Environmental Protection Authority

Guidance for the Assessment of Environmental Factors

(in accordance with the Environmental Protection Act 1986)

Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment

No. 29

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Western Australia

FOREWORD

The Environmental Protection Authority (EPA) is an independent statutory authority and is the key provider of independent environmental advice to Government.

The EPA's objectives are to protect the environment and to prevent, control and abate pollution and environmental harm. As a contribution towards achieving these objectives, the EPA develops Guidance Statements to assist the environmental impact assessment (EIA) of proposals.

This document is one in a series being issued by the EPA to assist proponents, consultants and the public generally to gain additional information about the EPA's thinking in relation to aspects of the EIA process. The series provides the basis for the EPA's evaluation of, and advice on, development proposals subject to EIA. The Guidance Statements are intended to assist proponents to achieve an environmentally acceptable proposal. Consistent with the notion of continuous environmental improvement and adaptive environmental management, the EPA expects proponents to take all reasonable and practicable measures to protect the environment and to view the requirements of this guidance as representing the minimum necessary to achieve an appropriate level of environmental protection.

In this Guidance Statement, the EPA has provided a set of principles to be applied by proponents and the EPA when considering development proposals that may result in removal or destruction of, or damage to, marine benthic primary producer communities or the habitats which support them. The EPA uses the term Benthic Primary Producer Habitat (BPPH) throughout this Guidance Statement to mean the ecological units that are BPPH including the dominant BPP communities they support, except where specific examples require communities and the habitats that support them to be treated separately to clarify the intent of this Guidance Statement. The EPA has also defined six categories of marine ecosystem protection and provided guidance on the amount of BPPH that may be lost due to development as a percentage of BPPH within a defined management unit for each category. These percentages are termed 'cumulative loss thresholds' that, if exceeded, will be used by the EPA as indicative of potential non-acceptability. However, given the difficulty of reliable measurement of the area of some BPPH, and considering the difficulty of quantifying the ecological significance of their loss, these thresholds will not be used as rigid limits. The acceptability of BPPH damage/loss will in all cases be a judgement of the EPA based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were allowed to be implemented. This will be a key focus of any assessment by the EPA where there is potential for direct or indirect loss of BPPH.

The EPA has identified the following principles that will apply to proposals which, if implemented, would cause damage/loss of BPPH (in order of priority):

1. All proponents should demonstrate consideration of options (e.g. project design) to avoid damage/loss of BPPH.
2. Where avoidance of BPPH is not possible, then design should aim to minimise damage/loss of BPPH and proponents will be required to justify the need for damage/loss of that area of BPPH.

3. Proponents will need to demonstrate 'best practicable' design, construction methods and environmental management aimed at minimising further damage/loss of BPPH through indirect impacts.

4. The EPA's judgement on environmental acceptability with respect to damage/loss of BPPH and the risk to ecosystem integrity will be based primarily on its consideration of the proponent's calculations of cumulative loss of BPPH within a defined management unit (including best, most probable and worst case scenarios), together with supporting ecological information, and expert advice, as required.

5. Where substantial cumulative losses of BPPH have already occurred, proponents should consider some form of environmental offset for the additional damage/loss of BPPH and/or their associated BPP communities within the management unit.

6. Proposals which, in the judgement of the EPA, pose a substantial risk to ecosystem integrity within a management unit will be presumed to be unacceptable.

The six categories of marine ecosystem protection and their corresponding cumulative loss thresholds are summarised in the table below.

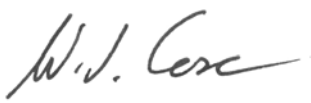
Cumulative loss thresholds for BPPH within defined management units for six categories of marine ecosystem protection that will be applied only after proponents can demonstrate to the EPA that all options to avoid/minimise damage/loss of BPPH have been considered.

Category	Description	Cumulative loss threshold *(percentage of original BPPH within a defined management unit)*
A	Extremely special areas	0%
B	High protection areas other than above	1%
C	Other designated areas	2%
D	Non-designated area	5%
E	Development areas	10%
F	Areas where cumulative loss thresholds have been significantly exceeded	0% net damage/loss (+Offsets)

Finally, the EPA has provided guidance on the methodology, by way of instructions and worked examples, to be adopted by proponents to determine cumulative loss of BPPH.

The Guidance Statement has the status of '**Final**' which means it has been reviewed by stakeholders and the public. The EPA has signed off the Guidance Statement as an expression of its current thinking on loss of BPPH as a *relevant environmental factor* in the EIA process.

I am pleased to release this document which now supersedes various draft versions.



Walter Cox
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8 JUNE 2004

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Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment

Key Words: coastal waters, marine habitat, primary producer, benthic, communities, coral reefs, mangroves, seagrass meadows, algal reefs, limits of acceptable change, cumulative loss thresholds, ecosystem integrity.

1 PURPOSE

Guidance Statements are developed by the Environmental Protection Authority (EPA) to provide non-statutory advice to proponents, consultants and the public generally about the minimum requirements for environmental management which the EPA would expect to be met by proposals it considers during the environmental impact assessment (EIA) process. The generic process within which Guidance Statements are prepared is shown in Appendix 1.

The EPA expects that proponents will give full attention to the information provided in this Guidance Statement when preparing documentation for the EIA process. Proponents should be mindful of this guidance at the earliest possible stage in the design of proposals and are encouraged to discuss the use of this Guidance Statement with staff of the EPA Service Unit.

This Guidance Statement provides overarching guidance for EIA under Part IV of the *Environmental Protection Act 1986* (EP Act) with respect to the protection of Benthic Primary Producer Habitats (BPPH) in Western Australia's marine environment. This Guidance Statement sets out:

(a) the guiding principles that the EPA will adopt when it considers proposals that may cause loss of marine BPPH and thereby potentially affect ecosystem integrity; and

(b) a risk-based framework that considers cumulative impacts and the ecological, conservation and social values of the marine environment to support the EPA's overarching environmental objective in respect of BPPHs, which is to maintain the integrity and biodiversity of the marine ecosystems of Western Australia while recognising current and projected uses.

2 OBJECTIVE

The objectives of this Guidance Statement are to:

(a) protect the environment as defined by the EP Act with a focus on State coastal waters in the context of activities which may directly or indirectly cause the loss of key BPPHs;

(b) express to development proponents who have proposals subject to EIA, and the general public, the EPA's contemporary thinking on activities which may directly or indirectly cause the loss of BPPHs; and

(c) provide guidance for the protection and maintenance of ecosystem integrity by applying a risk-based environmental protection framework which includes quantitative cumulative loss thresholds and which is linked to the ecological, conservation and social values of the environment to assist the EPA approach EIA of proposals impacting BPPH in a consistent manner.

3 PREAMBLE

3.1 Introduction

The State Government has recently released a *State Sustainability Strategy* (Government of WA 2003). The Strategy defines Sustainability as "…meeting the needs of current and future generations through an integration of environmental protection, social advancement and economic prosperity". The environmental advice provided to the Government by the EPA will contribute to Government's commitment to sustainability. Consistent with the *State Sustainability Strategy*, this Guidance Statement has been developed to help protect ecological integrity and the dependent biodiversity of our coastal waters and, in that way, it is fundamental to meeting the challenge of sustainable use of WA's marine environment.

Western Australia has over 12,000 km of coastline extending from the cool-temperate waters off the south coast through to the warm-tropical waters off the Kimberley coast. The characteristic marine biological communities and ecosystems differ considerably along this coastline. In temperate waters, the hard-substrate reef communities are characterised by kelps and other attached macroalgae (i.e. seaweeds), and seagrass meadows dominated by perennial temperate species occur in sandy sheltered embayments and coastal lagoons. Progressing northward, corals become more common on the reefs and tropical species of seagrasses occur on sand and mud substrata. Further north, mangrove communities inhabit some muddy tidal flats and creek banks, and coral reefs and algal-covered shoals are predominant in the clearer offshore waters.

For the purpose of this Guidance Statement, key definitions are as follows.

Benthic Primary Producers (BPP) are predominantly marine plants (e.g. seagrasses, mangroves, seaweeds and turf algae) but include invertebrates such as scleractinian corals, which acquire a significant proportion of their energy from symbiotic microalgae that live in coral polyps. These organisms grow attached to the seabed (i.e. subtidal and intertidal), sequester carbon from surrounding seawater or air and convert it to organic compounds through photosynthesis.

Benthic Primary Producer communities (BPP communities) are biological communities, including the plants and animals within which the benthic primary producers defined above predominate.

Benthic Primary Producer Habitats (BPPH) are both the BPP communities described above as well as the substrata that can/do support these communities.

This Guidance Statement specifically applies to development proposals that may result in removal or destruction of, or damage to, the BPPHs defined above.

Examples of BPPHs include coral reefs, dense and patchy seagrass meadows, mangrove forests, intertidal mud flats and seabed where macroalgal, coral or seagrass communities have grown and could grow. Examples of BPPH and their associated communities are shown conceptually in Figure 1.

