ARTIFICIAL REEFS

With reference to marine parks and reserves

BACKGROUND PAPER

Prepared for the
Marine Parks and Reserves Authority

MPRA
MARINE PARKS & RESERVES AUTHORITY

and Department of Environment and Conservation

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Cover photograph (HMAS Swan Dive Wreck) kindly provided by Geoff Paynter.

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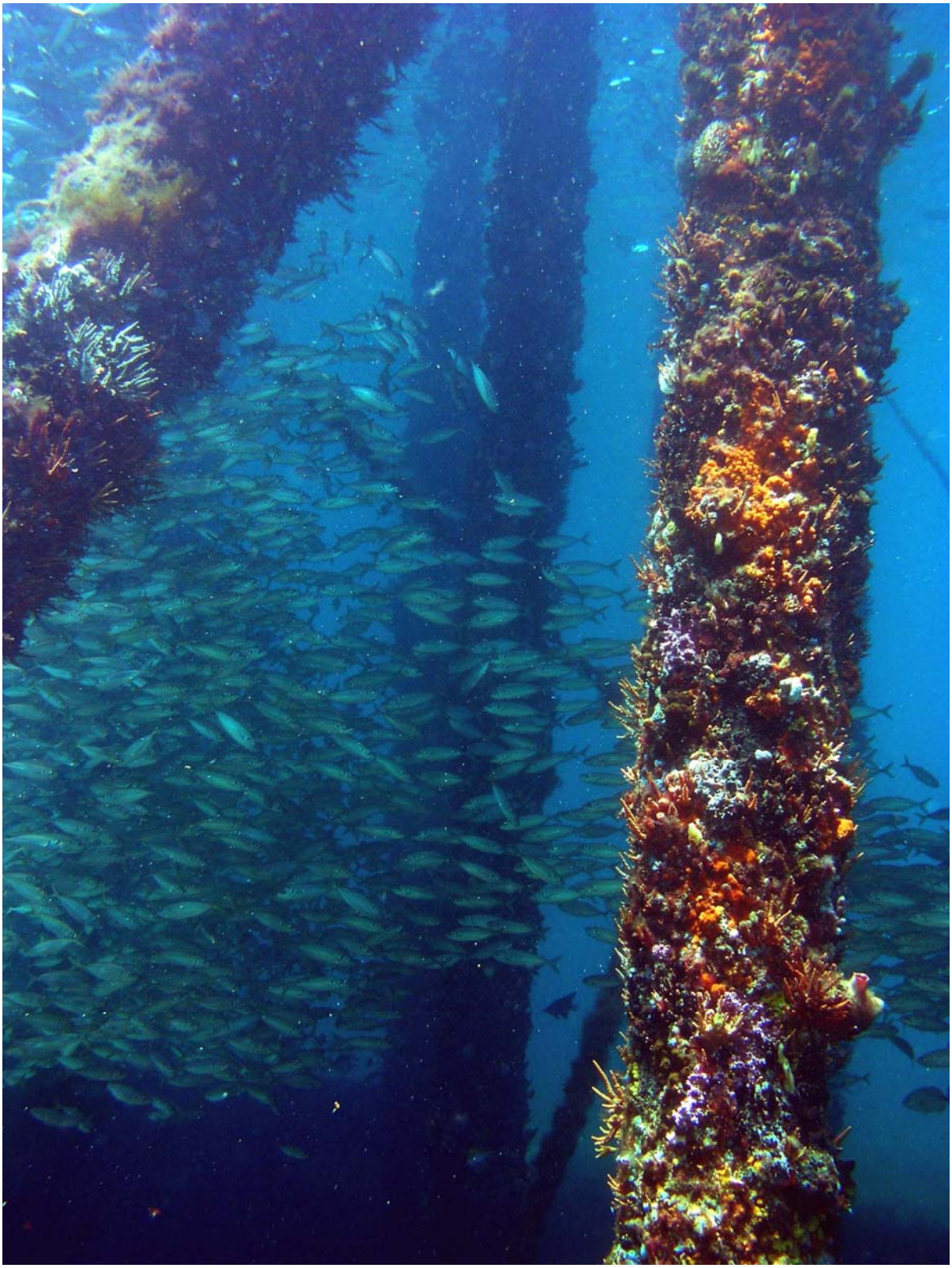


Busselton Jetty pylons
Photograph kindly provided by Peter MacDonald

Summary

Background
The Minister for the Environment has requested the Marine Parks and Reserves Authority (MPRA), in liaison with a ministerially appointed State Marine Policy Stakeholder Group (PSG), to provide advice in relation to the sinking of vessels as AR in the *West Coast Dive Park*, and marine parks and reserves in general.

Aim of this paper
The aim of this paper is to provide relevant information regarding artificial reefs (AR) so as to enhance discussions and inform decision-making.

Artificial Reef Definition
An AR is defined under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* as structures or formations placed on the seabed:

(a) for the purpose of increasing or concentrating populations of marine plants and animals; or
(b) for the purpose of being used in human recreational activities.

Artificial Reef Regulation
The Commonwealth Sea Dumping Act regulates the dumping of waste to Australian coastal waters. This Act is complemented in Western Australia by the WA Sea Dumping Act. The WA Act, while mirroring most of the Commonwealth Act, leaves the regulating of AR 'dumping' to the Commonwealth under the auspice of Department of Environment, Water, Heritage and the Arts (DEWHA) who may allow the deployment of AR under permit. Permits outline the conditions under which AR can be deployed and the level of monitoring required. Unfortunately, there are few instances where DEWHA permit conditions and monitoring requirements have related to ecological matters.

In Western Australia, proposals for AR deployment can be referred to the Environmental Protection Authority (EPA) to be assessed under the *Environmental Protection Act 1986* (EP Act). To date, there has not been a formal assessment of an AR proposal in Western Australia, nor have Ministerial conditions been provided.

In marine parks and reserves, the Department of Environment and Conservatoin (DEC) under the auspice of the MPRA and in keeping with the requirements of the *Conservation and Land Management Act 1984 (*CALM Act), may issue a commercial operations licence or lease agreement for an AR permitted under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* (Commonwealth Sea Dumping Act). A licence expresses the conditions placed on the use of an area by an operator.

It can be considered generally acceptable, within all parts of Australian waters, to dispose of benign waste or material (as listed in *Annex 1 of Article 4* of the *1996 Protocol for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972* (1996 Protocol)) to the marine environment upon the issue of a permit under the Commonwealth Sea Dumping Act – marine park or not.

Waste 'dressed' as Artificial Reef

There is a view that the disposal of vessels and similar structures is simply large scale, authorised dumping of 'waste' dressed as AR. However, literature suggests that work focusing on the re-use of materials as AR always attracts criticism from those convinced that a project is just an excuse for dumping waste in the marine environment and that AR habitat planning has not evolved beyond the availability of materials of opportunity.

Artificial Reefs – An Overview

An international review found that decisions regarding ARs were often made based on political expediency, absolute cost, materials readily available, navigational considerations, or solid waste disposal problems, without considering biological, economic or social effects. This review warned that the potential existed for major mistakes which could be difficult, if not impossible to correct.

Unfortunately few examples can be found where ARs are deployed purely for ecological benefit with no link to enhancement of fishing or tourism opportunity. The general view exists that ARs have tourism potential as diver attraction devices and are effective fish attractants and an important fishery management tool, particularly in ecologically damaged or low productivity marine environments.

By the early 1990s, Australia had a least 72 AR, most of which had been constructed from waste material. South Australia has the largest number of officially endorsed AR in Australia. However, recent research on the effects of ARs on fish populations has resulted in the South Australian government discouraging the construction of ARs in state waters. The Great Barrier Reef Marine Park Authority (GBRMPA) has developed guidelines for the management of ARs that could be described as onerous and would no doubt cause an applicant to be attentive to the costs versus benefits of an AR proposal.

In Western Australia, the *Cheynes III* was deliberately scuttled in King George Sound, Albany, in 1982/3. This was closely followed by the sinking of the *Miwok* off Rottnest in 1983. In 1993, the Department of Defence suggested the *HMAS Derwent* be gifted to Western Australia as a potential AR. It could be fair to say that the potential availability of the *HMAS Derwent* began a frenzy of activity in relation to the sinking of vessels of any type. However, the frenzy appears to have abated somewhat as the *Saxon Ranger* was the last vessel to be deliberately scuttled in Western Australia as an AR under the Commonwealth Sea Dumping Act.

