PRELIMINARY REVIEW OF THE MONITORING REQUIREMENTS FOR THE SHOALWATER ISLANDS AND MARMION MARINE PARKS

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SUMMARY

The successful management of a Marine Park is contingent upon a comprehensive long-term monitoring programme being established that characterises the hydrodynamic regime, provides information on the natural variation of key biological communities, determines the status of important chemical and biological attributes and, determines changes in chemical and biological indicators to quantify the impact of human activity on the environmental values of a Park.

The aim of this review is to provide a preliminary assessment of the monitoring requirements for Perth's two metropolitan marine parks, the Shoalwater Islands and Marmion Marine Parks. This review did not include the oceanography or marine wildlife (i.e. marine mammals, birds, reptiles) of these areas. Furthermore, the Health Department of Western Australia is currently initiating a review of the microbiological water quality monitoring of Perth's metropolitan beaches and therefore this document does not include this issue.

The central theme in CALM's approach to managing marine waters is to establish quantitative links between potentially threatening human activity (e.g. wastewater discharge) and environmental values (e.g. ecosystem protection). The principle threat to the environmental values of the Marmion and Shoalwater Islands Marine Parks is the discharge of domestic wastewater from the Cape Peron and Beenyup ocean outfalls. In January 1996, the Water Corporation commenced a five-year ocean outlet monitoring programme, focusing on nutrient effects water quality and biological monitoring, and toxic contamination, for Perth's metropolitan ocean outfalls.

A preliminary assessment suggests that in the short-term the Water Corporation's monitoring programme will provide CALM with the information necessary to ensure the environmental values of the Marmion and Shoalwater Islands Marine Parks are protected and maintained. In the longer-term however, the Marine Conservation Branch should ensure a more detailed review of all monitoring requirements, including marine wildlife, is undertaken for these Parks. The review needs to identify and quantify the key processes threatening the environmental values of these waters and link the monitoring, auditing and licensing requirements to these processes. This review is particularly important for the Shoalwater Islands Marine Park given the inclusion of the Cape Peron Ocean Outfall in the proposed extension of the Shoalwater Islands Marine Park.

Prior to the commencement of a detailed review of the monitoring requirements for the two metropolitan marine parks, the Marine Conservation Branch needs to provide a position paper broadly outlining CALM's philosophical and technical approach to managing Western Australia's marine waters. This paper would provide a strategic environmental framework for CALM's marine activities such as research, monitoring and policy.

1 INTRODUCTION

1.1 Background

The Marmion Marine Park (MMP) situated in the northern metropolitan coastal waters off Perth, covers an area of approximately 9500ha between Trigg Island and Burns Beach, and extends about 6kms offshore to the boundary of the State's territorial waters (Figure 1). The MMP was declared in 1987, and was the first marine park to be established in Western Australia, in recognition of the high conservation, recreation, education and research values in the area. The Marmion Marine Park Management Plan (1992-2002) was completed in 1992 (CALM, 1994a) .

The Shoalwater Islands Marine Park (SIMP) situated in the southern metropolitan coastal waters off Perth was declared in 1990. The SIMP covers an area of approximately 6500ha between Becher Point and the Garden Island causeway, including the waters of Warnbro Sound. The offshore boundary extends about 5kms off Becher Point and 2kms off Cape Peron (Figure 2). The Draft Shoalwater Islands Marine Park Management Plan (1996-2006) was released for public comment in 1995 (CALM, 1995) and the final management plan is due for completion in early 1997.

The successful management of a marine park is contingent upon a comprehensive long-term monitoring programme being established that characterises the hydrodynamic regime, provides information on the natural variation of key biological communities, determines the status of important chemical and biological attributes, and determines changes in chemical and biological indicators to quantify the impact of human activity on the environmental values of the park.

The key environmental values of the Shoalwater Islands and Marmion Marine Parks have been identified in the Management Plans however at present there are no formal comprehensive monitoring programmes for these waters. A number of monitoring programmes however are currently being undertaken by state departments (e.g. Health Department) and agencies (Water Corporation), research organisations (CSIRO) and universities (Murdoch), in relation to specific operations (e.g. wastewater outfalls) or components of the environment (e.g. Little Penguin). By far the largest and most comprehensive monitoring programme is being conducted by the Water Corporation (formerly the Water Authority of Western Australia).