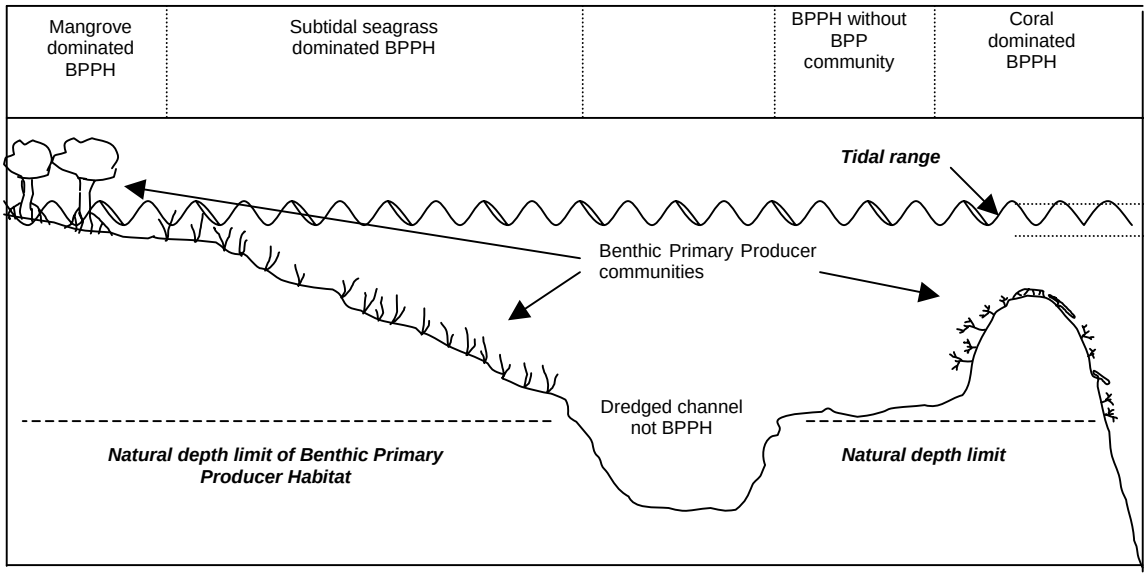

Figure 1: A conceptual diagram of BPPH and their associated BPP communities. The dashed line represents the natural depth limit of BPP.

There has been debate about the need for the EPA to protect BPPH that *can* and *do* support BPP communities in this Guidance Statement. Debate has focused around the relative ecological values of vegetated and unvegetated BPPH and how the protection of these BPPHs should be treated in the Guidance Statement. The EPA believes it is important to retain opportunities for re-establishment of BPP communities onto BPPH that *can* support these communities. The importance of protecting both vegetated and unvegetated BPPH can be explained by way of a common terrestrial example. If a natural catastrophic event such as a wild fire burnt a large area of sand plain heath in the Midwest of WA, the EPA would not consider that the burnt area has significantly lower value than nearby unburnt areas. This is mainly because we know there is a strong probability that the burnt heathland habitat will begin natural recovery within a short period after the fire.

An equivalent example in the marine environment would be the protection of ephemeral seagrass habitat that is currently unvegetated due to the effects of a storm where it is known that the seagrass community could become re-established on the currently 'bare' substratum. These examples call attention to 'recovery potential' and its relevance to considerations of loss of BPPH.

Nevertheless, it is recognised that not all benthos in the photic zone is BPPH. For example not all sandy banks can or do support seagrass and not all intertidal mud flats in the northwest can or do support mangroves.

Other benthic habitats such as those dominated by unattached microalgae (e.g. microphytobenthos) and sessile animals that have light-requiring organisms associated with them (e.g. soft corals, sponges and ascidians) are recognised as being important but the loss of or damage to these habitats would be treated separately in the EIA process. Due to the limited knowledge of these organisms and their role in maintaining ecosystem integrity, they are not addressed in this Guidance Statement. Their inclusion in the Guidance Statement will be reconsidered when the document is reviewed[1] and more ecological information is available.

The effects of excessive loss of key BPPH can be likened to the effects of excessive clearing of native vegetation and damage to its habitat in the terrestrial environment, in that native vegetation and the biophysical conditions within which it grows can be considered to be terrestrial primary producer habitat. Much time and effort has been expended in gaining general acceptance that the capability of large areas of the wheat belt ecosystems to support and maintain key ecological processes and biodiversity has been compromised due to salinity and water balance problems that have resulted from too much clearing of native vegetation. In the affected areas, 'ecosystem integrity' has been profoundly degraded, in part due to a lack of understanding of the key ecological processes and the long-term consequences for the landscape.

The EPA has defined *ecosystem integrity* as the capability of an ecosystem to support and maintain key ecological processes and organisms so that the species composition, diversity and functional organisations it supports are as comparable as possible to those occurring in natural habitats within the region (Government of WA 2004).

As pointed out above, on land, habitats have been dramatically changed to permit agriculture and other industries of value to the community. Of the many human uses of the marine environment (e.g. shipping, oil and gas exploration and production, fishing and aquaculture, eco-tourism and community uses such as recreational fishing, swimming and boating) most rely on the maintenance of healthy BPPHs and ecosystem integrity. In addition, the State's marine environment is a public asset that covers a very large area, of which only relatively small sections are actively managed or protected (e.g. marine conservation reserves, fish habitat protection areas).

Accordingly, the community expects the EPA to provide clear views about the protection of the environment, especially where the ecosystem structure and function is so important to BPPH and the reciprocal circumstance where BPPHs contribute to the maintenance of ecosystems themselves. In the sections that follow, the EPA provides further information about the

[1] *See Section 6.2*

ecological significance and values of BPPH, the current state of knowledge and the principles that the EPA has adopted for their protection.

3.2 The importance of benthic primary producer habitats

The Biodiversity Working Party (1991) concluded that the single biggest threat to the maintenance of ecological integrity is habitat destruction. This is because the plant and animal communities that contribute to the physical structure and biology of these habitats are central to the functioning of the ecosystem of which they are a part.

The ecological value and function of BPPHs can vary depending on factors such as species dominance and abundance, geographic location, seasonal/annual patterns of abundance, recovery potential, relative contributions of predominant organisms to the system's productivity, structural complexity and/or nutritional value. For example, the specific and localised *Halodule* sp. seagrass meadows in eastern Shark Bay are of great ecological importance as a food source for breeding aggregations of dugong during the non-winter months. The same species also occurs in areas outside the dugong's normal range. While *Halodule* has intrinsic value as a BPP throughout its distribution, it has special value in Shark Bay as a food source for a key ecosystem attribute, dugong, during a critical part of its life cycle and during a particular season. Similarly, while seagrasses such as *Halophila* and *Posidonia* also have intrinsic value as primary producers, the relatively low recovery potential and high structural complexity of BPPH dominated by *Posidonia* species are important factors to consider when assessing the relative value of these different seagrass-dominated BPPHs and the ecological implications of their loss.

Some important ecosystem services provided by BPPH include the provision of food (primary production), substrate and shelter, and physical stability of the seafloor and coastline. Key morphological, reproductive and functional attributes of seagrass and mangrove genera that occur in Western Australia are provided for information in Appendix 2.

3.2.1 Primary productivity

Through the process of photosynthesis, BPPs produce organic matter from carbon dioxide, water and nutrients, using sunlight for energy. This organic matter is then available to be consumed as food, either directly (e.g. some seagrasses are eaten by turtles and dugong, some reef algae are consumed by fish), or after it has been broken down into detritus, by bacteria and animals higher up the food chain. Some primary production from BPPHs may be exported and utilised by biota in adjacent habitats. BPPHs are generally highly productive and support diverse faunal and floral assemblages, though this can depend on the species that are dominant. Coral habitats, along with tropical rainforests, are thought to be the most diverse living systems in the world.

3.2.2 Substrate and shelter

BPPHs have a complex three-dimensional structure that provides substrata for the growth of sessile organisms (both plants and animals) and shelter for the juveniles and adults of mobile biota. They also support substratum-dwelling microbes and animals that feed on the organic matter produced and trapped within the BPPH. Coral reefs in particular provide substantial shelter when alive and their dead skeletons provide material for redistribution and consolidation into the reef framework as well as a substrate for the establishment of other BPP communities.

3.2.3 Physical stability

Benthic primary producer habitats can assist in stabilising soft subtidal and intertidal sediments and shorelines. Mangroves stabilise and protect coastal margins and reefs dissipate wave energy and protect inshore areas. Organisms that inhabit coral and algal-dominated reefs can consolidate rubble and other material produced within and/or deposited on these BPPHs.

The function and composition of these BPPHs will differ from place to place and for different ecosystem types. Accordingly, this Guidance Statement does not address the site-specific aspects of BPPH. Rather, it presents generic principles that the EPA will apply when assessing proposals which have the potential to cause loss of, and/or damage to, BPPH, either directly or indirectly by disturbing the ecological processes that sustain them.