Petroleum Platform Decommissioning

In the next few decades, many petroleum platforms located off Western Australia on the North West Shelf will become due for decommissioning. The Commonwealth Department of Resources, Energy and Tourism (DRET) has recently released a discussion paper which addresses the issues associated with decommissioning and presents options including use as an AR. It is expected cost will become a major criteria in determining decommissioning options. The use of petroleum platforms as AR has not occurred in Australia to date.

Artificial Reefs and the CALM Act

Under the CALM Act there are three types of marine reserve: marine park; marine management area; and marine nature reserve. While the CALM Act does not state it implicitly, it could be viewed that the deployment of ARs in marine parks and marine management areas may be an acceptable 'multiple-use' of the marine environment, similar to the placement of dive trail plinths or marine navigation infrastructure. However, the deployment of ARs to sanctuary zones or marine nature reserves is considered by some to be inconsistent with their statutory and intrinsic purpose to provide the highest level of protection for marine biodiversity. Section 13B of the CALM Act states the activities that shall not occur in a sanctuary zone and marine nature reserves, but not the overriding purpose of these areas. AR establishment is not specified as *not* being permitted.

The *Saxon Ranger* and a tyre AR exist within the Shoalwater Islands Marine Park (SIMP), the Busselton Jetty exists within the proposed Ngari Capes Marine Park and the *HMAS Swan Dive Wreck* lies encompassed by the proposed Eagle Bay Sanctuary Zone within this same marine park. All were in place prior to the marine parks being established and as such it could be concluded that AR exist within marine parks by default rather than intent.

Production versus Aggregation

A basic question revolves around the issue of whether ARs locally enhance sustainable production or just aggregate marine resources already present in an area. One fish tagging study revealed that in some case fishes moved up to 1.6km from natural reefs to ARs and some researchers have suggested that a separation of at least 600m is necessary to maintain the identity of natural reefs. While there are few conclusions for the production versus attraction debate, it may be necessary that an open mind be maintained to ensure yet unknown benefits and impacts can be fully explored.

Maritime Heritage

In Western Australia, a strong trend towards the use of contemporary steel vessels as AR has emerged over recent decades. These vessels may be expected to have a 'bottom-life' of up to or over 100 years with the sinkings presenting the Western Australian Maritime Museum (WAMM) with an opportunity to obtain biological, physico-chemical and corrosion data from time of 'wrecking'. These data will enable a better understanding of deterioration of historic shipwreck sites and assist in the development of appropriate *in situ* management strategies for underwater cultural heritage sites.

Research and Monitoring

There needs to be realisation that there is little understanding of the benefits or functions of natural reefs within or outside of marine protected areas, and that we have poor understanding of the relative importance of various processes in maintaining biodiversity. The general paucity of information and the relatively universal constraints on resource allocation for research and monitoring begs the question: could a marine management body justifiably shift resources from research and monitoring of a natural reef to research and monitoring of an AR, particularly in marine parks and reserves?

Liability
ARs can exist for a great length of time, perhaps beyond corporate or community memory or will. In the case of decommissioned naval vessels, the Commonwealth 'gifts' the ships to the State for disposal. The State may be represented by a corporate body, such as a local government or community group. The Commonwealth then has no further interest in the vessel, except in the issuing of a sea dumping permit. It could be construed that the issuer of the permit may retain some liability, particularly where the issuer does not appropriately monitor the permit holder's activities or reporting requirements. Legal opinion would be required to determine the level of liability if any the issuer of the permit has in this regard.

Consultation
Unfortunately, the level of consultation required for the issuing of sea dumping permits appears to have been relatively informal in Western Australia to date.

Inventory of AR in Western Australia
There is a need for Western Australia to prepare an inventory of ARs in coastal waters, inclusive of vessels and other materials.

Beneficial and Negative Impacts
Most deployments and studies of ARs have taken place in the context of degraded or overfished environments, where there is greater scope for beneficial outcomes. In contrast, the relatively healthy ecosystems of Western Australia may be vulnerable to negative impacts. A list of potential beneficial and negative impacts has been compiled with reference to as many points of view as possible.

Conclusions
The discussion of ARs is only just beginning to be seriously explored in Western Australia and has the potential to cause angst within the community if not appropriately and formally dealt with. It is necessary for marine managers, in particular, to participate in a proactive process to fully discuss the issues relevant to their areas of interest in regard to deployment of ARs and to determine a way forward. It may be necessary for the Western Australian State Government to discourage the placement of ARs in Western Australian coastal and inland waters until the State establishes a policy or legislated position on AR deployment. Agencies responsible for sea areas, such as the MPRA and Port Authorities, would ideally provide input to policy by establishing positions of their own.

1. Background

In 2000, the State Government announced a commitment to the development of the 279 square kilometre *West Coast Dive Park* (dive park) to promote dive wreck tourism in Rockingham, south of Perth. The dive park concept was driven by the City of Rockingham and in 2002 a dive park steering committee, comprising representatives from State and Local government, was formed to guide the project. To launch the dive park, a 400-tonne former fishing vessel, known as the *Saxon Ranger*, was scuttled in May 2005. The scuttling of a vessel for tourism purposes was considered to have significant economic and social benefit for marine tourism including dive charter operations and recreational diving. However, the deployment of the vessel within the Shoalwater Islands Marine Park (SIMP) was considered by some to be contrary to the purpose of a marine park, and marine conservation in general.

The Marine Parks and Reserves Authority (MPRA), as the vesting authority for marine parks and reserves, was briefed on the proposal to deploy the *Saxon Ranger* within the marine park (MPRA, 2005a). In short, the MPRA responded that while uncomfortable with the principle of sinking ships in a conservation reserve, it endorsed the project, in principle, subject to the resolution of tenure issues and noting that it was not in favour of the term 'Dive Park' (MPRA, 2005b). In hindsight, the MPRA was not in a strong position to provide a comprehensive response due to: the SIMP not having a statutory management plan; there being no precedent upon which to evaluate the proposal; and the MPRA having no policy position upon which to rely. As such the MPRA relied on the requirements of the *Environmental Protection Act 1986* (EP Act) and the Environmental Protection Authority (EPA) to determine a level of assessment and provide appropriate advice to the Minister for the Environment on the proposal. It also relied on the Department of Conservation and Land Management (CALM) to issue a licence for use of the site through the most appropriate process.

The EPA determined not to formally assess the proposal. Concern expressed by a non-government organisation over this decision resulted in an appeal being lodged under Section 100(1)(a) of the EP Act. This appeal was dismissed as the Appeals Convenor supported the EPA's judgment that a proposal of that scale was not likely to have a significant impact on the environmental values or ecosystem integrity of Warnbro Sound (Office of the Appeals Convenor, 2005). This decision-making process set a precedent for the assessment for sinking of vessels in the marine waters of Western Australia, regardless of the marine water's conservation status. However, the Appeals Convenor did suggest that the appeal raised 'valid issues with respect to the policy framework for these types of proposals, particularly within marine parks and reserves' and further suggested the EPA provide the Minister with advice in relation to the sinking of vessels in the West Coast Dive Park and marine parks and reserves in general' (Office of the Appeals Convenor, 2005). However, under Section 26B of the *Conservation and Land Management Act 1984* (CALM Act) the MPRA is responsible for preparing policy in relation to marine parks and reserves and as such the task of providing advice to the Minister has passed to them.

As a first response by the MPRA, the Shoalwater Islands Marine Park Management Plan (SIMP plan) was finalised (Department of Environment and Conservation (DEC), 2007) to include

strategies relating to the development of the West Coast Dive Park (Section 9.2.7[1]). The SIMP plan does not prohibit such proposals. It may also be interpreted that the wording in the strategies relating to dive wreck proposals may result in only dive wreck proposals that are likely to have a significant impact on the marine park being referred to the MPRA. Nevertheless, by including these strategies, the MPRA, as the vesting body for the marine park, now has a responsibility to determine a position upon which to base future advice should further deployment of dive wrecks be proposed in the SIMP.