The Beenyup Wastewater Outfall discharges domestic wastewater, including sewage, directly into the Marmion Marine Park. The Cape Peron Wastewater Outfall discharges domestic wastewater into Sepia Depression which is just west of the present offshore boundary of the Shoalwater Islands Marine Park. This area of Sepia Depression however has been proposed by *the Marine Parks and Reserves Selection Working Group* for addition to the marine park (CALM, 1994b).

In 1992, the Water Corporation initiated the Perth Coastal Waters Study (PCWS), to provide information on acceptable levels of nutrient loading to these waters. The PCWS was completed in 1994, and a major recommendation was the implementation of a five-year ocean outlet monitoring programme. This recommendation was initiated in 1996, as *the Perth Long-term Ocean Outlet Monitoring Programme* (PLOOM), focusing on nutrient effects water quality and biological monitoring and toxic contamination for the three metropolitan ocean outfalls (Water Corporation, 1996a,b).

The aim of this review is to provide a preliminary assessment of the monitoring requirements for the Shoalwater Islands and Marmion Marine Parks. This review did not include the oceanography or marine wildlife (i.e. marine mammals, birds, reptiles) of these areas. In addition, the Health Department of Western Australia is currently initiating a review of the microbiological water quality monitoring for Perth's metropolitan beaches and therefore this document does not include this issue.

