cockburn Sound where shellfish are grown commercially for the food market. The Department of Health recommends only eating shellfish harvested commercially under strict quality assurance monitoring programs. <sup>11</sup>
	Maintenance of aquaculture			Based on the information available, physical-chemical conditions in the shellfish harvesting areas are generally good for growing shellfish. Physical and chemical parameters (e.g. dissolved oxygen concentrations, pH) and toxicant concentrations are suitable for maintaining aquaculture production in the shellfish harvesting areas in southern Cockburn Sound.  Black mussels ( <i>Mytilus</i> spp.) production in the southern region of Cockburn Sound has continued to decline. The decline may be attributed to a decline in phytoplankton primary productivity (chlorophyll <i>a</i> ) and potentially an increase in predation by snapper and crabs.
<b>Recreation and aesthetics</b>	Maintenance of primary contact recreation <sup>12</sup>	 		As part of the microbiological water quality monitoring program for recreational/environmental waters, administered by the Department of Health, temporary beach grades are assigned to swimming and other recreational environmental waters in accordance with the National Health and Medical Research Council's 2008 <i>Guidelines for Managing Risks in Recreational Water</i> .  Provisional bacterial water quality risk classifications for beaches on Cockburn Sound's coastline are 'good' (safe for swimming most of the time). Potential site-specific risk factors' influence on water quality (e.g. rainfall) have been identified for further assessment at North Hymus Street and Palm Beach. Occasional elevated bacterial levels are likely to be from animal pollutant sources (e.g. bird faeces) and contaminants flushing into the water following rainfall. Standard warnings to avoid swimming apply for up to one day in ocean/marine waters after heavy rainfall (>10mm).  Standard Department of Health warnings apply. <sup>13</sup>
	Maintenance of secondary contact recreation <sup>14</sup>			Based on the information available, water quality in Cockburn Sound is suitable for secondary contact recreation activities.
	Maintenance of aesthetic values			Records of visual indicators of aesthetic quality (including the presence of nuisance organisms, faunal deaths, water clarity, the presence of surface films and debris, and odours) are made monthly and reported annually. Many of the guidelines for aesthetic quality are subjective and relate to the general appreciation and enjoyment of Cockburn Sound by the community as a whole.
<b>Cultural and spiritual</b>	Maintenance of Indigenous cultural and spiritual values			Inclusion of this environmental value recognises the cultural and spiritual values of Cockburn Sound to the Indigenous peoples of the area. To date, no specific environmental quality criteria have been established for this value and there are no specific monitoring programs in place.  Ensuring that the quality of the marine waters of Cockburn Sound is sufficient to protect ecosystem integrity, protect the quality of seafood, enable safe recreation and maintain aesthetic values may go some way towards maintaining cultural values. <sup>15</sup>
<b>Industrial water supply</b>	Maintenance of water quality for industrial use			Minor exceedances of guidelines in the intake water for the Perth Seawater Desalination Plant were reported for some parameters. No significant reduction in efficiency of the desalination process or significant increases in maintenance requirements were reported. <sup>16</sup>

<sup>11</sup> Source: Department of Health (2010). [Wild shellfish collection](#). Environmental Health Directorate, Department of Health (Accessed: 7 December 2022).

<sup>12</sup> Primary contact recreation includes all recreational activities where the participant comes into frequent contact with the water, either as part of the activity or accidentally (e.g. swimming, water-skiing, wind surfing or diving).









<sup>13</sup> Source: Department of Health (2022). [Beach Grades for Western Australia](#), Perth Metro Recreational/Environmental Waters (Accessed: 7 December 2022).

<sup>14</sup> Secondary contact recreation includes recreational activities in which the participant comes into direct contact with the water infrequently, either as part of the activity or accidentally (e.g. boating, canoeing or fishing).

<sup>15</sup> Source: Environmental Protection Authority (2017). *Environmental Quality Criteria Reference Document for Cockburn Sound*. A supporting document to the State Environmental (Cockburn Sound) Policy 2015.

<sup>16</sup> Source: Water Corporation, Western Australia (personal communication, 28 July 2022).

# Emerging issues

State categories	Explanation
	For this environmental value, based on available environmental monitoring data, the state of the Cockburn Sound marine area is presently meeting all environmental quality criteria and the environmental quality objective is being achieved.
	For this environmental value, based on available environmental monitoring data, the state of the Cockburn Sound marine area is presently not meeting all the environmental quality criteria and there is a risk the environmental quality objective is not being achieved.
	For this environmental value, based on available environmental monitoring data, the state of the Cockburn Sound marine area is presently meeting none or only a few of the environmental quality criteria, and the environmental quality objective is not being achieved.
	For this environmental value, the state of the Cockburn Sound marine area is not known as there are no specific environmental quality criteria and monitoring programs in place.
Trend categories	Explanation
	Available information indicates that for this environmental value, the state of the Cockburn Sound marine area is improving.
	Available information indicates that for this environmental value, the state of the Cockburn Sound marine area is unchanging (it is not getting better or worse).
	Available information indicates that for this environmental value, the state of the Cockburn Sound marine area is declining.
	The trend in the state of the Cockburn Sound marine area for this environmental value is not known as there are no specific environmental quality criteria and monitoring programs in place.