While the gazettal of the SIMP plan provides some guidance for vessel sinking, other existing CALM Act marine parks and reserves, and marine areas of interest[2], do not have the same level of guidance. In addition, it should be acknowledged that dive wrecks are not the only form of artificial reef (AR) that exist or may be proposed for deployment in the marine environment of Western Australia in years to come and as such, the MPRA may need to consider a wider view of the deployment of ARs. For example, the acceleration of offshore resource extraction in the north- west of the State may give rise to proposals for decommissioned petroleum platforms to act as AR. This has become common place in the Gulf of Mexico where 1,879 platforms had been removed from the Gulf of Mexico up till 1999, 151 of which had been disposed of as AR (Department of Resources, Energy and Tourism (DRET), 2008).

The Western Australian Minister for the Environment has requested the MPRA work closely with, and receive advice through, a ministerially appointed State Marine Policy Stakeholder Group (PSG). It is the intention of the MPRA to provide advice, in liaison with the PSG, to the Minister for the Environment regarding the deployment of ARs in the marine environment, but with emphasis on marine parks and reserves.

2. Aim of this Background Paper

The aim of this paper is to present information relevant to AR deployment. It is intended that this information enhance discussions, assist in decision-making and lead to a considered response to the Minister for the Environment in relation to AR deployment in marine parks and reserves, and all of Western Australia's coastal waters.

3. Artificial Reef Definition

For the purposes of this paper, 'artificial reefs' are taken to mean structures or formations placed on the seabed:
(a) for the purpose of increasing or concentrating populations of marine plants and animals; or

[1] SIMP Plan strategies – 'Assess on a strict need and environmental impact basis any future proposals for development, exploration and the establishment of dive wrecks, and refer any proposals likely to significantly impact on the marine park's values to the MPRA and EPA for assessment, if appropriate' and 'Ensure that any future sinkings or additions to the West Coast Dive Park have the appropriate lease arrangements with the proponent for the seabed to ensure ongoing maintenance and monitoring, gazettals and proclamations declared governing commercial and recreational use of such sites'.
[2] Marine areas of interest were identified by the Marine Parks and Reserves Selection Working Group in 1994 (MPRSWG, 1994). DEC has also commenced planning in 2007 for the Pilbara region within three study areas. In addition, Government has a commitment to undertake planning for the Recherche Archipelago in the South Coast region.

(b) for the purpose of being used in human recreational activities.
(Commonwealth *Environment Protection (Sea Dumping) Act 1981).*

4. Artificial Reef Regulation

Australia is a signatory to the *1996 Protocol for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972* (1996 Protocol but previously referred to as the London Convention) which came into force in Australia in March 2006. The 1996 Protocol represents a major change of approach to the question of how to regulate the use of the sea as a depository for waste material and specifically lists waste material excepted[3]:
1. Dredged material;
2. Sewage sludge;
3. Fish waste, or material resulting from industrial fish processing operations;
4. **Vessels and platforms or other man-made structures at sea;**
5. Inert, inorganic **geological material;**
6. Organic **material of natural origin;** and
7. **Bulky items primarily comprising iron, steel, concrete and similar unharmful materials**
for which the concern is physical impact and limited to those circumstances, where such wastes are generated at locations, such as small islands with isolated communities, having no practicable access to disposal options other than dumping *(Article 4, Annex 1 of the 1996 Protocol).*

To ratify the 1996 Protocol (originally signed in 1972), Australia enacted the *Environment Protection (Sea Dumping) Act 1981* (Commonwealth Sea Dumping Act) to provide for the protection of the environment by regulating dumping into the sea. In 2001, this Act was amended to include the regulation of AR deployment due to increasing interest in ARs throughout Australia. If the Federal Minister is satisfied that the law of a State makes provision for giving effect to the 1996 Protocol in relation to the coastal waters of that State, the Minister may pass Commonwealth responsibilities for sea dumping to the State. As such, and in conformation with the Commonwealth Act, Western Australia promulgated the *Western Australian Marine (Sea Dumping) Act 1981* (WA Sea Dumping Act). The WA Sea Dumping Act complies with the requirements of the 1996 Protocol and regulates the dumping of waste into the coastal waters of Western Australia. However, it continues to leave the regulating of AR deployment, including vessels, aircraft or platforms, to the Commonwealth under the *Environment Protection (Sea Dumping) Regulations 1983* (Commonwealth Sea Dumping Regulations) with the exception of 'internal waters' as described in Section 14 of the Commonwealth *Seas and Submerged Lands Act 1973.* Under this Act the State of Western Australia holds sole responsibility for bays, gulfs, estuaries, rivers, creeks, inlets, ports or harbours which were on January 1, 1901, within the limits of the State e.g. King George Sound. In these areas the State is responsible for providing permission for AR deployment – as was the case with the scuttling of the *HMAS Perth* at Albany.

Under the Commonwealth Sea Dumping Regulations, a proposed AR is considered environmentally sensitive if it appears that the dumping may have an impact on places, habitat

[3] Excepted –allowed to be dumped under permit.

and species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). These places, habitats and species are generally limited to protected and/or species of concern, ecologically threatened habitats and places of national significance (e.g. World Heritage and Ramsar properties or places listed on the National or Commonwealth Heritage Lists). As a result, the impact of an AR which may appear to be significant locally or regionally, may not be considered environmentally sensitive under the EPBC Act, and therefore may not be assessed at the Commonwealth level.

An application fee of $5,000 is required by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) to process an AR application (Department of Environment and Water Resources, 2007). In issuing an AR permit for a period of up to 50 years, DEWHA set out conditions and monitoring requirements which are required to be adhered to, but which may only be required for the first five years. Monitoring requirements appear to vary on a case-by-case basis.

In addition to the Commonwealth Sea Dumping Act, the Commonwealth *Sea Installations Act 1987* (Sea Installations Act) ensures that sea installations, of any man-made structure, in Commonwealth waters are operated with regard to the safety of the people using them and of the people, ships and aircraft near them, and to ensure they are operated consistent with the protection of the environment. An application fee is required under this Act commensurate with the cost of the installation, up to a maximum of $60,000. However DEWHA would not usually require the payment of both permit fees (Sea Dumping and Sea Installations fees) for a single AR application, and would probably issue a certificate of exemption under the Sea Installations Act (D. Cassanell, Pers. Comm.).

Unfortunately, there are few instances where DEWHA permit conditions and monitoring requirements for AR deployment have related to ecological matters, and almost never for wider scale impacts such as monitoring of changes to nearby reef ecology. Arguably this is unfortunate as it may overlook opportunity to consider ARs as tools for conservation, aquaculture or some combination of the two. In the main the permit conditions and monitoring requests require reporting on issues related to the structural integrity of the AR and diver access and safety. For example, monitoring of the *Saxon Ranger* involves: (a) monitoring of the nature and extent of vessel degradation; (b) contingency measures to ensure that the placement site is maintained in a safe condition for use by divers and other users and for navigation; and (c) colonisation of marine life (Minister for the Environment, 2005). Comments within annual reports submitted to DEWHA by the City of Rockingham (the permit holder for the *Saxon Ranger*) relating to ecological matters are confined to: ‘no marine mammals or penguins observed on the day of inspection’ and ‘hard and soft marine growth has increased over the last 12 months since the last inspection, but not enough to become a hazard or obstruct entry/exit to the vessel’ (Allied Diving Services, 2008).

In regard to the *HMAS Swan Dive Wreck*, 24 conditions were placed on the Sea Dumping permit held by the Geographe Bay Artificial Reef Society Inc. (GBARS), of which one relates to ecological matters post-sinking: ‘A baseline study of the dump site is to be carried out and sediment samples taken prior to the sinking, and the wreck is to be monitored following sinking and at specific intervals’. This monitoring requirement basically involved sediment sampling for

detection of metals and hydrocarbons in the first year and monitoring the stability of the wreck. However, an additional monitoring program was devised by a reputable marine scientist in a voluntary capacity to monitor marine growth and fish presence at the wreck for a five year period (Morrison, 1999& 2003), a brief description of which is included within Annex A of the permit[4]. While this monitoring program was devised in consultation with DEWHA (formerly Environment Australia), it was not a firm requirement of the Commonwealth (P. Morrison Pers. Comm.). In regard to the other requirements, sediment monitoring was concluded after the first year, and wreck stability is being monitored by the Western Australian Maritime Museum (WAMM) as part of an opportunistic 100-year corrosion experiment (as are other contemporary wrecks) (see Section 10.0).