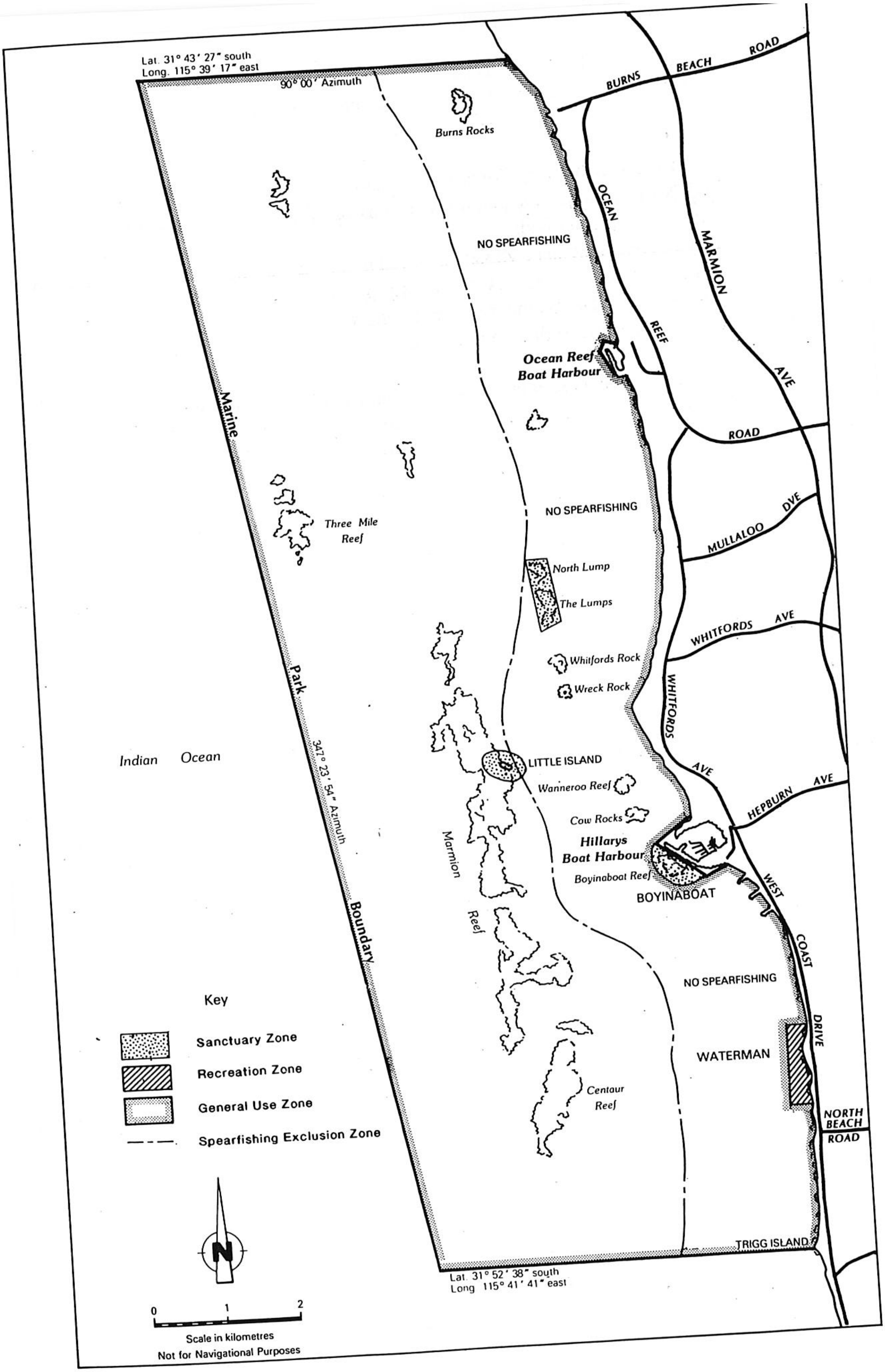

Figure 1. Location map of the Marmion Marine Park

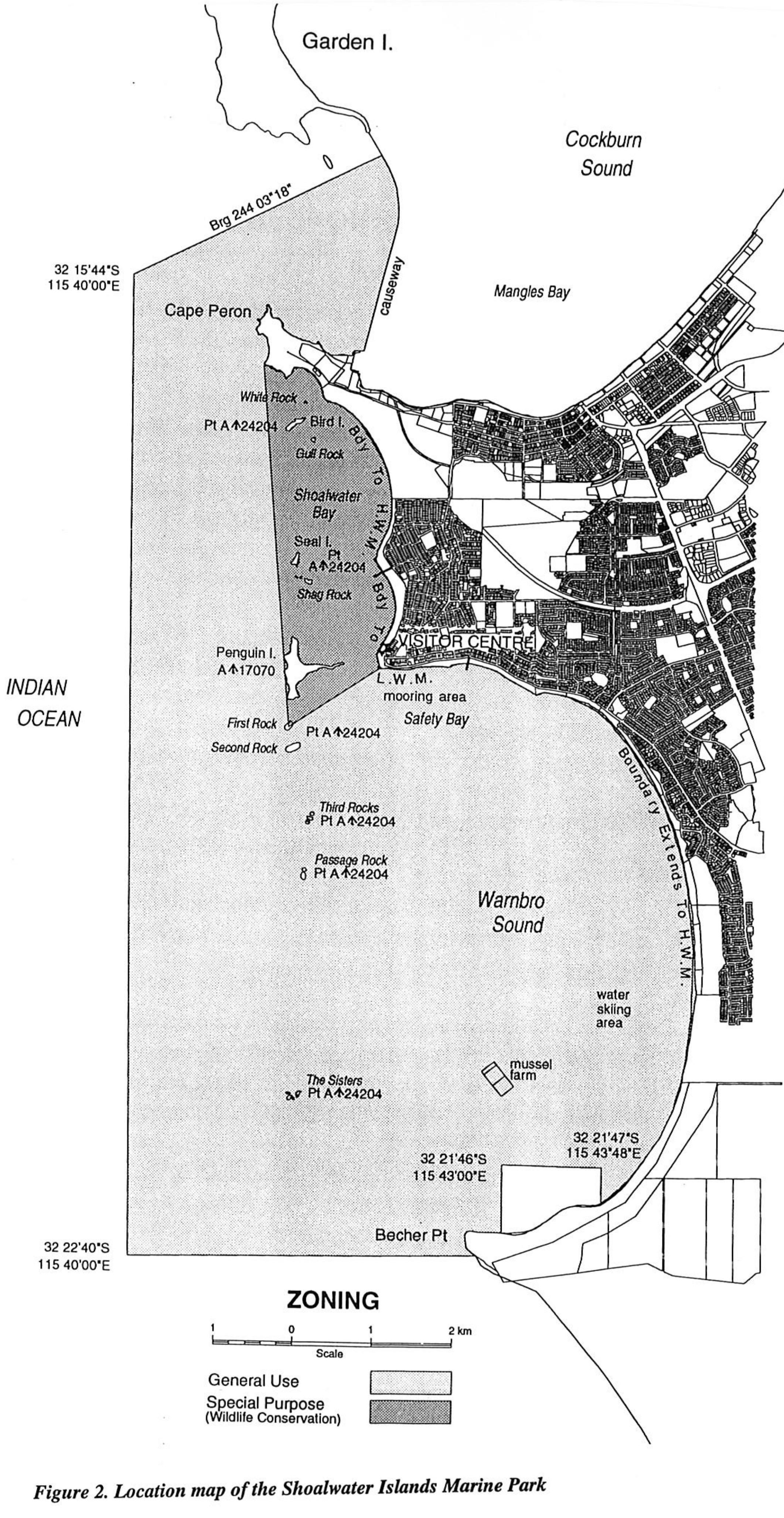

Figure 2. Location map of the Shoalwater Islands Marine Park

1.2 Environmental management framework

The central theme in CALM's approach to managing marine waters is to establish quantitative links between potentially threatening human activity (e.g. wastewater discharge) and environmental values (e.g. ecosystem protection).

Environmental quality objectives (EQOs) are the more detailed scientific expressions of environmental values. Environmental quality criteria (EQCs) provide a benchmark which can be used to assess whether the EQOs are being achieved or maintained. This EQO-based management approach applies at an ecosystem-scale.

Once these objectives and criteria have been formalised, they provide a clear guide and focus for environmental monitoring programmes. In an operational context, if monitoring showed that the EQOs are not being met then this would trigger a management response. In most cases this management response would be tiered. A first tier response may initiate a detailed review of the data to assess the spatial extent of the problem and the identify potential causes. A second tier response could take the form of specific investigations (e.g. toxicity testing) or it could involve the formulation and implementation of remedial and preventative strategies.

At present CALM does not have a position paper that outlines the departments philosophical and technical approach to managing Western Australia's marine waters. As part of the Perth Coastal Waters Study however the EQOs and EQCs for the Marmion Marine Park were defined by an *ad hoc* committee consisting of representatives from the National Parks and Nature Conservation Authority (NPNCA, vesting body for marine reserves), Water Corporation, CALM and the Department of Environmental Protection (Hillman *et al*., 1995). The status of this document is unclear. In general terms the approach is consistent with the informal *working position* adopted by the Marine Conservation Branch however in some incidences, such as the use of nutrient concentrations as EQCs, there are fundamental differences.

Recommendation