4 ECOSYSTEM APPROACH

An ecosystem approach acknowledges the 'interconnectedness' of the physical, chemical and biological components of the marine environment and the various time and space scales over which 'connectivity' occurs. Issues such as cumulative impact, intergenerational equity and maintenance of biodiversity can only be addressed if management decisions take account of the interconnectedness of aquatic ecosystems and the temporal and spatial scales over which ecological processes occur. The EPA has applied the ecosystem approach in developing the principles and the risk-based environmental protection framework that underpins the EPA's thinking on damage/loss of BPPH in this Guidance Statement.

4.1 Management Units

Marine environmental managers are becoming increasingly aware that key issues such as ecosystem integrity, cumulative impact and biodiversity need to be addressed within a defined geographic area or 'management unit'. There is no accepted scientific method for determining ecosystem or management unit boundaries. However, an understanding of spatial hierarchies in natural systems and a recognition of the spatial scales of human impacts can assist in defining management units required to determine cumulative loss of BPPH using the guidance provided in this document.

The *Interim Marine and Coastal Regionalisation for Australia* (IMCRA) has been developed to provide a framework for planning sustainable resource use and biodiversity conservation in Australia and New Zealand (IMCRA Technical Group, 1997). While the present regionalisation of inshore waters is at the meso-scale (length scales of 100s-1000s km), the IMCRA proposes the need to consider and define smaller ecological units at the local or micro-scale (10s-100s km) and the site or pica-scale (<10 km), both to assist in developing a system of representative marine reserves and to assess the ecosystem impacts of marine use and development proposals.

In WA, the North West Shelf Joint Environmental Study (NWSJEMS 2002) has developed a hierarchical classification system for marine ecosystems of the North West Shelf (NWS). Regionalisation of the more structurally complex nearshore areas of the NWS was possible to a unit called a 'primary biotype'. The NWSJEMS (2002) identified 115 primary biotypes in the nearshore (i.e. within about 30 m depth) of the study area between Port Hedland and Exmouth.

For the purposes of considering the impact of habitat loss on ecological integrity, management units will need to be much smaller than the meso-scale 'bioregions' (and possibly even smaller

than the 'local'/micro-scale units) described in the IMCRA Technical Group (1997) document. A spatial hierarchy of human-marine interactions proposed by Edyvene (1996) during workshops associated with *Developing Australia's Representative System of Marine Protected Areas* (Thackway 1996) lends support to the use of 'local' scale management units. This hierarchy suggests that development activities causing habitat loss which are regularly considered by the EPA (e.g. reclamation, dredging and aquaculture) require management at local length scales of between 1-10s km. These distances fall within the pica (<10 km) and micro-scales (10-100s km) of the IMCRA hierarchy. Although the regionalisation products of IMCRA and NWSJEMS are currently too large for the purpose of defining a management unit, it may be possible to utilise future outcomes of the IMCRA and the NWSJEMS to refine the process for determining management unit boundaries.

In the interim, to provide clear guidance in relation to the delineation of management units, the EPA considers that a management unit would normally be approximately 50 km^2 (e.g. a rectangular area defined by a 10 km stretch of coastline extending 5 km offshore).

The EPA will consider larger or smaller management units if well justified. Cases for management units larger or smaller than proposed by the EPA should take into account aspects of marine ecosystems such as bathymetry and position of offshore reefs/islands, substrate type, water circulation patterns and biological attributes such as habitat types. It is recommended that wherever possible, other variables at finer levels of detail, such as the dispersal ranges of benthic primary producers, or of their dependent fauna, are considered in this determination.

Proponents are strongly encouraged to seek the advice of the EPA Service Unit on the appropriateness of the proposed management unit boundaries as early as possible in the design of proposals.

Proponents with proposals in existing or proposed marine conservation reserves should also consult the Department of Conservation and Land Management (CALM) at an early stage. The Department of Fisheries (DoF) should be consulted if the proposal is within or adjacent to areas managed by that Department.

4.2 Cumulative impact

Cumulative impacts are defined as the sum of all damage/loss of BPPH caused by human activities since European habitation of Western Australia (approximately 200 years Before Present) and do not include changes to BPPH caused by natural catastrophic disturbances such as severe storms. A critical element of the guidance is to express the cumulative impact as the percentage of the BPPH originally present before European habitation within the defined management unit. This highlights the importance of appropriately defining the extent of the management unit as described above.

There may be difficulties in quantifying all of the changes in the extent of BPPH. However, in many cases these should be able to be addressed to a level enabling the calculation of cumulative BPPH loss. As BPPs require light for photosynthesis, the guidance deals mostly with BPPHs in relatively clear and shallow (<20m) coastal waters. There are records (e.g. aerial photographic records) that can assist in determining gross change in the extent of BPPH over the last 50 or so years, that is, the period over which most impacts associated with human activity are likely to

have occurred. Proponents could maximise the utility of aerial photography by capturing images during periods of high water clarity. Information collected in relation to other development projects within a management unit (e.g. environmental review documents, environmental management plans, monitoring reports) may also help to establish the likely original extent of BPPH within a management unit and the cumulative losses that have occurred to date.

Similarly, knowledge of the biophysical conditions required to support various types of BPP communities has improved in recent years allowing surrogates, such as sediment type, degree of exposure to waves/currents and water depth, to help predict locations and estimate the original areas of BPPH within management units. For example, under certain circumstances, it is possible to predict with reasonable confidence that a given area is 'coral reef habitat' or 'seagrass habitat' based predominantly on its physical characteristics and geographic setting. With this type of information and knowledge of the biology of dominant BPP communities, it is possible to estimate the total area of each BPPH in a management unit, whether or not they support continuous cover of BPP communities. Proponents should also provide the EPA with a range BPPH loss scenarios (best, most probable and worst cases).

Given that research has shown that BPPHs dominated by long-lived temperate seagrass meadows are generally restricted to relatively shallow, low-energy environments with adequate light levels year round, it is extremely unlikely, at least over the last 200 years, that these BPPHs would have been present in high energy environments subject to ocean swells, or at water depths where light availability is below certain critical levels. The corollary to this is that it can be predicted with reasonable confidence that there will be a loss of these BPPHs, when human activity changes the substratum and associated environmental conditions such that an area of seabed is no longer BPPH. An example of this could occur where dredging has been, or will be, carried out to increase water depth resulting in light levels at the seabed that are not sufficient for the re-establishment and survival of BPP communities. Land reclamation also removes BPPH from a management unit. In this case, the dredged or reclaimed seabed can no longer be considered BPPH and the area must be included in calculations of cumulative loss of BPPH.

To ease the burden of data collection during the EIA process, operators of existing marine facilities that have, or are likely to have, plans for expansion in the future are encouraged to invest in strategic information gathering to inform cumulative loss calculations and best practice design of future proposals that would be referred to the EPA. For example, over a period of time, proponents could collect data on the current extent of BPPHs, any losses that have occurred and the reasons for those losses, as part of routine ongoing management of their existing facilities.

In the example above, dredging and land reclamation activities caused direct loss of both the substratum component of BPPH and the associated BPP communities. Development proposals also have the potential to cause indirect damage to BPPH (e.g. through shading, sedimentation) to the extent that only the BPP communities (e.g. seagrass meadows, coral communities) are lost and the substratum component of BPPH remains largely intact. Where there is a significant risk of both direct loss of BPPH and indirect damage to BPPHs to the extent that BPP communities are lost but the substratum remains largely intact, proponents should assess risk, predict the areal extent of direct and indirect damage/loss and include these areas in the calculation of cumulative loss as part of the EIA process (either in the referral, scoping or environmental review document). If losses of BPPH are predicted to occur beyond the boundary of the management unit and into an adjacent unit (this may occur as a result of indirect effects such as sediment

plumes from dredging etc), then proponents should make separate calculations of the cumulative losses of BPPH for each management unit.

The EPA will determine the adequacy of the proposed methodology through its consideration of a proponent's referral and/or scoping document. As a general rule, the level of understanding about the role and importance of BPPH for the maintenance of ecosystem integrity and the detail of survey work required will increase as the cumulative loss threshold is approached. The EPA's expectations regarding the level of knowledge that should be acquired by proponents about BPPHs in the management unit proposed to be impacted is shown conceptually in Figure 2. In most cases, however, an estimate based on interpretation of high quality, high resolution aerial photographs with a few days of ground truthing by underwater survey should be adequate.