There appears to be scope to establish guidelines that demand a more rigorous and perhaps broader-scale approach to monitoring of ARs. DEWHA has suggested that it is continuing to improve its approach to the issuing of permits for ARs in all State waters through experience gained over time, and is looking to become far more stringent in regard to environmental monitoring and reporting (D. Cassanell, Pers. Comm.).

In Western Australia, proposals for development in State waters, including ARs, can be referred to the EPA for assessment under the requirements of the EP Act. Section 38 of the EP Act details the process by which a proposal can be referred and in general, any person may refer a significant proposal for assessment. Under section 38A the EPA can request the level of information it requires to make a decision on a proposal. After considering a submission, the EPA must decide whether or not to assess a proposal, and whether or not to provide advice. To date there has not been a formal assessment of an AR proposal in Western Australia, nor have Ministerial conditions or advice been provided. However, as early as 1993 the EPA held concerns over the unnecessary dumping of unused vessels, structures and materials at sea (particularly in the nearshore zone). In particular, it was concerned that there was no clear mechanism or policy to control the total number of vessels which may be disposed of in a particular region. The EPA acknowledged that the development of a long-term policy would take some time to resolve (EPA, 1993).

In relation to marine parks and reserves, a commercial operations licence or lease agreement can be issued to operators under Section 101 of the CALM Act and Part 7 of the *Conservation and Land Management Regulations 2002* (CALM Regulations), to conduct commercial enterprises, such as diving or fishing charters that may be permitted under gazetted management plans or notices. This is the formal approach DEC has taken in relation to the *Saxon Ranger*'s operator: the City of Rockingham. The licence contains conditions including scuttling requirements, mooring and anchoring requirements, monitoring and maintenance and reference to the requirements of the permit issued by the Commonwealth (CALM, 2005). A range of conditions can be placed on a licence or lease agreement, including the level of environmental monitoring considered appropriate for the site and level of operation. The MPRA were consulted in April

[4] Monitoring brief contained in Annex A of permit to dump HMAS Swan - The wreck is to be monitored following sinking. This is to be undertaken one month after the sinking and then four times a year for the first year, 6 monthly for the second year and then at yearly intervals until 2002. All sites should be monitored by using line transects. A written and illustrated report should be forwarded to [the Commonwealth] and is to address the extent to which the reef structure has succeeded in attracting marine invertebrates, fish and plants.

2005 regarding the City of Rockingham's application for a commercial operations licence and endorsed the application subject to adequate consultation with local fishing groups, six monthly reporting by the City of Rockingham about wreck usage, compliance with conditions and management implementation (CALM, 2005). It is expected DEC will also issue a lease to the City of Rockingham for the *Saxon Ranger*, in addition to the commercial operations licence. The City of Rockingham will then have sole responsibility for the management of the wreck for the period of the lease. This lease could potentially include conditions relating to ecological monitoring and reporting (M Briggs, Pers. Comm.). The lease agreement is yet to be formulated.

As shown with the assessment and permitting process undertaken in regard to the *Saxon Ranger*, and with consideration to Commonwealth and Western Australian legislation, it can be considered generally acceptable, within all parts of Australian waters, to dispose of benign waste or materials (listed in *Annex 1 of Article 4* of the 1996 Protocol) to the marine environment upon the issue of a permit – marine reserve declared under the CALM Act or not. Nevertheless, it could be construed that the approach taken by Commonwealth and State agencies in assessing and providing permission for the deployment of AR through sea dumping acts, environmental protection acts and other legislation may be deficient. The approach does not have an in-built requirement for 'fine scale' assessment of environments that are to be impacted, does not require stringent ecological monitoring on impacted environments or their surrounds, and does not consider a strategic approach for the deployment of AR in Commonwealth or State marine waters.

5. Waste 'Dressed' as Artificial Reef

ARs may only be created for legitimate purposes and cannot pose a significant threat to users or surrounding environments (Department of Environment and Water Resources, 2007). Regardless, the disposal of waste 'dressed' as AR occurs for economic reasons in all parts of the world. The disposal of tyres being one such commonly used AR material which is difficult to dispose of on land (Downing, Tubb, El-Zahr & McClure, 1985). In the United States most ARs are constructed of discarded tyres, concrete blocks, pipes, tile, rock, shell, barges, ships, bundled solid waste, cars, coal ash and oil and gas platforms (Bohnsack & Sutherland, 1985). A review of ARs in Australia, in 1985, found that most of the ARs constructed in state waters consisted of tyres, derelict ships, car bodies and other waste materials (Burchmore *et al*, 1985). Close to home in Geographe Bay (~4nm from shore), 34,000 tyres were used to create 1,200 tetrahedron shaped ARs in 1987 (Branden, Pollard & Reimers, 1994). Unfortunately, some of these structures have dismantled and tyres are now strewn across the sea floor, some being moved some distance from their original location. This AR project was undertaken with funding from the Commonwealth government in Commonwealth waters, but there appears to be no local 'ownership' of the site or materials by any organisation some 20 years on (N. Taylor, Pers. Comm.). At about the same time, 250kg of tyres was deployed as AR off Port Hedland (date unknown) in 24 separate units (WAMM File MA 12/93) and an AR constructed of tyres and 2 derelict crayboats was dumped in Warnbro Sound, prior to the establishment of the SIMP (T. Goodlich, Pers. Comm.). The AR in Warnbro Sound is also reported to have dismantled, with tyres strewn across the seafloor, and sunken into the sediment. Apparently, this site is a known snapper aggregation site within Warnbro Sound. However, there appears to be no local 'ownership' of these AR either. It could

be argued that the tyres are still providing AR habitat for marine life, however, the value of tyres as a substrate for ecosystem enhancement is open to conjecture. Many would argue that the tyres are now littering the seafloor as 'waste' and should be disposed of in a more appropriate manner regardless of their perceived value to fishers as fish aggregation sites.

Tyre reef in the United States.
More than 30 years ago, with government approval, recreational fishing groups dumped an estimated 1 million to 2 million tires off Broward County to create a huge artificial reef. On a single day in 1972, as the Goodyear blimp flew overhead, more than 100 boats headed off shore to heave tires into the water. Like similar efforts around the country, the project was intended to build structures that would attract fish by providing hiding places and vertical formations in the ocean. But few fish showed up. Worse, many tires broke free of their nylon bonds and damaged the real reefs where the fish did live. Today, the tires cover about 36 acres of ocean floor, where they continue to harm corals, sponges and other marine life

DEWHA has recently suggested that materials such as fibreglass vessels, building rubble, car bodies, tyres and white goods are not suitable materials for use as AR (Department of Environment and Water Resources, 2007) and materials for ARs that lack structural integrity are unlikely to be issued a permit (M. Paull, Pers. Comm.). Permit or not, it has been suggested that without basing the construction of an AR upon proper scientific principles, it becomes at best a temporary high relief area of questionable value, or at worst an ocean junk pile whose major value has been as a promotional gimmick of a special interest group (Bohnsack & Sutherland, 1985 after Turner et al, 1969). There is also a view, held by those with a conservation interest, that the disposal of vessels and similar structures is simply large scale, authorised dumping of 'waste' dressed as AR and permitted because of its perceived, but seemingly undemonstrated, economic advantages. Literature suggests that work focusing on the re-use of materials as AR always attracts criticism from those convinced that a project is just an excuse for dumping waste in the marine environment (Jensen *et al*, 2000) and that AR habitat planning has not evolved

beyond the availability of 'materials of opportunity' i.e. habitat development is nothing more than a form of ocean dumping (Gordon, 1994).

6. Artificial Reefs – An Overview

An international review of the placement of ARs (Bohnsack & Sutherland, 1985) found that decisions regarding ARs were often made based on political expediency, absolute cost, materials readily available, navigational considerations, or solid waste disposal problems, without considering biological, economic or social effects. This review warned that the potential existed for major mistakes which could be difficult, if not impossible to correct.

ARs in marine ecosystems are employed on a limited basis to restore degraded natural habitats and fisheries, and more extensively for biological enhancement and social and economic development (Seaman, 2007). Unfortunately, few examples can be found where ARs are deployed purely for ecological benefit with no link to enhancement of fishing or tourism opportunity. However, the Philippines has deployed over 21,600 reef modules (Jebreen, 2001) with 5,000 dome-like structures having been placed in Sarangani Bay to restore coral and fish presence lost due to destruction associated with fishing practices. The community-initiated placement of these ARs is for restoration purposes, and fishers have begun to notice an increase in fish in the area and are looking to fish it once again. This type of 'ecological' repair appears to be common in the Philippines due to the loss of over 70% of natural coral reef systems. In Spain and Italy, ARs have been deployed at particular depths to act as 'anti-trawling' devices to protect seagrass habitat, however, economic advantages have resulted with the area becoming available for low impact fisheries and aquaculture (Jensen *et al*, 2000).