The Marine Conservation Branch should prepare a departmental position paper outlining CALM's philosophical and technical approach to managing Western Australia's marine environment.

1.3 Potentially threatening human activities

There are few natural sources of nutrients to Perth's coastal waters. Nutrients discharged into these waters from the Swan-Canning and Peel-Harvey estuaries are restricted to the winter and spring periods and offshore waters are nutrient-deplete (Cary *et.al*., 1995a,b). As a result these waters do not support an abundance of phytoplankton and zooplankton. The animal and plant communities of these waters therefore have evolved in a relatively clear, low nutrient environment.

Seagrass and macroalgae are the dominant benthic plants in Perth's coastal waters (Paling, 1991). Seagrass meadows are generally found on stable sediments whereas attached macroalgae such as kelp are confined to hard substrata such as reefs and limestone pavements and therefore seagrass communities are usually the dominant primary producer in the more protected inshore waters of the temperate zone. Meadow forming *Posidonia* seagrasses also assist with stabilising sediments, provide substrata for a diverse assemblage of plants and animals, and habitat and nursery areas for a number of important recreational and commercial species.

Posidonia seagrasses are the dominant meadow forming species is Perth's coastal waters. These seagrasses are highly susceptible to the effects of nutrient enrichment. In broad terms, the link between nutrient input and seagrass death is well understood (Dennison *et al*., 1993). Excessive nutrient inputs stimulates algal growth which in turn, reduces light reaching seagrasses to levels insufficient for long-term survival. In Princess Royal Harbour, near Albany, seagrass decline was attributed to a combination of shading due to excessive epiphyte loads on seagrass leaves and to smothering by unattached macroalgae (EPA, 1990). In contrast, past studies of Cockburn Sound concluded that excessive growth of epiphytes and increased phytoplankton in the water were considered key factors contributing to the loss of seagrasses from these waters (DCE, 1979). The loss of *Posidonia* seagrass meadows is essentially irreversible due to the slow rates of rhizome spreading and an apparent inability to successfully re-colonise areas from seed (Clark and Kirkman, 1989).