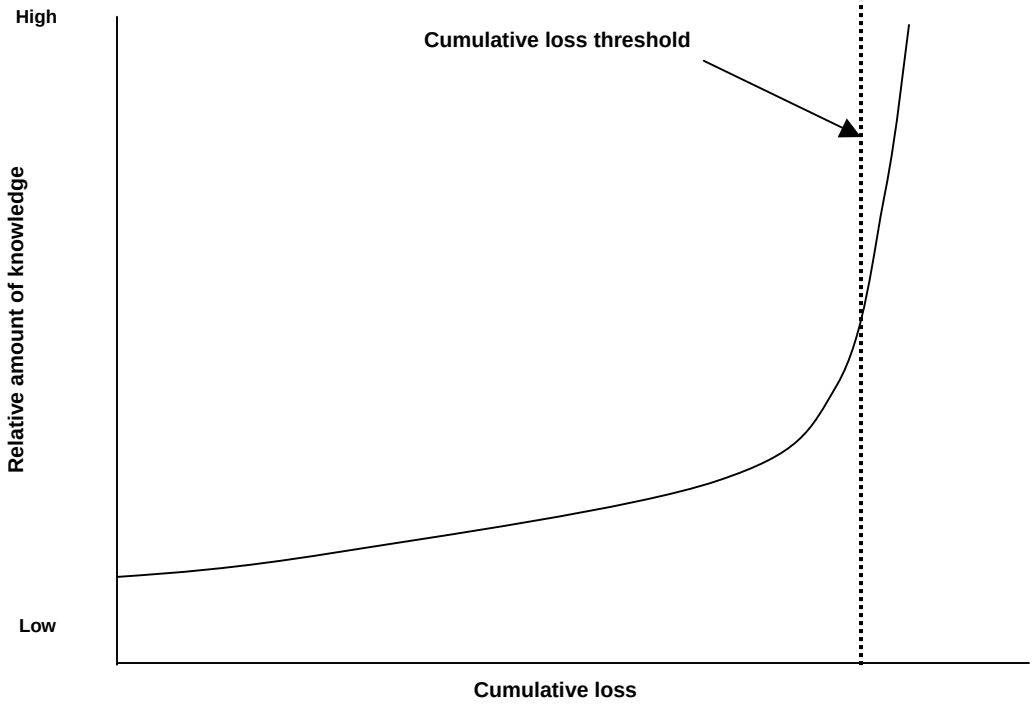

Figure 2: Conceptual representation of the EPA's expectations with regard to knowledge requirements.

4.3 Biodiversity

Biodiversity is a relevant factor in most environmental impact assessments carried out by the EPA. It is also a factor that is difficult to address, particularly in the marine environment where there is a paucity of information on species/assemblage distribution, with many remaining undescribed. From the little that is known, however, it is clear that BPPHs are areas of high biological diversity. Therefore, protecting ecosystem integrity, and primary producer habitats in particular, will contribute to the maintenance of biodiversity. Indeed, without ecosystem integrity, biodiversity conservation cannot be assured.

5. THE EPA'S GUIDANCE ON THE PROTECTION OF BPPH

5.1 Introduction

Although there is some guidance on the habitat requirements to protect fisheries and biodiversity, there is very little guidance available on the level of disturbance that pristine marine ecosystems can endure without ecosystem integrity being compromised in the long term. The 'Limits of Acceptable Change' concept is useful to environmental managers (Oliver 1995), and has been employed with some success to manage development impacts within the Great Barrier Reef. The concept has also been adopted by natural resource managers who have developed a best practice model for performance assessment in management of marine parks and reserves (ANZECC 1997).

Key components of a best practice model include:

- clearly stated management goals (desired outcomes); and
- performance indicators and targets against which to assess the degree to which goals have been achieved.

Adoption of a best practice model outlined above reflects a global trend by managers of marine natural resources to establish measurable targets for protection of these resources to ensure their sustainability in the long term (Kenchington 1990).

WA is fortunate, in comparison with many other parts of the world, in that it has a relatively pristine marine environment which is largely unmodified except in localised areas adjacent to population centres, and even there, most ecosystems are in a healthy condition. Therefore, we have the opportunity, and the responsibility to future generations, to set high aspirational targets for protection of key BPPH. The EPA considers that such targets should vary depending on the designated use of a water body, the current condition and abundance of the BPPH, and should aim to protect the 'jewels' of the marine conservation estate while allowing for environmentally responsible development elsewhere.

To implement this philosophy, the EPA developed a risk-based framework guided by a set of principles to be applied when considering development that may result in the damage/loss of BPPH. The risk-based framework is underpinned by six categories of marine ecosystem protection and precautionary quantitative cumulative loss thresholds for BPPH within a defined management unit for each category. The cumulative loss thresholds will be used by the EPA as indicative of potential non-acceptability. However, given the difficulty in reliable measurement of the area of some BPPHs, and given the difficulty in determining the ecological significance of their loss, these thresholds will not be considered as rigid limits. The acceptability of BPPH damage/loss will, in all cases, be a judgement of the EPA, based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were to be implemented. In cases where proponents can demonstrate that a proposal, if implemented, would pose little or no risk to the ecosystem and is consistent with the primary use of an area determined by Government or a relevant statutory management body (e.g. Marine Parks and Reserves Authority), then the EPA may consider exceedance of a cumulative loss threshold to be acceptable. Conversely, if a proponent cannot demonstrate that the proposal, if implemented, would pose little or no risk to the ecosystem, or if the proposal is not consistent with the primary use of an area determined by Government or a statutory management body, then the EPA may

recommend against the proposal proceeding, even though the cumulative loss threshold would not have been exceeded.

The EPA also provides guidance on the methodology to be adopted by proponents to determine cumulative loss of BPPH within a defined management unit. Proponents and their consultants are advised to include in their Environmental Referral and/or Scoping documents:

- a suggested boundary for the management unit and justification for that boundary;
- a scope of survey works proposed to determine the current area of BPPH within that management unit; and
- the approach used to assess and quantify historical losses of BPPH within the management unit.

The effects of pollution, waste discharges and deposits on BPPH that are associated with ongoing operations of development projects will be considered and addressed through the EPA's Environmental Quality Management Framework which is outlined in *Perth's Coastal Waters, Environmental Values and Objectives* (EPA 2000) and presented in more detail in the EPA's (2002) *Revised Environmental Quality Criteria Reference Document (Cockburn Sound)* and its updates.

5.2 General principles of assessment

For its consideration of proposed development activities, the EPA has developed general principles aimed at protecting BPPH.

The EPA will give effect to this Guidance Statement by:

- implementing a set of general principles which provide guidance on the process for environmental impact assessment; and
- judging the acceptability of cumulative impacts in each category of marine ecosystem protection against the cumulative loss threshold set for each category and the risk to ecosystem integrity within the management unit in question.

The EPA expects the following hierarchy of principles to be addressed by all proponents and the EPA will apply these to its consideration of proposals that could cause damage/loss of BPPH:

1. All proponents should demonstrate consideration of options to avoid damage/loss of BPPH.
2. Where avoidance of BPPH is not possible, then design should aim to minimise damage/loss of BPPH and proponents will be required to justify the need for damage/loss of that area of BPPH.
3. Proponents will need to demonstrate 'best practicable' design, construction methods and environmental management aimed at minimising further damage/loss of BPPH through indirect impacts.
4. The EPA's judgement on environmental acceptability with respect to damage/loss of BPPH and the risk to ecosystem integrity will be based primarily on its consideration of the proponent's calculations of cumulative loss of BPPH within a defined management unit (including best, most probable and worst case scenarios), together with supporting ecological information, and expert advice, as required.

5. Where substantial cumulative losses of BPPH have already occurred, proponents should consider some form of environmental offset[#] (e.g. artificial reefs, seagrass transplants) for the additional damage/loss of BPPH and/or their associated BPP communities within the management unit.
6. Proposals which, in the judgement of the EPA, pose a substantial risk to ecosystem integrity within a management unit will be presumed to be unacceptable.

5.3 Guidance on categories of marine ecosystem protection and cumulative loss thresholds

Table 1 describes marine areas of the State in terms of six categories of marine ecosystem protection and sets out cumulative loss thresholds for each of these categories. The categories take into account statutory planning for regional development as well as the system of existing or planned marine reserves under the *Conservation and Land Management Act 1984* (CALM Act) and other legislation.

Table 1: Cumulative loss thresholds for BPPH within defined management units for six categories of marine ecosystem protection that will be applied only after proponents can demonstrate to the EPA that all options to avoid/minimise damage/loss of BPPH have been considered.