The concept of multi-purpose ARs that would serve the need of commercial and recreational fishers, divers, surfers and nature conservation is an attractive one from an economic and social viewpoint, but a considerable design challenge for proponents of AR (Jensen *et al*, 2000). The general view exists that ARs have tourism potential as diver attraction devices (Dowling & Nichol, 2000) and are effective fish attractants and an important fishery management tool (Bohnsack & Sutherland, 1985), particularly in ecologically damaged or low productivity marine environments. While the use and deployment of ARs in Western Australia is only beginning to be explored, other countries have invested heavily in AR development in an attempt to enhance and/or restore depleted fisheries and improve their economic situation.

Japan

ARs have been purposefully constructed in Japan since at least the 1700's (Ambrose & Swarbrick, 1989) and Japan currently leads the world in the design and development of engineered steel and concrete AR frameworks (Seaman, 2007), most of which have been developed to attract or support commercially exploitable fish species. However, in 2008, Japan is building its first artificial surf reef near the City of Osaka in an attempt to enhance tourism and promote recreation (Audley, 2008).

Historically, emphasis was placed on improvement or revitalisation of existing fishing grounds and in 1962 a large scale effort was initiated to create new fishing grounds using ARs. It was aimed at improving the productivity of coastal fisheries, modernising fishing villages, and

increasing the income of fishermen (Yamane, 1989). In 1976 the Japanese Government began a 6-year, $700 million fishery improvement plan which earmarked about $250 million for AR projects. In 1982, Japan began a second 6-year plan with a commitment of about $500 million to be spent on ARs (Bohnsack & Sutherland, 1985). This represents a significant investment, and a comprehensive anthropocentric approach to marine resource management. No doubt there is some concern over the loss of natural marine ecological function in many areas but it would appear Japan's incentive to invest so heavily has been based on the desire to be less susceptible to foreign manipulation through becoming reliant on its own semi-cultured resources.

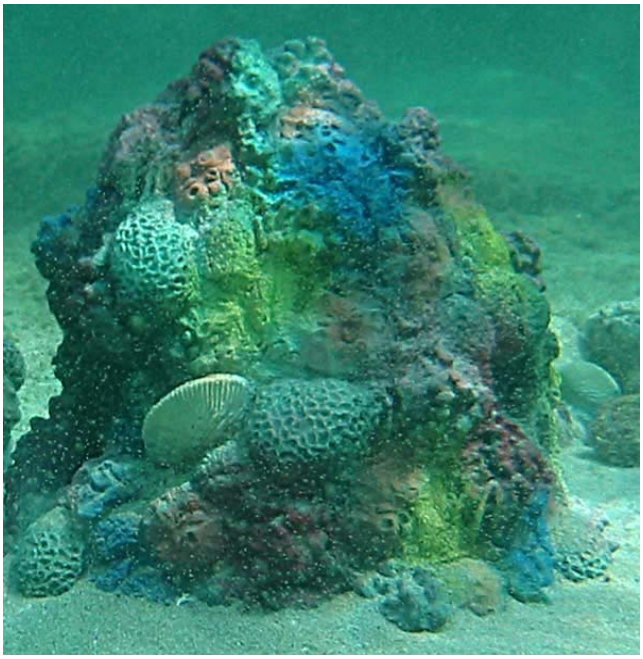
In Japan, fishermen commute to known artificial fishing grounds, guided by timetable and catch quotas imposed by the governing fishery cooperatives. These fishing grounds may be manipulated through engineering undersea upwelling walls and pumping nutrient rich water from depth into the near surface. Marine ranching is a variation of aquaculture with Japanese engineers designing 'cages' with a special capability to detain fish through acoustic conditioning. In a marine ranch, the fish roam in unfenced areas, but are periodically summoned to feed stations with acoustic signals. The fish are trained to learn the meal call while in captivity as juveniles. To further encourage the fish to stay close to the feeding station, ARs are installed in the vicinity of the acoustic fish aggregation device (FAD) (Grove *et al*, 1994). The Japanese have an arbitrary volume figure of 2,500 cubic metres below which they consider a fishing AR to be ineffective and a volume of 150,000 cubic metres for a regional AR development (Jensen *et al*, 2000). Japanese AR structures are designed and constructed by engineers, built of durable, non-waste, prefabricated materials, placed in scientifically selected sites in shallow and deep water, and are primarily used by commercial fishermen. Interestingly, Japan will not fund AR made from waste material (Bohnsack & Sutherland, 1985).

United States

In the United States, a need for comprehensive planning to guide AR development was recognised during the 1970's with greater impetus given to a national approach due to a government requirement that offshore petroleum platforms be removed completely when they were no longer producing. The use of platforms as AR was considered a practical and economically attractive alternative to dismantling, as the platform essentially acted as AR when in commission anyway. It was determined that the size, shape, design, profile, density and openness of petroleum structures made them the most durable reusable material readily available for permanent AR construction (Stephan *et al*, 1990). Loss of this habitat due to de-commissioning was considered by some as negative and resulted in the US government paving the way for what is termed the *Rigs to Reef Program*, where decommissioned structures are semi or fully dismantled and relocated to enhance fisheries.

Governing the United States approach to AR deployment is the *National Fishing Enhancement Act 1984*. This Act requires the development of a national AR plan (NAR plan) with the first being developed in 1985 and then updated in 2007 (National Oceanic and Atmospheric Administration, 2007). AR development and management protocols and guidelines contained in the NAR plan are designed to enhance the use of ARs as fishery management tools and suggests, at a minimum, that placement of ARs cause no harm to existing living marine resources and habitats and be developed such that aquatic resources and habitats are enhanced (National Oceanic and Atmospheric Administration, 2007). It appears the general consensus of those

involved in AR development in the United States is that ARs are fisheries management tools, and that their use should be addressed accordingly. The use of ARs as marine protected areas has been applied in very few areas to date. However, ARs have been employed to mitigate the destruction or degradation of various marine habitats due to coastal development or catastrophic loss. Regardless, the NAR plan warns that the use of ARs to mitigate loss or damage of marine habitats is a complex issue that involves more than substituting one type of habitat for another as the benefits gained from creating an AR may not be the same as those derived from the natural system it is intended to replace (National Oceanic and Atmospheric Administration, 2007). In the Biscayne National Park, damage caused by the impact of a large vessel on a coral reef was mitigated by the use of state-of-the-art technology that simulated natural coral. In another example, a successful temporary translocation program was undertaken to protect spiny lobster inhabiting a man-made rock marina during its repair in Florida. Alternative AR rock habitat was created in close proximity to the marina wall providing a refuge for displaced lobster. Upon completion of repair work the alternative AR rock habitat was removed and the lobster returned to the marina's rock wall (Davis, 1985).



Eco-coral ™ (look-a-like coral bommie); At deployment and after 3 months. (www.eco-coral.com)

In response to the United States national AR legislation and planning, several coastal states have developed specific legislation for AR development and planning. For example, in Texas the *Artificial Reef Act 1989* provides guidance for planning and developing ARs in a cost effective manner to minimise conflicts and environmental risks (Stephan *et al*, 1990). This Act is administered and implemented by the Texas Parks and Wildlife Department to promote, develop, maintain, monitor and enhance the AR potential in state and federal waters adjacent to Texas. Prior to the development of this Act and an AR plan, placement of structures and rigid materials

in the aquatic environment off Texas resulted in the indiscriminate dumping of various materials of opportunity which led to interference with navigation, expensive marking, and sites becoming inaccessible to anglers. Deployment of AR in Texas waters can still be undertaken by any proponent capable of meeting the requirements of the AR plan, with some suggesting that this approach limits the plan's strategic value (Stephan *et al,* 1990).