The discharge of nutrients, particularly nitrogen, from the Cape Peron Ocean Outfall and the Beenyup Ocean Outfall are the main environmental threat to the environmental values of the Shoalwater Islands and Marmion Marine Parks. From 1990 to 2040, wastewater disposal requirements from metropolitan Perth will treble to approximately 660 ML/day (Water Corporation, 1996b). At current levels of treatment, and assuming all treat effluent continues to be discharged to the ocean, treated wastewater discharges to Perth's coastal waters will contribute nearly 80% of the total land based sources of dissolved inorganic nitrogen (i.e. in a readily available form for plant uptake).

The rationale for developing a nutrient effects water quality monitoring programme that is based on the link between dissolved inorganic nitrogen (human activity) and the survival of *Posidonia* seagrass (biological effect) is briefly outlined below:

* The productivity of temperate coastal ecosystems in Western Australia are limited by the availability of total inorganic nitrogen (TIN);
* TIN is a constituent of domestic sewage and significant loads enter Perth's coastal waters from point (e.g. industrial outfalls) and diffuse (e.g. groundwater) sources;
* excessive inputs of TIN can lead to the loss of benthic plant communities through light starvation;
* *Posidonia* seagrass communities grow in the more protected inshore areas, relatively close to nutrient sources and, where water residence times are relatively long, making these communities more vulnerable to nutrient enrichment than offshore plant communities;
* the ecological importance of *Posidonia* seagrasses coupled with their apparent inability to regenerate over periods of less than decades.

2 MONITORING PROGRAMMES

2.1 Nutrient effects water quality monitoring

Parameters

Light availability is generally regarded as the key factor controlling seagrass depth distribution (Duarte, 1991). If a seagrass meadow is to survive, sufficient light is required to ensure that photosynthetic production is greater than, or equal to, the growth and respiratory requirements of the plant over the annual cycle (Masini *et al*., 1995). At a given water depth, light availability at the surface of the seagrass leaf is dependent on the clarity of the water and the amount of epiphytic material growing on the leaf. Nutrient enrichment of coastal waters can lead to excessive growth of phytoplankton in the water column and/or epiphytic algae on the leaf surface, resulting in the decline of benthic plant communities, such as seagrass meadows due to light starvation (Clark and Kirkman, 1989).

The relationships between the vertical light attenuation coefficient and the concentrations of phytoplankton (measured as chlorophyll *a*), and suspended organic and inorganic matter in the water column and, between epiphyte biomass and light reduction were derived in recent studies (Burt *et al*., 1995a, b) conducted by the Department of Environmental Protection as part of the Southern Metropolitan Coastal Waters Study (SMCWS). These relationships in junction with laboratory studies of seagrass photosynthesis-irradiance relationships (Masini and Manning, 1995) have been applied using empirical and modelling approaches to examine the minimum light requirements of *Posidonia sinuosa* seagrass meadows in Perth's coastal waters (Masini *et al*., 1995, Masini and van Senden, 1995). The results of this study indicate that the maximum depth of seagrass survival, and hence the distribution of seagrass in an area, can be accurately predicted using epiphyte loading and water column vertical light attenuation coefficient.

Changes in the species composition of epiphytes growing on the leaves of seagrass are also typical responses to a changing nutrient status of waters over seagrass meadows, with a higher proportion of corralline species in oligotrophic waters compared to eutrophic waters, where the assemblages are generally dominated by filamentous algae (May *et al*., 1978; Harlin and Thorne-Miller, 1981, Hillman *et al*., 1991 and Burt *et al*., 1995a).