Category	Description	Cumulative loss threshold *(percentage of original BPPH within a defined management unit)*
A	Extremely special areas	0%
B	High protection areas other than above	1%
C	Other designated areas	2%
D	Non-designated area	5%
E	Development areas	10%
F	Areas where cumulative loss thresholds have been significantly exceeded	0% net damage/loss (+Offsets)

Category A: Extremely Special Areas

a) Area of Application[*]

- Marine Nature Reserves created under the provisions of the CALM Act;
- High protection zones in Marine Parks created under the provisions of the CALM Act (i.e. sanctuary zones, recreation zones and some special purpose zones);
- Some zones within Marine Management Areas as detailed in their Management Plans (i.e. some special conservation zones);
- Sanctuary zones in the Rottnest Island Reserve;

[#] *At the time this Guidance Statement was released, the EPA was preparing a Position Statement on environmental offsets to articulate its position on this matter. In the interim, the EPA will consider environmental offsets on a case-by-case basis.*

[*] *Proponents should seek advice from the relevant management agencies (e.g. CALM, DoF, Rottenest Island Authority) at an early stage where proposals are located in existing or proposed marine conservation reserves or other specially managed areas.*

- Some Fish Habitat Protection Areas (FHPA) created under the *Fish Resources Management Act 1994* and some special areas within FHPAs as defined in their Management Plans (e.g. Reef Observation Areas and 'no take' areas); and
- Other areas identified through a statutory process or by the EPA as having extremely high conservation or ecological significance or otherwise being extremely special.

b) Guidance

- No development activities should take place in these areas, nor should there be any development elsewhere that would cause direct or indirect damage/loss of BPPH or ecosystem integrity of these areas. (Cumulative Loss Threshold = no loss of BPPH)
- The EPA will give BPPH in these areas the highest degree of protection and as such proponents should be aware that, where development-related activity in these areas will cause the damage/loss of BPPH or pose a substantial risk to ecosystem integrity, the EPA will adopt a presumption against finding the proposals environmentally acceptable.

Category B: High Protection Areas other than the above

(a) Area of Application*

- Marine Park zones other than those in Category A above;
- Some zones within Marine Management Areas as detailed in their Management Plans (i.e. some special conservation zones);
- Waters of the Rottnest Island Reserve, other than those specified in Category A above;
- Other areas recommended for inclusion in WA's representative marine reserve system (i.e. 'Wilson' report areas, CALM 1994); and
- Other areas identified through the literature, by statutory processes or by the EPA as having a high conservation or ecological significance or otherwise being special.

(b) Guidance

- No development should take place that would adversely affect the ecosystem integrity of these areas.
- Minor damage/loss of BPPH and/or their associated BPP communities may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid damage/loss and/or where proposals are consistent with relevant management plans (e.g. an approved management plan for a marine reserve) or a use of the management unit that is consistent with a State Government decision. (Cumulative Loss Threshold = 1% loss of BPPH)
- The EPA expects a substantial justification for the proposal supported by technically defensible information demonstrating understanding of the ecological role and value of the BPPH in the local context. Using this understanding, the proponent would be expected to describe and evaluate the significance of potential impacts on ecosystem integrity.
- The acceptability of any damage/loss will be a judgement of the EPA.

* *Proponents should seek advice from the relevant management agencies (e.g. CALM, DoF, Rottnest Island Authority) at an early stage where proposals are located in existing or proposed marine conservation reserves or other specially managed areas.*

Category C: Other Designated Areas

a) Area of Application*

- All parts of Marine Management Areas other than those set out in Category A and Category B above;
- Areas as defined in FHPA Management Plans other than those set out in Category A above; and
- Areas identified either by the EPA or through the literature as having high conservation significance or otherwise being special, and where the land use has been designated for industrial or related purposes either by a State Government decision, a statutory planning process where environmental factors have been demonstrably addressed, or any other planning process which can be, or has been, referred to the EPA for assessment.

b) Guidance

- Development proposals should not cause significant direct or indirect loss of BPPH and/or their associated BPP communities, and the ecosystem integrity of the BPPH dependent ecosystems must be maintained.
- Limited damage/loss of BPPH and/or their associated BPP communities may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid damage/loss and/or where proposals are consistent with relevant management plans or a use of the management unit that is consistent with a State Government decision. (Cumulative Loss Threshold = 2% loss of BPPH)
- The proponent will need to demonstrate and commit to a 'best practice' approach to minimising impacts and demonstrate how ecosystem integrity, overall biological value and environmental quality of the area would be protected and maintained.
- The EPA expects proponents to develop and commit to the implementation of a comprehensive environmental management plan (including decommissioning) that has as its primary objective the long-term maintenance of ecosystem integrity.
- Proposals which can meet the above objectives and have applied the general principles outlined earlier in this document, may be considered by the EPA to be acceptable as long as the cumulative loss threshold would not be exceeded.
- Proposals which can be shown to be consistent with the guidance above and satisfy the general principles of assessment, but exceed the cumulative loss threshold will need to undergo detailed environmental impact assessment. The EPA will expect a substantial justification for the proposal, supported by technically defendable information demonstrating a significant understanding of the ecological role of the BPPH within that management unit. Using this understanding, the proponent would be expected to evaluate how any impacts might be manifested and the environmental significance of those impacts. In these cases, the acceptability of the proposal will be a judgement of the EPA.

* *Proponents should seek advice from the relevant management agencies (e.g. CALM, DoF, Rottnest Island Authority) at an early stage where proposals are located in existing or proposed marine conservation reserves or other specially managed areas.*

Category D: Non-Designated Areas

a) Area of Application

- Non-designated areas identified either by the EPA or through the literature as having conservation or ecological significance, and where the land use has not been designated for industrial or related purposes prior to the formulation of these policies. (e.g. the coast between Leeman and Dongara); and
- General coastal waters other than those in Categories A, B, C, E and F.

b) Guidance

- Limited damage/loss of BPPH and/or their associated BPP communities may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid damage/loss and/or where proposals are consistent with relevant management plans or a use of the management unit that is consistent with a State Government decision. (Cumulative Loss Threshold = 5% loss of BPPH)
- The EPA expects proponents to design proposals to minimise damage/loss and to develop and commit to the implementation of a comprehensive environmental management plan that provides a context for the development in relation to the management unit and the wider area, with an objective of protecting and maintaining ecosystem integrity.
- The acceptability of any damage/loss in these areas will be a judgement of the EPA.

Category E: Development Areas (e.g. inner port areas)

a) Area of Application

- Areas identified either by the EPA or through the literature as having moderate conservation or ecological significance, and where the land use has been designated for heavy industry, large coastal proposals or related purposes by a State Cabinet decision (e.g. inner port areas), a statutory planning process where environmental factors have been demonstrably addressed, or any other planning process which can be, or has been, referred to the EPA for assessment (e.g. proposals within a management unit focused on the inner Dampier Port, Oakajee Port proposal).

b) Guidance

- Moderate damage/loss of BPPH and/or their associated BPP communities may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid damage/loss and/or where proposals are consistent with relevant management plans or with a use of the management unit that is consistent with a State Government decision. (e.g. port expansions, dredged navigation channels, land reclamations and marinas). (Cumulative Loss Threshold = 10% loss of BPPH)
- The EPA expects the proponent to apply the general principles of assessment (see Section 5.2) and develop and commit to the implementation of a comprehensive environmental management plan with an objective of protecting and maintaining ecosystem integrity. The plan must provide the basis for the ongoing development of an understanding of the environmental impacts of the proposal in question in the context of existing and approved

development and minimising cumulative impacts on BPPH arising or predicted to arise from these developments.

- The acceptability of any damage/loss in these areas will be a judgement of the EPA.

Category F: Areas where cumulative loss thresholds have been significantly exceeded

a) Area of Application

- Degraded areas where a substantial proportion of BPPH has already been lost (e.g. Cockburn Sound, Albany Harbours), and where, in the judgement of the EPA, unacceptable damage/loss is likely to occur during the life of the proposed development as a result of direct loss (e.g. breakwaters, dredged channels or land reclamation) or indirect disturbance (e.g. eutrophication or siltation); and
- Category B, C, D, or E areas where, in the judgement of the EPA, the cumulative loss threshold has been significantly exceeded.

b) Guidance

- The EPA's environmental objective in these areas is to ensure no net loss of BPPH and where possible, to generate a net gain in the area of BPPH and/or their associated BPP communities. (Target = no net loss, and where possible, a net increase, of BPPH)
- The EPA will expect the proponent, who wishes to remove BPPH, to have applied the principles of this Guidance Statement and to have developed an adequate environmental offset package to counterbalance the further damage/loss of BPPH[#]. Environmental offsets aim to ensure that environmental impacts are counterbalanced by an improvement in environmental condition in another location, with a goal of meeting 'no net loss' and preferably achieving a 'net environmental benefit'. Primary offsets that aim to counterbalance the loss of BPPH may include replacement, using proven mitigation techniques, of habitat and/or the associated communities that would be lost as a result of the development (e.g. the creation of artificial reefs in cases where a natural reef would be lost). In addition, these primary offsets should be located within the management unit and be acceptable to the relevant management body and the EPA. After the proponent has addressed the practicality of primary offsets, the EPA may also consider secondary offsets, such as contribution by the proponent to enhance the management of a degraded area that would preferably result in a net improvement of environmental quality within the management unit. In addition, the proponent would be expected to monitor the effectiveness of any environmental offsets.
- The EPA expects a substantial justification for the proposal, supported by technically defendable information that demonstrates understanding of the ecological role and value of the BPPH within the local context. Using this understanding, the proponent would be expected to evaluate any impacts, and to determine the significance of those impacts on ecosystem integrity.