Conversely, in the state of New Jersey the Department of Environmental Protection holds all permits and is the sole entity building ARs. The intent of the AR program in New Jersey is not to change the marine environment, but rather to enhance a small portion (<1%) of the sea floor to benefit about 150 species of fish and other marine life that prefer structured, reef habitat. The benefited species are endemic to New Jersey waters, but limited in extent and abundance due to there being only one naturally occurring reef which experiences occasional sand inundation. New Jersey has developed a network of 15 ARs encompassing a total of 25 square nautical miles of sea floor, primarily to enhance fishing and diving experience. Through the introduction of AR, New Jersey ranked first for commercial catch of some reef associated species among 14 Atlantic coast states during 1998-2002 (Department of Environmental Protection, 2005). New Jerseys' paucity of natural reef may be a unique situation enabling some justification for deployment of ARs, and, it could be postulated that if natural reef habitat was plentiful, then there may be no need for ARs (Pitcher & Seaman, 2000).

As at October 1987, 572 permitted AR sites were located in the marine or estuarine waters of 23 coastal states of the United States with 14 of the states having government sponsored ocean reef programs (McGurrin *et al,* 1989, Murray & Betz, 1994).

Australia

Australia also has some recent history relating to deployment of AR. By the early 1990s, Australia had at least 72 AR, most of which had been constructed from waste material (Kerr, 1992). In the 1970's, derelict vessels ranging in size from 34-88m in length were scuttled in the Pacific Ocean off Sydney. These AR were established for the benefit of fishers and were reported to be a reliable source of dhufish, snapper and kingfish (Morrison, 2003). Between 1984 and 1994, the South Australian Fisheries Department embarked on a program of installing seven ARs each consisting of about 900 tetrahedron modules constructed from discarded tyres. The aim of the ARs was to improve recreational fishing opportunity and provide economic benefit in waters adjacent the metropolitan area (Branden *et al*, 1994). The benthos in this area is described as a broad, featureless expanse of sand fringed by seagrass beds (Department of Industry and Resources, 2008). As a program, South Australia has the largest number of officially endorsed ARs in Australia. Early research showed a 16 to 20% higher fish stock abundance on ARs when compared with nearby natural reefs and it was believed that this highlighted the usefulness of ARs as an effective mechanism to enhance and/or attract populations of fish species of economic importance (Branden *et al*, 1994). However, recent research on the effects of the ARs on fish populations brings the motive to improve fishing opportunity into question as there is enough evidence to suggest that the construction of any new reefs would increase the potential for species such as snapper and King George whiting to be taken without actually enhancing stocks of these species. As such the South Australian government now discourages the construction of any additional ARs in state waters (Department of Industry and Resources, 2008). However, the *HMAS Hobart* was sunk in Yankalilla Bay, south of Adelaide, in 2002. The Yankalilla Council

was the proponent for this AR which is protected under the South Australian *Historic Shipwreck Act 1981* and lies within a Historic Shipwreck Protected Zone. Fishing at the site is prohibited under the South Australian *Fisheries Act 1982* and the wreck is promoted as a recreation and tourism destination (District Council of Yankalilla, 2008).

A report funded by the CRC Reef Research Centre in 2005 reviewed available information relevant to the possible creation of ARs on the Great Barrier Reef (Pears & Williams, 2005) and found that the literature on ARs is quite extensive, but there is surprisingly little strong evidence on either socio-economic or environmental benefits or impacts. The report suggests there is a need for a careful, evidence-based, risk assessment and cost-benefit analysis, which critically considers:

- The values and motivations underlying the potential social and/or economic benefits of ARs (e.g. enhanced fishing experiences);
- The likelihood of ARs effectively addressing those values;
- Potential alternative solutions;
- The balance between social and economic benefits of ARs and potential loss of value to other interest groups (e.g. loss of naturalness or [conservation] value);
- Evidence for other potential effects, including environmental impacts;
- Potential impacts on fisheries and fisheries management; and
- Strategies to maximize benefits and minimise environmental, social and economic risks.

It was found that much of the information required for this assessment is either very limited or unavailable (Pears & Williams, 2005).

Installation and operation of an AR in the GBR Marine Park requires the permission of the Great Barrier Reef Marine Park Authority (GBRMPA) and depending on its scale may also be considered under the EPBC Act and Commonwealth Sea Dumping Act. In response to pressures to deploy ARs to enhance fishing and tourism opportunity, GBRMPA developed AR guidelines (GRMPA, 2008). The guidelines specify that in the initial application stage, the proponent must pay a Permit Application Assessment Fee of between $31,000 and $85,000 depending on the level of risk the proposal represents. AR proponents are required to meet all costs associated with the permit assessment and subsequent installation and operation of the AR; carry appropriate insurance; and, as a precaution, provide a bond for the cost of removal or relocation of the AR, to be held by GBRMPA in perpetuity or until the AR is removed from the marine park. The bond is reviewed by GBRMPA from time to time to ensure it keeps abreast of inflation, increases in cost of removal, and any other changes. ARs in the GBR Marine Park remain the responsibility of the applicant and an Environmental Management Plan is required to detail the proposed installation, operation, maintenance, funding sources and ongoing management of the AR. The effort and cost to the applicant to undertake all of GBRMPA's requirements could be described as onerous and would no doubt cause an applicant to be attentive to the costs versus benefits of a proposal.

There are a number of wrecked ships and aircraft sunk unintentionally that act as AR in GBR Marine Park and are popular with fishers and/or divers, the best known being the S.S. Yongala. Since the inception of the guidelines, GBRMPA has discussed a number of AR proposals with prospective applicants but there have been no applications lodged (Pears and Williams, 2005; J. Monkavitch Pers. Comm.).

In Western Australia, the *Cheynes III* was deliberately scuttled in King George Sound, Albany in 1982/3 with the encouragement of the WAMM which was interested in promoting diving on contemporary wrecks and the development of shipwreck dive trails. This scuttling was undertaken without reference to legislation with the ship simply towed into place and blown up (to the extent it split in half). It has remained one of the more popular dive destinations in Albany, partly because it provides variation to an area dominated by granite reef, but mostly because it lies in a protected location and, generally, has good visibility compared to most other sites close to Albany. There is no management body for this AR and as it is corroding may represent an unquantified risk for divers visiting the site. The *Cheynes III* lies within 'inland waters' as described in Section 4 of this paper.

The Cheynes III was followed by the sinking of the barge *Miwok* off Rottnest Island in 1983 to provide a site for Army diver training and in 1988 the Fremantle Port Authority assisted in the transfer of a sunken barge from Rous Head to North Mole (WAMM File MA 12/93). It is unclear what legislative processes the placement of these AR involved.

In 1993 the Department of Defence had suggested the *HMAS Derwent* be gifted to Western Australia as a potential AR. There was intense competition between the Rockingham and Busselton community to become the proponent for the ships sinking. Unfortunately for these interest groups, the Navy had previously used this ship to conduct explosive experiments and these rendered it both unsafe and unsuitable as a recreational dive wreck. The *HMAS Derwent* was eventually sunk in 200m of water, 27km west of Rottnest in December 1994 in Commonwealth waters known as the Rottnest Graveyard (Plunkett, 2003; WAMM File MA 12/93).

It could be fair to say the potential availability of the *HMAS Derwent* began a frenzy of activity in relation to the sinking of vessels of any type. This frenzy appears to have continued throughout the 1990's and early 2000's in Western Australia and other parts of Australia. However, it appears to have abated somewhat in Western Australia as the *Saxon Ranger* was the last vessel to be deliberately scuttled in Western Australia as an AR under the Commonwealth Sea Dumping Act.

On a different note, the *Cables Artificial Surf Reef* was constructed of granite boulders within the Cottesloe Fish Habitat Protection Area on reef platform at Mosman Park in 1998/99. There remains conjecture over the success of this project in relation to wave enhancement, however, initial studies confirmed that the reef was meeting expectations (Pattiaratchi, 2001). This reef has become something of a catalyst for the construction of other surfing reefs around the world, including the United Kingdom. No ecological studies have been undertaken on this reef (A. Hill, Pers. Comm.) despite its location within a community-initiated marine protected area introduced under the *Fish Resources Management Act 1995.*

In relation to the emerging industry of marine aquaculture the definition of what an AR is could be questioned. For example, abalone aquaculture platforms used in South Australia at present, and proposed for Flinders Bay in Western Australia could be referred to as large floating AR as

they have hard bottom which floats above the seafloor and supports reef dwelling species. This issue may need further discussion.