Recommendation

A nutrient effects water quality monitoring programme should include the following parameters:

*** Chlorophyll *a;***

*** vertical light attenuation coefficent;**

*** periphyton biomass and calcium carbonate content.**

Sampling period

Results from the PCWS and SMCWS show significant seasonal variation in the water quality of Perth's coastal waters. During periods of high river flow, which occur during winter and to a lesser extent spring (May-October), estuarine nitrogen discharges cause significant elevation of nutrient and phytoplankton concentrations over most of Perth coastal waters (Cary *et. al*., 1995b). By contrast during the non-winter period (November-May) water quality, as indicated by chlorophyll *a*, inorganic nitrogen concentrations and light attenuation, is primarily determined by local forcings such as domestic and industrial wastewater discharges and groundwater inflows. To determine the influence of anthropogengic nutrient loadings on the water quality of Perth's coastal waters, and avoid the confounding regional influences, monitoring programme should focus on the non-winter period.

Furthermore, studies conducted in Perth's coastal waters as part of the SMCWS indicate that water quality during the *non-winter* period is an important factor influencing the survival of *Posidonia* seagrasses growing at there depth limit in these waters (DEP, 1996). Empirical relationships derived from studies of seagrass photosynthesis-irradiance (Masini and Manning, 1995), and light attenuation through the water column and the epiphytic layer (Burt *et al*.,1995a,b) indicate that photosynthetic production of *P. sinuosa* in Perth's coastal waters is highest during summer and lowest during winter. Simulation modelling of seagrass growth (Masini *et al*., 1995, Masini and van Senden, 1995) supports these findings and indicates that *P. sinuosa* plants are in positive carbon balance during summer and negative carbon balance during winter. These findings support the view that reductions in light reaching seagrass meadows during the *non-winter* period, due to factors such as increased phytoplankton in the water column or epiphyte biomass on the seagrass leaves, will change the annual energy balance of the plants and jeopardise their long-term survival.

Recommendation

Nutrient effects water quality monitoring should be conducted during the *non-winter* period.

Sample frequency

In a EQO-based management framework water quality monitoring programmes need to accurately represent the water quality of an area using a number of key environmental indicators. Water quality indicators such as chlorophyll *a* concentrations and light attenuation coefficient are statistically compared with environmental quality criteria (EQC) to determine whether the EQOs of an area are being protected. The statistical compliance of water quality EQCs means that the experimental design of water quality monitoring programmes need to focus on aspects such as sampling frequency, number of sites and sample replication to ensure that experimental error is minimised.

Recommendation

Nutrient effects water quality parameters should be sampled weekly.

Site locations

Experimental sites for nutrient effects water quality monitoring need to be located outside designated exclusion zones (e.g. mixing zone) but within the area of potential influence. The spatial distribution of these sites should reflect the *threat* to the environment (i.e. probability of exceedences), conservation *value* (e.g. presence of endemic species) and the *vulnerability* of the environment (i.e. ecosystem resilience). In the case of a wastewater outfall the monitoring sites should generally be located in a pattern that radiates away from the outfall, both *upstream* and *downstream*, and/or adjacent to sites of high conservation value or ecological importance.

Control sites need to be local sites, that are biologically representative of the monitoring sites and protected from the direct and indirect effects of human activity (i.e. Sanctuary Zones).

Recommendation
Locate monitoring sites according to a threat-value-vulnerability model.

Establish long-term monitoring control sites within Sanctuary Zones.

Methods
The results of a water quality monitoring programme should provide an accurate representation of the entire water column. Integrated or stratified sampling of the water column reduces the sample bias that can be introduced into samples by factors such as surface algal blooms (e.g. Trichodesmium *sp*.) or benthic microalgae.

Recommendation
Nutrient effects water quality monitoring programmes should use integrated samples of the water column.

2.2 Toxic contaminants

The Cape Peron and Beenyup Wastewater Outfalls are by far the largest potential source of toxic contaminants into the Shoalwater Islands and Marmion Marine Parks. The Water Corporation periodically undertakes surveys of contaminant concentrations in the sediment, indicator species (e.g. sentinel mussels) and other important commercial and recreational species (e.g. Western Rock Lobster) in the area of influence around these outfalls as part of the Water Corporations *Metals and Pesticides Monitoring Programme* (Water Corporation, 1996a,b).