[#] *At the time this Guidance Statement was released, the EPA was preparing a Position Statement on environmental offsets to articulate its position on this matter. In the interim, the EPA will consider environmental offsets on a case-by-case basis.*

- The proponent will need to demonstrate and commit to a 'best practice' approach to minimising impacts and must ensure the maintenance of ecosystem integrity, overall biological value and environmental quality of the area.
- The EPA expects the proponent to develop and commit to the implementation of a comprehensive environmental management plan that has as its primary objective the long-term maintenance of ecosystem integrity.
- The acceptability of any impact in these areas will be a judgement of the EPA.

5.4 Guidance on the methodology for determining cumulative impact on BPPH

Cumulative impacts result from the combined effect of multiple activities within a defined geographic area over a period of time. Whilst the concept is relatively simple, assessment of cumulative impact is far from simple and is hampered by the conceptual problems of defining the key issues, specifying the appropriate spatial and temporal scales, and determining the numerous interactions and indirect effects (MacDonald 2000). However, that difficulty should not prevent a proponent and the EPA from attempting to assess the effects of cumulative impacts on marine ecosystems.

The sequence of actions listed below is offered as guidance by the EPA to facilitate the acquisition of appropriate information needed to assess the acceptability of cumulative loss (including historical losses) from any proposal which indicates a loss of BPPH.

- Assess and define, according to ecological principles, the areal extent of the management unit (ecosystem).
- Demonstrate how impacts have been avoided or, if avoidance is not possible or practicable, demonstrate how impacts have been minimised by best practice with respect to siting, design, construction and management, incorporating, where appropriate, ongoing improvement.
- Determine the total cumulative loss of each BPPH within the management unit, accounting for historical human-induced losses and losses resulting from the proposal in question but excluding any natural catastrophic losses.
- Seek a determination of the acceptability of the proposal according to the judgement of the EPA.

5.4.1 Generic guidance for determining cumulative impact on key benthic primary producer habitat

The following evaluation scheme should be applied for assessing the ecological implications of a proposal that may result in the direct or indirect loss of key BPPH.

An evaluation scheme to assess the environmental impact associated with a proposal which, if implemented, may result in direct removal or indirect loss of key ecosystem components is presented in Section 5.4.2 and a generalised decision scheme for applying this guidance is provided in Appendix 3. Worked examples of how the scheme should be applied are also presented in Section 5.4.4. The evaluation scheme is based on cumulative changes within a defined management unit and includes determining the areal extent of BPPH:

(i) prior to all human-induced disturbance;

(ii) existing at the time of the proposal; and
(iii) remaining after implementation of the proposal.

Steps 1-6 outlined below are designed to provide the information required to assess the proposal against the cumulative loss thresholds set out in Table 1.

5.4.2 *Evaluation scheme*

Steps in the acquisition of information required for assessment are:

1. **What is the 'management unit'?**
   Define an appropriate management unit boundary, taking into account key physical and biological ecosystem attributes such as bathymetry and position of offshore reefs/islands, water circulation patterns, habitat/substrate types and energy/material flows. A management unit is generally geomorphologically determined and the area will be of the order of 50 km^2.

2. **What is there now?**
   Determine the current areal extent of each of the BPPHs in the management unit. This can generally be achieved through analysis of suitable aerial photographs or remotely sensed data with an appropriate level of ground-truthing of habitat types.

3. **What was there originally? (Pre-existing conditions)**
   Establish a best estimate of the areal extent of each BPPH that existed (pre-existing conditions - conditions existing prior to European habitation) in the management unit to establish the baseline for cumulative impact assessment. This process may include assessing the areal extent of BPPH that is currently unvegetated by taking into account knowledge of habitat requirements as well as the knowledge gained through establishing the current areal extent of BPPH (in 2 above). This approach will be particularly useful where habitats are subject to episodic but severe natural disturbance (e.g. coral reefs in the Pilbara) or where the distribution is naturally dynamic and changes may be gradual but significant (e.g. *Posidonia coriacea* seagrass meadows on Success Bank).

4. **What percentage remains?**
   Express the current areal extent of each BPPH (considering areas that do, once did, or can support the dominant BPP communities) in the management unit (from 2 above), as a percentage of pre-existing conditions (from 3 above) and not including the current proposal.

5. **How much more will be lost?**
   Determine the area of each BPPH type in the management unit that would be directly and indirectly damaged/lost as a result of the proposal and express as a percentage of pre-existing conditions (from 3 above).

6. **How much would have been lost in total if project proceeds?**
   Re-determine the potential cumulative loss in areal extent of each BPPH in the management unit to include the direct and indirect impacts of the current proposal and express as a percentage of pre-existing conditions (from 3 above). Note that this is an additive approach and provides a way of viewing the proposal from a cumulative impact perspective.

5.4.3 *Evaluation against criteria*

In order to evaluate the proposal, the EPA will compare the predicted cumulative loss in the areal extent of each key BPPH in the management unit (from step 6 above) with the criteria in Table 1.

5.4.4 *Worked examples*

To assist in following the evaluation scheme above, three hypothetical proposals and how they may be considered in the context of this Guidance Statement are presented below. The calculations at each step of the evaluation scheme are also provided for example 1.

Example 1 – a proposal to cause loss of coral habitat

The proposed development is situated within a semi-circular bay with a 4 km radius, sheltered by a coral barrier reef approximately 4 km offshore measured at the shoreline in the centre of the bay. It is a Category E area. A port and an associated access channel were built in 1970, taking 89 ha of habitat. A second channel was dredged in 1983 to allow for port expansion, removing a further 13 ha. A sewage outfall caused the indirect loss of 58 ha. A proposal is presented in 1997 to develop a recreational marina which, if built, would cause the unavoidable loss (after evaluating alternatives) of 20 ha of habitat. Examples of the calculations required to determine cumulative loss of BPPH within the management unit are set out on page 20.

Two additional examples (2 and 3) are provided to show how the guidance would be applied to situations where historical losses of BPP communities and their habitat differ in spatial extents within the same management unit.

In both examples Cockburn Sound is the management unit. Within that management unit approximately 80% of the original seagrass meadows and approximately 7% of benthic habitat where seagrass once grew has been lost due to eutrophication and maritime infrastructure (shipping channels, harbours etc). The shallow sandy margins of the Sound less than 10 m deep are BPPH (seagrass habitat) for the purposes of the following two examples. In these examples, Cockburn Sound is considered to be a Development Area where the cumulative loss threshold is 10%.

Example 2 - a proposal to cause loss of seagrass

Given that 80% of the original seagrass is lost (i.e. significantly more loss than the cumulative loss threshold of 10%), any new proposal that would cause further loss of seagrass would be considered under Category F (0% + offsets). In this case, the EPA could only consider further losses if the proponent can demonstrate that the proposal would not adversely impact ecosystem integrity and that there would be a net gain in seagrass meadows as a result of the proposal's implementation.

Example 3 - a proposal to cause loss of BPPH where seagrass is not present

Remembering that approximately 7% of the BPPH has been lost, a new proposal that would result in further loss of BPPH that does not contain seagrass, would be considered under Category E because approximately 3% additional loss could be considered before the 10% cumulative loss threshold for Category E areas is reached.

Regardless of the environmental setting of a proposal, it is expected that the proponent will give attention to the underpinning principles of this Guidance Statement at the earliest possible stage of project design. Moreover, consistent with the conceptual model of 'cumulative loss' in relation to 'knowledge' (see Figure 2), the EPA would expect that where a CLT is being approached or exceeded, a proponent will provide the EPA with robust, scientifically defensible information upon which the EPA could judge whether further loss of BPPH would be acceptable. In the absence of adequate information, the EPA is likely to apply the precautionary principle.

Calculations for Example 1

Step 1: **What is the 'management unit'?**

The physical characteristics of the 'bay', the water circulation patterns and the distribution of benthic habitats provide a good basis to define the bay as the management unit. It has an area of approximately 25 km^2 or 250,000 ha.

Step 2: **What is there now?**

Aerial photographs are used to map the benthic habitats. Corals are dominant and 1,840 ha of coral habitat are estimated to occur in the management unit.

Step 3: **What was there originally?**

The management unit currently contains 1,840 ha of coral habitat, and some 160 ha has been lost previously, so the original habitat is estimated to have been 1,840 ha + 160 ha = 2,000 ha.

Step 4: **What percentage remains?**

The amount of coral habitat remaining, expressed as a percentage of the original habitat, is

$^{1840}/_{2000}$ x 100 = 92%

Step 5: **How much more will be lost?**

The additional amount of coral habitat that will be lost from the management unit, if the development proceeds, expressed as a percentage of the original habitat, is $^{20}/_{2000}$ x 100 = 1%

Step 6: **How much would be lost in total if project proceeds?**

The percentage remaining in the management unit, if the development proceeds, is 92% - 1% = 91%. Therefore, the cumulative percentage loss would be 100% - 91% = 9%.