In 2005/06, as part of offset negotiations through an informal assessment process under Section 45C of the EP Act, Pilbara Iron undertook to translocate 0.5ha of coral and introduce 0.5ha of AR for coral settlement in Dampier Harbour under a proposal to extend a sea wall. The introduced AR includes the use of: up to 10,000 tonnes of sea-weathered rock from a dismantled groyne and newly quarried rock; up to 2,000 tonnes of concrete conveyor footings from an industrial site; and 24 purpose-built concrete ReefBalls©. A sea dumping permit was required for this AR with Pilbara Iron required to monitor the site both structurally and ecologically for a period of 10 years (DEWHA, 2006). Pilbara Iron has committed to a target of 10% coral cover on the AR to provide functioning coral reef habitat to offset the loss (together with the translocation area) which occurred during seawall extensions (J. Stoddart, Pers. Comm.; P. Royce, Pers. Comm.). In gaining a sea dumping permit for the placement of the AR, Pilbara Iron was required to develop an environmental management plan to the satisfaction of DEWHA, and include measures to determine the rate and effectiveness of colonisation by scleractinian corals and other marine organisms on the various materials used for AR; measures to determine the validity of the use of the AR as an environmental offset; and measures to address any observed decline in coral communities adjacent to the proposed placement sites (DEWHA, 2006). Pilbara Iron has also included assessment of the use of the AR by fish in its monitoring. This project may be an example where DEWHA is looking to improve its approach in regard to environmental monitoring and reporting (see Section 4.), perhaps because it relates to environmental offsets and as such DEWHA and the EPA have an interest in the proponent's commitment to provide information on the value of different substrate used as AR. Dampier Port Authority has prohibited anchoring over the AR to reduce impacts on the translocated and newly settled coral, however, concern exists that future development within Dampier Harbour, outside the AR area, may impact on the success of Pilbara Iron's efforts.

Narrowneck Queensland – Artificial Surf Reef designed to mitigate coastal erosion (Burgess *et al,* 2003).

7. Petroleum Platform Decommissioning

There is a diverse choice of material available for use in AR construction with a potential source being petroleum platforms, of which Australia has over sixty currently in operation in Commonwealth and State waters. More than half are located off Western Australia on the North West Shelf and most are producing oil (DRET, 2008). In the next few decades, many of these petroleum platforms will become due for decommissioning.

Decommissioning of offshore platforms is subject to Article 60(3) of the United Nations Convention on the Law of the Sea 1982 (UNCLOS), the Commonwealth *Petroleum (Submerged Lands) Act 1967* (PSLA - *soon to be replaced by the Offshore Petroleum Act which will be identical in substance*), the EPBC Act, the Commonwealth Sea Dumping Act, the WA Sea Dumping Act, the *Petroleum (Submerged Lands) Act 1982* (WA) and the EP Act.

UNCLOS states:
'Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organisation (i.e. International Maritime Organisation (IMO)). Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed'.

The IMO established guidelines and standards (IMO, 1989) for the removal of offshore installations (excluding pipelines) which are not legally binding in Australia, but are generally adhered to (DRET, 2008). Section 107 of the Commonwealth and Western Australian PSLAs requires the removal of all 'property', the plugging of all wells, the making of provisions for the conservation and protection of natural resources, and the making good of any damage to the sea-bed or subsoil caused by operations at the cancellation or expiry of a permit or licence. Under these Acts the operator is required to produce a 'safety case' for decommissioning identifying and addressing risks. Different decommissioning options for the same platform may pose different levels of risk and these have to be taken into account with other factors in determining a final decommissioning plan (DRET, 2008).

The responsibility for decommissioning a platform lies with the operator; however, regulators have a role in determining the acceptability of any decommissioning project (DRET, 2008). The Commonwealth DRET has released a discussion paper (DRET, 2008) which addresses the issues associated with decommissioning in Commonwealth waters, and which is also relevant to WA coastal waters. This paper may lead to the development of a Commonwealth policy for decommissioning of platforms.

Types of petroleum platforms that have been installed or planned for in Australia include concrete gravity platforms[5], conventional fixed steel jacket production platforms[6], various types

[5] Concrete gravity structure – is a structure made of concrete and kept in place by gravity. They are usually floated into place and then sunk into position by flooding spaces within the structure. They may be ballasted in position using dense ballasting material such as iron ore.

of fixed mini platforms, floating production facilities[7], subsea completions[8], together with their associated pipelines and flowlines. Six facilities have been abandoned[9] to date (DRET, 2008). The largest concrete gravity platform, weighing approximately 91,500 tonnes is located in 55 metres off Karratha having an oil storage capacity of 400,000 barrels of crude oil. The removal of concrete gravity structures can pose difficulties as their weight does not allow them to be lifted and refloating can prove difficult resulting in the need to leave them *in situ*. Conventional steel platforms operating in the North West Shelf are constructed with modular decks supporting crew accommodation, drilling rigs and production facilities, and are supported by drilled and grouted pile foundations. These facilities can be 'lightweight', often weighing between 2,000 and 50,000 tonnes and may in part be easier to remove. The oldest conventional steel platform still in production is North Rankin which was installed in 1984, weighs approximately 43,000 tonnes and supports 24 gas production wells (DRET, 2008)

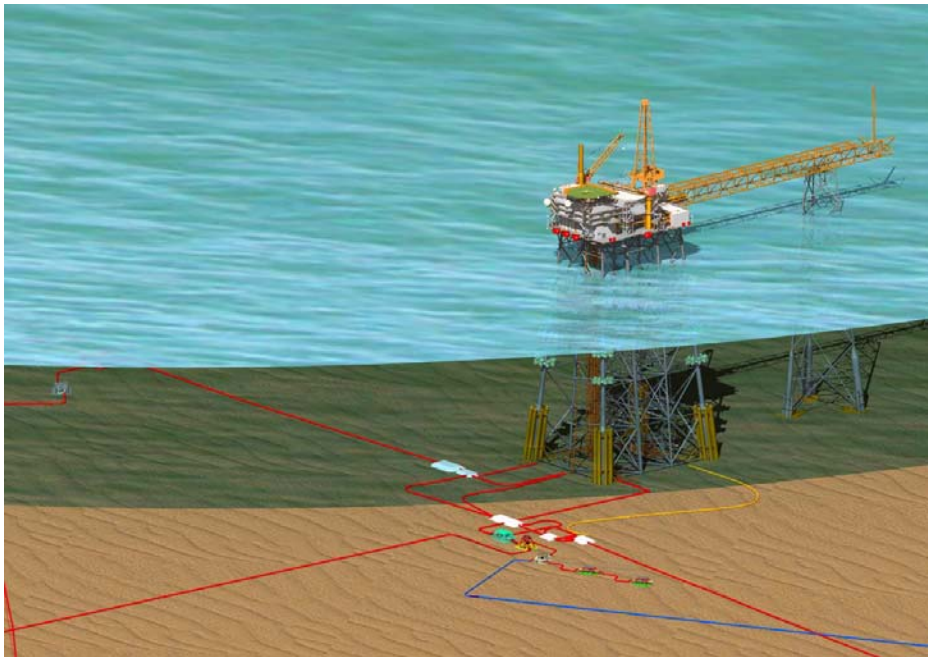


Figure 1: North Rankin A Complex on the North West Shelf (DRET, 2008)

[6] Conventional steel jacket platforms are generally large complex structures, installed in deep water (45-135m) with four or more legs fixed to the seabed by piles and catering for dry wellheads on the topsides. Steel jjackets are part of the oil and gas platform that extends from the seabed and supports the rest of the structure. Steel jackets are usually fixed in place by piles driven into the seabed.

[7] Floating production storage and off-take consists of a floating system, which may be converted oil tanker or a purpose built ship or some other type of floating structure which is moored in position and receives petroleum from the wells in the sea floor. The produced petroleum is usually initially processed and stored temporarily in the floating structure. The product is exported by tankers which visit the facility for this purpose.

[8] Completion refers to complete finishing of all work on a particular well to make it capable of its function e.g. production, or water/gas reinjection. Completion may also refer to a producing zone within a well or to subsea completion.

[9] Abandoned – applies to wells and involves a full process of plugging the well, and, usually, the removal of any equipment that protrudes above the seabed.