## Plastic pollution

Plastic pollution in oceans and waterways has become a growing concern. Marine plastic pollution is mostly in the form of microplastics resulting from the breakdown of larger plastic waste such as bags, bottles and cigarette butts. Microplastics are often mistaken for food and eaten by marine life.

A recent study which investigated beach litter at Woodman Point in Cockburn Sound found plastics made up 96 per cent of the litter and was mostly associated with fishing and boating.<sup>17</sup> The study also found that during the study period from November 2018 to January 2021, a statistically significant reduction in eight types of plastics, including fishing/boating items, balloons and straws, which coincided with the implementation of State and local government regulation and waste education initiatives to reduce plastic use.

In November 2020, the State Government released a strategy to reduce the use of single-use plastics – Western Australia’s Plan for Plastics. The Plan for Plastics is being implemented in a staged approach. [Stage 1 regulations](#), which came into effect on 1 January 2022, ban single-use or disposable plastic items such as plates, unlined takeaway containers, cold beverage cups, drinking straws and stirrers, thick plastic shopping bags, polystyrene food containers and helium balloon releases. [Stage 2 regulations](#) will phase out a second set of single-use or disposable items, including degradable plastics, produce bags, coffee cups and lids, and cotton buds with plastic stems. The Stage 2 regulations came into effect on 27 February 2023.

The Australian Government released the [National Plastics Plan](#) in March 2021. It outlines an approach to increase plastic recycling, find alternatives to unnecessary plastics such as polystyrene packaging products and reduce the impact of plastic on the environment. On 24 October 2022, the Australian Parliament’s House Standing Committee on Climate Change, Energy, Environment and Water launched an [inquiry](#) into the effectiveness of Australia’s plastics management framework under the National Plastics Plan and related policies to reduce plastic pollution, particularly in oceans and waterways.

<sup>17</sup> Davies, L, Kemp, A, O’Loughlin, C, and Korczynskij, D (2022). Is conscientious beachcombing the key to ‘unlock’ marine plastic pollution trends through citizen science? A case study from Cockburn Sound, Western Australia. *Marine Pollution Bulletin* 177: 113519.

# Conclusions

## Climate Change

Climate change impacts on marine ecosystems include changes in temperature, circulation, stratification, nutrient input, oxygen content, and ocean acidification.<sup>18</sup> These changes ultimately reduce marine biodiversity and increase the risk of irreversible loss of marine and coastal ecosystems.

Marine species distribution and populations will change in response to warmer sea-surface waters. Temperature-sensitive fish species may move to cooler waters. Increasing sea-surface temperatures appear to affect the reproduction of some fish species such as snapper.<sup>19</sup> These potential shifts in fish stocks may require new approaches to fisheries management and catch levels for some species and stocks.

The [Western Australian Climate Policy](#), published in 2020, outlines climate change actions the State Government is taking to achieve net zero greenhouse gas emissions by 2050. The Policy includes initiatives that support clean manufacturing and future industries, transformation of energy generation and use, and low-carbon transport.

The State Government, in partnership with industry, local government and the community, continues to work to improve the environmental health of Cockburn Sound through a range of collaborative management and mitigation efforts. Despite these efforts, there are ongoing concerns about poor water quality in some areas of Cockburn Sound, declines in seagrass shoot density at some sites, and a decline in productivity of some commercial fisheries (including aquaculture) and recreational fisheries, as well as the emergence of new threats.

Based on the available information, the water quality in Cockburn Sound is such that its environmental values and uses – including recreational use, ensuring shellfish from the shellfish harvesting areas in southern Cockburn Sound are safe to eat, and industrial water supply – are being maintained.

There is no information available on whether aesthetic and Indigenous cultural and spiritual values are being maintained. Ensuring that the quality of the marine waters of Cockburn Sound is sufficient to protect ecosystem integrity, protect the quality of seafood, enable safe recreation and maintain aesthetic values may go some way towards maintaining the cultural values of the Sound.

Cockburn Sound is likely to experience further pressures in the future from urbanisation, industrial and infrastructure development, and climate change. There is still only a limited understanding of the Cockburn Sound marine ecosystem's ecological resilience to these pressures.

<sup>18</sup> Source: United Nations (n.d.) [How is climate change impacting the world's ocean \(Accessed: 9 March 2023\)](#).

<sup>19</sup> Source: Pankhurst, NW and Munday, PL (2011). Effects of climate change on fish reproduction and early life history stages. *Marine and Freshwater Research* 62: 1015-1026.



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