Step 7: **Comparison with cumulative loss threshold.**

The total predicted cumulative loss is 9% and is within the cumulative loss threshold for category E areas.

6 APPLICATION

6.1 Area

This guidance applies to proposals within the marine waters of the state of Western Australia. Marine waters means that portion of the environment that is on the landward side of the territorial sea of Australia, as determined under Schedule 2 of the *Petroleum (Submerged Lands) Act 1967* (Commonwealth), and includes the intertidal zone bounded by the high water mark of the ocean, but does not include rivers and estuaries within the limits of the State.

This Guidance Statement complements the EPA's Guidance Statement No 1 *Protection of tropical arid zone mangroves along the Pilbara coast* (EPA 2001). Guidance Statement No. 1 sets out the EPA's guidance on the protection of mangroves along the Pilbara coast, having particular regard for the conservation significance of the mangrove systems in the region. For a

proposal with the potential to cause impacts in an area where there is overlap of the two Guidance Statements, the EPA will assess environmental acceptability in the context of guidance provided in both documents.

6.2 Duration and review

The guidance in this document may be changed by the EPA at any time without notice and will be reviewed within five years ensuring that consideration is given to any statutory processes which are affected by this guidance.

6.3 Limitations clause

This Guidance Statement has been prepared by the EPA to assist proponents and the public. While it represents the contemporary views of the EPA, each proposal which comes before the EPA for environmental impact assessment will be judged on its merits. Proponents who wish to deviate from the guidance provided in this document should, therefore, provide robust justification for the proposed departure.

In addition to the objective for BPPH, the EPA will also have objectives for other factors that may need to be considered during an assessment.

7 RESPONSIBILITIES

7.1 Environmental Protection Authority responsibilities

The EPA will apply this guidance in making decisions about whether or not to assess any proposal which could impact upon Benthic Primary Producer Habitat, and in any assessment of such proposals.

The EPA will recommend to the Minister for the Environment the imposition of the requirements in the guidance following EPA assessment of a proposal for which BPPH is a relevant factor.

7.2 Department of Environment responsibilities

The Department of Environment will assist the EPA in applying this guidance in environmental impact assessment and in the conduct of its own functions under the EP Act, giving due consideration to this guidance.

7.3 Proponent responsibilities

Where proponents demonstrate to the EPA that these guidance requirements are accountably and enforceably incorporated into proposals, the assessment of such proposals is likely to be facilitated.

8 DEFINITIONS

Algae	Group of single-celled, filamentous, or fleshy non-flowering aquatic plants.
Assemblage	Recognisable grouping or collection of individuals or organisms.
Bathymetry	The measurement of ocean depths to determine the sea floor topography.
Benthic	Living upon or in the sediment of the sea.
Biodiversity	The variety of all life forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form. It is often considered at three levels: genetic diversity, species diversity and ecosystem diversity.
Community	Ecologically, any naturally occurring group of different organisms sharing a particular habitat.
Direct loss	Activities causing immediate loss of BPPH. In the context of this Guidance Statement, direct losses relate primarily to human activities that have immediate consequences, such as the removal of habitat or communities from the ecosystem due to dredging or land reclamation.
Environmental Values	The particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health.
Ecosystem integrity	The capability of an ecosystem to support and maintain key ecological processes and organisms so that the species composition, diversity and functional organisations it supports are as comparable as possible to those occurring in natural habitats within the region
Ecosystem	Unit including a community of organisms, the physical and chemical environment of that community, and all the interactions among those organisms and between the organisms and their environment.
Habitat	The natural home of a plant or animal.

Indirect loss	Losses associated with far-field effects. In the context of this Guidance Statement, indirect losses relate to the effects of human activities that alter the suitability of habitats for growth and survival of benthic primary producers over varying time scales.
Intergenerational equity	Availability to future generations of at least the range of natural resources and opportunities available to the present generation.
Management unit	A specific geographical area which provides the most effective boundaries for management of cumulative environmental impacts on marine habitats.
Photic zone	The surface layers of the seas and oceans penetrated by light and inhabited by photosynthetic organisms.
Photosynthesis	A process, operating in chlorophyll containing plants, which uses solar energy to convert carbon dioxide and water into carbohydrate.
Primary producer(s)	Organisms (mainly green plants) which can manufacture organic substances (food) from simple inorganic substances.
Seagrass	Submerged flowering plants that occur mainly in shallow marine areas and estuaries.
Sedentary	Confined to one spot.
Species	Generally regarded as a group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not normally breed with members of another group.
Substrate	The layer immediately underneath something or to which it is attached.

9 ACKNOWLEDGEMENTS

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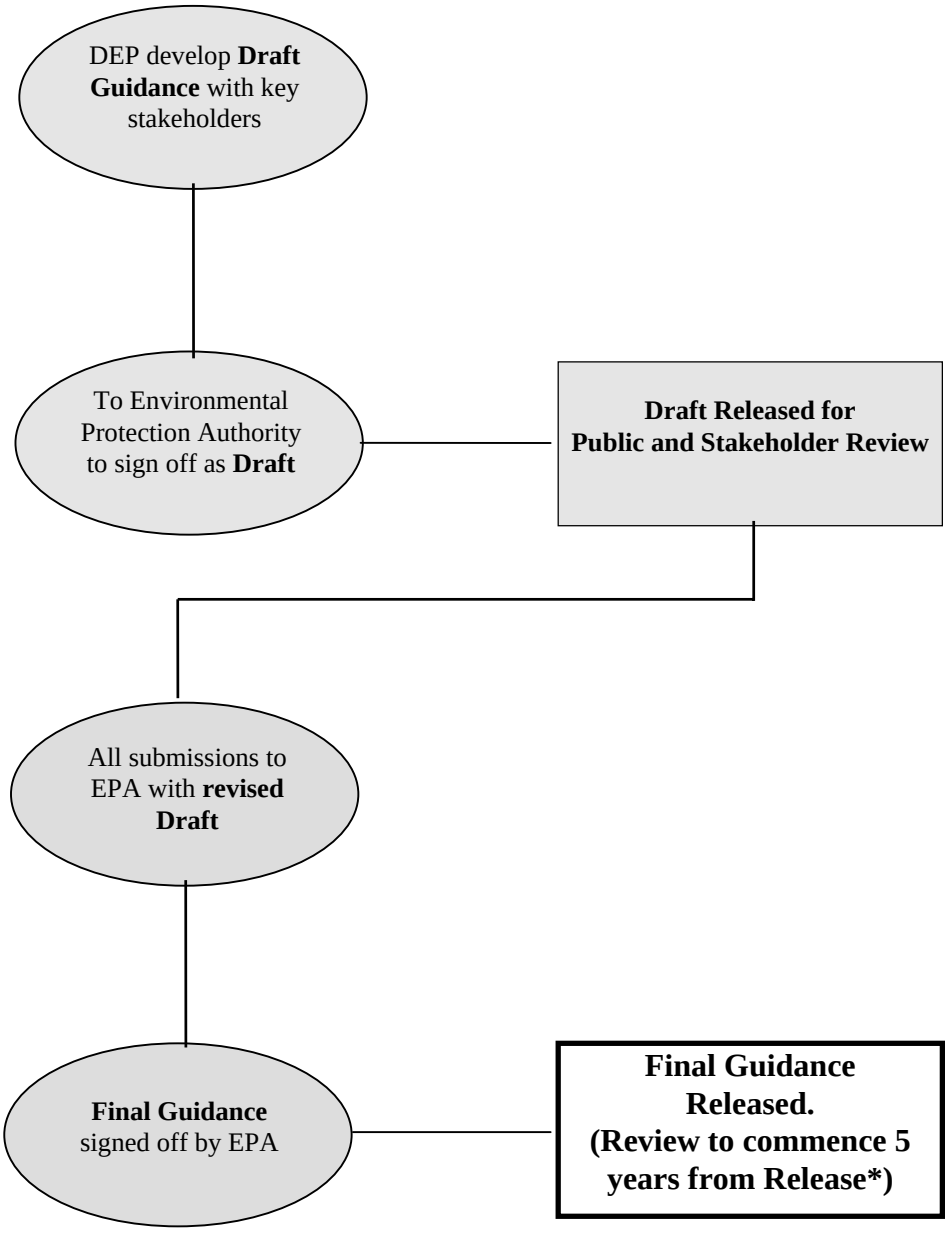
APPENDIX 1

Generic Flow Diagram for the Guidance Statement Process



* Guidance may be reviewed earlier if circumstances require it.