Recent baseline surveys of heavy metals and organic pollutants in mussels and sediments conducted in the southern metropolitan coastal waters of Perth, including the Shoalwater Islands Marine Park, by the Department of Environmental Protection provided a comprehensive quantitative baseline of toxic contamination in these waters (Burt and Scrimshaw, 1993, Burt and Ebell, 1995, Burt *et al*., 1995c). These surveys indicated that stormwater and municipal drains and boat harbours can also be significant sources of toxic contaminants.

By contast, in the Marmion Marine Park, there is currently no broadscale baseline information of the mineralogical or chemical status of the sediments or biota. Past monitoring programmes of toxic contaminants in these waters have focused on the Beenyup Ocean Outfall however other potential sources of contaminants include stormwater (e.g. Carine Main drain) and municipal drains, and the Hillary's and Ocean Reef Boat Harbours.

Recommendation
The Marine Conservation Branch should undertake a baseline survey to determine the mineralogical and chemical (i.e. heavy metals and organic pollutants) status of the marine sediments in the Marmion Marine Park (see Appendix I).

3 CONCLUSIONS

The principle threat to the environmental values of the Shoalwater Islands and Marmion Marine Parks is the discharge of domestic wastewater from the Beenyup and Cape Peron ocean outfalls. In January 1996, the Water Corporation commenced a five-year ocean outlet monitoring programme focusing on nutrient effects water quality and biological monitoring, and toxic contamination, for the three metropolitan ocean outfalls. A preliminary assessment suggests that in the short-term the Water Corporation's monitoring programme will provide CALM with the information necessary to ensure the environmental values of Perth's metropolitan marine parks are protected and maintained. In the longer-term however the Marine Conservation Branch should ensure a more detailed review of all monitoring requirements, including marine wildlife, is undertaken for the Shoalwater Islands and Marmion Marine Parks. The review needs to identify and quantify the key processes threatening the environmental values of these waters and link the monitoring, auditing and licensing requirements to these processes. This review is particularly important for the Shoalwater Islands Marine Park given the possible inclusion of the Cape Peron Ocean Outfall into the marine park.

Prior to the commencement of a detailed review of the monitoring requirements for the two metropolitan marine parks the Marine Conservation Branch needs to provide a position paper broadly outlining CALM's philosophical and technical approach to managing Western Australia's marine waters. This paper would provide the overall environmental framework and context for all of CALM's marine functions including policy, research and monitoring.

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Appendix I

Brief outline for a comprehensive baseline survey of the mineralogy, and toxic contamination of the marine sediments and biota, of the Marmion Marine Park.

Mineralogy

Background
A thorough knowledge of the mineralogy of marine sediments is generally necessary to interpret sediment contaminant and infaunal distributions and to understand ecological processes such as sediment oxygen flux.

Objective
- to provide baseline information of the mineralogical status of the marine sediments in the Marmion Marine Park

Timing
Summer (December-February)

Parameters
redox potential (pH & Eh), grain size (1.00mm, 0.60mm, 0.15mm, 0.38mm, <0.38mm), sediment composition (organic, carbonate and refractory content), major ions (strontium, magnesium, sulphur and calcium).

Methods
Analyses conducted on a scoop sample (approximately 1kg) of surficial sediment (top 20mm) collected at approximately 100 sites throughout the Marmion Marine Park.

For comparative purposes the methodologies used for this study should be the same or compatible with the analytical techniques used in the baseline surveys of organic pollutants conducted by the Department of Environmental Protection in 1991 and 1994 as part of the Southern Metropolitan Coastal Waters Study (DEP, 1996).

Technical details on analytical methodologies and quality assurance protocols can be found in Burt and Ebell (1995) and Burt *et al.* (1995c).

Contaminants in sediments

Background
Marine sediments act as long-term integrators of contaminant inputs to coastal waters, particularly in sheltered depositional environments such as embayments and lagoons where sediments are relatively undisturbed by water movement from waves and currents. The re-suspension of contaminated sediments may also act as a source of contaminants to water and biota long after the cause of the initial contamination has ceased.