Appendix 2A

Morphological, reproductive and functional attributes of seagrass genera that occur in Western Australia

Genus	Season of propagule production	Seed dormancy	Position of leaf meristem	Rhizome elongation (cm/y)	Rhizome with dormant buds	Root penetration depth (cm)	Propagule Development period	Mature canopy height (cm)	Life form	Potential for seagrass replacement using restoration techniques	"Reversible" (R) or "Irreversible" (IR) impacts on basis of key seagrass features
Amphibolis	July-Nov	No, VS	Ap	20-50 (moderate?)	No?	0-3 (reef) 10-20 (sediment)	2-3 years (long)	40-100	P	Not fully tested: probably low to moderate	IR
Cymodocea	Jan-May	7-8 mths	I	160-260[1,2] (fast)	No?	?	?	7-15	P	Not fully tested: probably low to moderate	IR
Enhalus	All year?	No	I	?	?	10-20	?	30-150	P	Not tested	IR?
Halodule	Oct-Jan	3 years	I	292[4] (fast)	No	7-10 (shallow)	?	5-20	P	Relatively high based on overseas experience	R
Halophila	summer (temperate)	Yes?	Ap	70-335 (fast)	Yes	4-7 (shallow)	2-3 months	3-12	A/P (different species)	High based on overseas experience	R
Heterozostera	Seeds late summer; VP Jan-March	Yes?	I	100-200 (fast)	?	4-10 (shallow)	3-4 months	7-25	P	Not fully tested: probably moderate to high	R
Posidonia	Nov-Jan	No	I	2.6[3] -20 (slow)	Yes/No?	15-25 (P. coriacea deep)	4-6 years? (slow)	40-100	P	Not fully tested; low to moderate and with long timeframes for returns based on work with a Mediterranean species	IR
Syringodium	Feb-Mar in WA	?	I	38-200[4,5] (mod. - fast)	Yes	4-7	?	7-30	P	Relatively high from overseas experience	R
Thalassia	? in WA; July-Nov in Qld	No	I	36 - 117[2,6,7]	Yes?No?	?	?	10-40	P	Low with long time frames from overseas experience; analogous to Posidonia in Australia	IR
Thalassodendron	Oct-Dec?	No, VS	Ap	5-10 (slow)	Yes	0-3 (reef)	?	10-20	P	Not tested	IR
Zostera	Seeds: Aug-Dec	Yes	I	?	Possibly	5-10	3-4 months	2-50	A/P (different species)	Moderate to high in low energy settings overseas	R

Source note. Modified from Clarke & Kirkman (1989). Restoration potential is based on a recent review of the outcomes of restoration projects using different species (after Gordon 1996).
NOTE: Key over page.

Key to Appendix 2A

Ap: apical;
I: intercalary;
A: annual;
P: perennial;
VS: viviparous seedlings;
VP: vegetative propagules
?: unknown or incomplete information

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(7) Gallegos, M.E., Merino, M., Marba, N. and Duarte, C.M. (1993). Biomass and Dynamics of *Thalassia testudinum* in the Mexican Carribean : elucidating rhizome growth. *Marine Ecology Progress Series* **95**:185-192.

Appendix 2B

Morphological, reproductive and functional attributes of mangrove genera that occur in Western Australia. (Sources: Semeniuk et al. 1978; Saenger 1982; Semeniuk 1983; Tomlinson 1986; Gordon 1993).

Mangrove genus	Typical position along tidal gradient	Habit	Approx max. height (m)	Flowering period (WA)	Pollinating agent	Germination type and resulting propagule	Propagule production, mortality and dispersal	Coppicing ability and presence of stem sprouts	Root types and features	Susceptibility to windthrow and uprooting	Approx. upper salinity tolerated by mature stands (^{0}/00)	Salt shedding via salt glands on leaves	Leaf anatomy (protective hairs; and main position of stomata (leaf pores for vapour exchange)	Restoration potential byreplanting techniques	"Reversible" (R) or "Irreversible" (IR) on basis of key features
Avicennia	low through to high	ms, c, sp	15	Nov-Jan (north) Mar-Apr (south)	insects, (bees) birds	v sheds many bean-like precocious seedlings that are initially buoyant; note high propagule production observed in WA stands growing at chronic high salinity and aridity	high medium low	yes / yes	shallow, spreading cable roots; abundant pnematophores with lenticels; sometimes with aerial roots	no	90 (+)	Yes: with very high rates demonstrated at high salinity in arid regions in WA	Tomentose on underside of leaf; stomata mostly on underside	not yet fully tested or developed in WA; likely to be more difficult and slower at high salinity	R? Correct planting elevation, shelter, and sedimentary environment is critical
Aegiceras	low; some mid-tidal, interior of forest	c	1.5	May-Dec	insects (bees) birds	cv precocious seedling	medium low medium	no / no	surface or shallow, spreading cable roots	no	60-70?	yes	stomata mainly on underside	n.d.	n.d.
Aegialitis	low; mid-tidal; or areas flooded by spring tides	ms	1.5	Oct-Dec	insects birds	cv precocious seedling	high very low very low	no / no	surface or shallow, spreading cable roots	no	60-70?	yes; on upper surface	stomata mainly on underside of leaf	n.d.	n.d.
Rhizophora	low to medium	c	20	Apr-Aug	wind	v precocious seedling; hypocotyl slender to 30 cm ; drops and pierces sediment	high high high	no / no	numerous prop or stilt roots with underlying root mass; also aerial roots	yes	45-50	no	stomata mainly on underside of leaf	not fully tested or developed in WA; moderate to high success likely based on experience in tropical humid environments overseas	R? Shelter important; salinity shock detrimental;
Ceriops	low through to high	c	20	Sep-Dec	insects (moths)	v precocious seedling; hypocotyl to 30 cm drops and pierces sediment	medium medium medium	no / no	buttress roots at base of stems, straight or branched roots from trunk to underlying root mass; may be knee roots present	yes	85-90; often grows stunted at high salinity in landward zone	no; note high leaf salt content reported in stunted stands growing at high salinity in WA	stomata mainly on underside of leaf	see comments for Rhizophora; restoration potential higher for low tidal stands growing at lower salinity	R?
Bruguiera	low to mid	c, ms	15	May-Nov	insects birds	v precocious seedling; hypocotyl to 9 cm; drops and pierces sediment	medium ? ?	no / no	shallow radially spreading with knee roots ; may also have buttress roots, stilt rots and aerial roots	yes	45-50?	no	stomata mainly on underside of leaf	see comments for Rhizophora	R? Shelter important; salinity shock detrimental
Osbornia	low	ms, c	3	Dec-Feb	insects birds	non v 1-2 smal l seeds	low ? ?	no / no	surface cable roots	?	?	no	stomata on both sides of leaf	n.d.	n.d

Mangrove genus	**Typical position along tidal gradient**	**Habit**	**Approx max. height (m)**	**Flowering period (WA)**	**Pollinating agent**	**Germination type and resulting propagule**	**Propagule production, mortality and dispersal**	**Coppicing ability and presence of stem sprouts**	**Root types and features**	**Susceptibility to windthrow and uprooting**	**Approx. upper salinity tolerated by mature stands (^{0}/00)**	**Salt shedding via salt glands on leaves**	**Leaf anatomy (protective hairs; and main position of stomata (leaf pores for vapour exchange)**	**Restoration potential byreplanting techniques**	**"Reversible" (R) or "Irreversible" (IR) on basis of key features**
Lumnitzera	high	c	5		insects birds	non v solitary seed	high very low low	no / no	knee roots and stilt roots may occur	no	70?	no	stomata on both sides of leaf	n.d.	R?
Excoecaria	high	ms, c	6	Oct-Dec	wind	non v globular seeds; resting stage prior to germination	low ? ?	no	surface cable roots	yes	70?	no; milky latex occurs in all plant parts	stomata mainly on underside of leaf	n.d.	n.d.
Xylocarpus	usually high	c	20	June-Aug	insects birds	non v l8-16 large seeds; resting stage prior to germination	low ? ?	no	butttress roots with surface and shallow, radially-disposed roots with sinuous, plate-like pneumatophores	no	? can be associated with lower salinity in upstream river settings		stomata mainly on underside of leaf	n.d.	n.d.
Camptostemon	low-mid (high-water neap)	c	20	Nov-Dec	?	non v 2 small seeds	? ? ?	?	surface cable roots and buttress roots	yes	?		silvery glandular scales on underside of leaf, flower & fruit; stomata mainly on underside of leaf?	n.d.	n.d.
Sonneratia	low	c	12	June-Aug	bats insects	non v many large seeds	? ? ?	yes / ?	surface cable roots, shallow, radiating cable roots with stout peg like pneumatophores	yes	60-70?		stomata on both sides of leaf	n.d.	n.d.
Scyphiphora	high	c, sp	2	?	?	non v 4x 1-seeded cells	? ? ?	? / no	surface cable roots?	?	?		stomata mainly on underside of leaf?	n.d.	n.d.
Pemphis	low; strand plant	c	3	Apr	0.6	non v many seeds	? ? ?	? / no	?	?	?		?	n.d.	n.d.

c: columnar; ms: multi-stemmed; sp: spreading; v: viviparous; cv: cryptoviviparous n.d: no data.

APPENDIX 3

Pictorial decision scheme for applying the EPA's guidance.