Objectives
- provide a quantitative baseline of the chemical status of the marine sediments in the MMP for future reference;
- identify areas of highest contamination;
- determine areas of significant contamination where contaminant concentrations exceed sediment quality criteria for the maintenance of Environmental Quality Objectives.
-

Timing
Summer (December-February)

Parameters
Heavy metals: Al, As, Cd, Cr, Cu, Fe, Hg (total), Mn, Ni, Pb, Zn

Pesticides
organochlorine (OCs): aldrin, dieldrin, alpha and beta chlordane, oxychlordane, heptachlor epoxide, HCB, lindane, p-p'DDE, p-pDDD, o-p and p-p'DDT.
organophosphate (OPs): chlorpyrifos, fenitrothion, maldison (malathion).

Polychlorinated biphenyls (PCBs): Arochlor1254 (most commonly used PCB)

Organotin compounds: monobutyltin (MBT), dibutyltin (DBT), tributyltin (TBT)

Hydrocarbons
aliphatic hydrocarbons: C9 - C25
polycyclic aromatic hydrocarbons (PAHs): naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, ,benzo(a,h)anthracene, total.

Methods
Analyses conducted on core samples of surficial sediment (top 20mm) collected at approximately 100 sites throughout the Marmion Marine Park.

For comparative purposes the methodologies used for this study should be the same or compatible with the analytical techniques used in the baseline surveys of organic pollutants conducted by the Department of Environmental Protection in 1991 and 1994 as part of the Southern Metropolitan Coastal Waters Study (DEP, 1996).

Technical details on analytical methodologies and quality assurance protocols can be found in Burt and Ebell (1995) and Burt *et al.* (1995c).

Contaminants in biota
Background
Filter feeders such as mussels bioaccumulate contaminants that occur in seawater, and therefore contaminant concentrations in their tissue provide an integrated measure of the concentrations of these substances in the water column; an indication of the concentrations of these substances entering the food chain; and the level of risk to human health associated with the consumption of seafood.

The Water Corporations monitoring programme for toxic contaminants in biota including the blue mussel *Mytilus edulis* would satisfy CALM's short-term monitoring requirements for the Marmion Marine Park providing the details listed below were included. In the longer-term the adequacy of this programme needs to be reviewed in the context of results from the above baseline survey of toxic contaminants in sediment.

Timing
Annual survey during summer (December-February)

Parameters
Heavy metals: Al, As, Cd, Cr, Cu, Fe, Hg (total), Mn, Ni, Pb, Zn

Pesticides
organochlorine (OCs): aldrin, dieldrin, alpha and beta chlordane, oxychlordane, heptachlor epoxide, HCB, lindane, p-p'DDE, p-pDDD, o-p and p-p'DDT.
organophosphate (OPs): chlorpyrifos, fenitrothion, maldison (malathion).

Polychlorinated biphenyls (PCBs): Arochlor1254 (most commonly used PCB)

Organotin compounds **(*Thais orbita* only)**: monobutyltin (MBT), dibutyltin (DBT), tributyltin (TBT)

Hydrocarbons
aliphatic hydrocarbons: C9 - C25
polycyclic aromatic hydrocarbons (PAHs): naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, ,benzo(a,h)anthracene, total.

Methods
For comparative purposes the analytical methodologies should be the same or compatible with the techniques used in the baseline surveys of organic pollutants conducted by the Department of Environmental Protection in 1991 and 1994 as part of the Southern Metropolitan Coastal Waters Study (DEP, 1996). Technical details on analytical methodologies and quality assurance protocols can be found in Burt and Ebell (1995) and Burt *et al.* (1995c).

The NPNCA and CALM endorse the philosophical approach to waste management adopted by the Western Australian Environmental Protection Authority and the Department of Environmental Protection (EPA Bulletin). Following is a brief summary of the key points:-

- society produces waste and some of this waste will inevitably require disposal to the natural environment;
- any amount of waste entering the environment causes change, even if this alteration cannot be measured;
- between the state of no change (i.e. from natural variation) and the point just before the ecological integrity of the natural system begins to breakdown, there is a level of change in the natural environment, induced by human activity, that society is prepared to accept;
- maintenance of biodiversity, ecosystem integrity and intergenerational equity are fundamental attributes that should never be compromised;
- unacceptable change is defined in terms of measurable departures from clearly stated environmental quality objectives (EQOs).
- for each EQO specific Environmental Quality Criteria (EQCs) are determined.