Decommissioning options for platforms in the North West Shelf include finding an alternative use for part or all of the structure, recycling of part or all, final disposal onshore of part or all, leaving the structure in place, toppling the structure in place, or disposal of the structure elsewhere at sea, as an AR or deep sea disposal (DRET, 2008). Most of the options involve heavy lifting. However, vessels operating in the Australian region generally have a maximum lift capacity of only 500 tonnes (DRET, 2008). The most appropriate decommissioning option will likely vary between installations, depending on a number of site specific factors and the ways these interact, while also considering the need to satisfy criteria relating to environmental impact, cost, safety, and the interests of other users or the sea.

It is expected cost will become a major criteria in determining decommission options. It has been estimated that on-shore disposal costs for North Rankin will be around $150 million (O'Neill *et al*, 2005). The high costs reflect the need to bring in – on contract – heavy lift equipment from overseas, as this equipment is never likely to be available directly from Australia (DRET, 2008).
In regard to environment, complete removal of a structure may give an area the opportunity to return to a natural state, with the rate at which this occurs being dependent on the level of disturbance. Total removal will also result in the loss or displacement of marine life that has become dependent on the structure during its life. Partial removal may provide for the establishment of deep-water AR with strong consideration necessary in regard to the disintegration of remnant materials and the risks this presents. It must also be recognised that the decommissioning activity has the potential to impact the local marine ecosystem, particularly if explosives become necessary. However, these impacts may be no more intrusive than those experienced at the time of commissioning (DRET, 2008). Consideration should also be given to the beneficial and negative impacts of using decommissioned platforms as AR, for all the same reasons discussed in this paper. The use of petroleum platforms as AR has not occurred in Australia to date (DRET, 2008).

8. Artificial Reefs and the CALM Act

Twelve marine reserves have been established under the CALM Act in Western Australia (Appendix 1). In addition, there are currently a further 4 reserves awaiting final government endorsement of the boundaries and management plans.

The reserves have been created within the framework of the National Representative System of Marine Protected Areas (NRSMPA) which has been formulated by the Commonwealth and State Governments. Development of the NRSMPA helps to fulfill Australia's international responsibilities and obligations as a signatory to the *Convention on Biological Diversity* (United Nations Environment Program, 1994), provides a means of meeting obligations under the *Convention on Migratory Species* (Bonn Convention) and bilateral agreements for migratory birds with Japan, China and Korea (JAMBA, CAMBA and ROKAMBA). In addition, it supports the World Conservation Union's (IUCN) World Commission on Protected Areas Program that promotes the establishment and management of a global representative system of marine protected areas (ANZECC Task Force on Marine Protected Areas, 1999).

Under the CALM Act, there are three types of marine reserve: marine park; marine management area; and marine nature reserve. Each has a different level of protection, and each permits a different range of use (see Section 13 of the CALM Act). Marine parks and marine management areas are designed to cater for multiple-use and may be zoned into management areas (more commonly known as zones) to set aside areas of special conservation, recreational or commercial interest. An important design feature of marine parks and marine management areas can be the designation of sanctuary zones. Sanctuary zones are no-take and contribute to comprehensive, adequate and representative (CAR) protection of ecological values. Sanctuary zones primarily provide for nature appreciation and scientific reference. In a similar vane to sanctuary zones, marine nature reserves have a primary purpose of conservation and restoration with nature appreciation and scientific reference being the primary uses. While the CALM Act does not state it implicitly, it might be viewed that the deployment of ARs in marine parks and marine management areas may be an acceptable 'multiple-use' of the marine environment similar to the placement of dive trail plinths or infrastructure such as navigation markers. Further to this point, it may not be considered out of place, by some, for AR deployment to be considered during marine reserve design as a possible compensation mechanism for the introduction of no-take sanctuary zones. This approach may mitigate some of the negativity that can be generated by fishers and compensate their perceived loss of fishing area. On the other hand, it could be argued that the pacification of fishers should not be the catalyst for the *ad hoc* deployment of ARs in areas identified as having significant marine conservation value. Nevertheless, the deployment of AR in marine parks and marine management areas might potentially be considered under specific circumstances if an AR is designed and responsibly placed to serve a particular ecological purpose. The provision of alternate substrate for specially protected species affected by the acceleration of climate change and/or sea level rise may be one situation where it may be deemed acceptable.

In relation to marine nature reserves and sanctuary zones, deployment of ARs is considered by some to be inconsistent with their statutory and perceived purpose which is essentially to provide the highest level of protection for marine biodiversity. There should, however, be caution in accepting this view on a legal basis as the CALM Act could be open to interpretation. Under the CALM Act a specified purpose of a marine nature reserve is for the '*conservation* and *restoration* of the natural environment'. In some parts of the world ARs have been used as a catalyst for *restoration* of the natural environment, and may provide *conservation* benefit in some situations. Similarly, sanctuary zones may be established as 'look but don't take' areas managed solely for nature *conservation* and low impact recreation and tourism (Department of Conservation and Land Management, 1999). It appears that a weakness of the CALM Act lies in that it only states the activities that may **not** occur in a sanctuary zone and marine nature reserve, not their overriding purpose. However, upon the preparation of a statutory management plan it is possible for AR establishment to be listed as not being permitted should all parties involved in planning agree.

A point of discussion may be generated in regard to the Busselton Jetty located within the proposed Ngari Capes Marine Park. The jetty's pylons provide a stable AR platform upon which a unique arrangement of marine life has colonised over a long period. The marine life of this AR is highly valued resulting in the end of the jetty being proposed a sanctuary zone (completely no-

take). The vast majority of marine life dependent on the jetty pylons would not naturally be present if the jetty pylons were removed.

It has also been suggested that attractive underwater sceneries created artificially should be offered with a view to diverting some diving activity away from natural reefs (Van Treek & Schuhmacher, 1999). The *HMAS Swan Dive Wreck* (*HMAS Swan*) was deployed in Geographe Bay in December 1997 as a dive-able shipwreck, artificial reef and tourist attraction (Dowling & Nichol, 2000; Morrison, 2003). By 1999, it was estimated that approximately 18,000 people had dived the wreck (Dowling & Nichol, 2000) which is located in an area previously unattractive to divers. The ~500 square metre area in which the wreck lies has been declared a no-take area under the *Fish Resources Management Act 1995* (FRM Act) and environmental monitoring recorded a marked increase in fish species richness within two years (Morrison, 1999). However, the value of *HMAS Swan* in diverting diver impacts from natural reefs to an artificial one has not been investigated, nor was it required to be investigated.

The area in which the *HMAS Swan* lies is now encompassed by the proposed Eagle Bay Sanctuary Zone within the proposed Ngari Capes Marine Park[10]. It could be expected the designation of the proposed sanctuary zone will further enhance the abundance and diversity of species found on and around the wreck and the wider area of the zone, ultimately benefiting its tourism value. The lease for the area around the *HMAS Swan* expires in 2019, at which time the MPRA may investigate the inclusion of the wreck in the proposed Eagle Bay Sanctuary Zone (Department of Environment and Conservation, 2008). This would result in two dive wrecks being located within multiple-use marine parks, the other being the *Saxon Ranger* in the SIMP.

However, it should be made clear that the proposal to sink the *Saxon Ranger* in the SIMP was an anomalous situation where the marine park had been gazetted but a statutory management plan had not been finalised and endorsed by Government. In the absence of a plan the Minister for the Environment was able to determine that the deployment of the *Saxon Ranger* in the proposed general use zone of the SIMP conformed with a 1993 Ministerial compatible operations notice relating to tourism licensing. As the creation of the *Saxon Ranger* AR was undertaken to benefit tourism and is promoted as a dive site as part of the *West Coast Dive Park*, a tourism-based venture, it was considered appropriate to allow it to be deployed at the chosen site under this notice. The site is now a no-take area administered under Section 43 of the FRM Act and managed for tourism by the City of Rockingham under a commercial operations licence issued by DEC for 'dive wreck and dive operations' (CALM, 2005). The site was not designated a sanctuary zone in the SIMP plan.

Initial estimates in 1998 concluded that the sinking of a single vessel off the Rockingham coast would generate economic benefits of more than $2.2 million per year by: stimulating job growth in the tourism sector; increasing tourism-related spending; create employment opportunities in related industries and increase income generation for Rockingham dive companies (City of Rockingham, date unknown). However, it appears its direct economic value to dive tourism is

[10] The Geographe Bay Artificial Reef Society Inc. hold a 21 year lease over the HMAS Swan area, and as such it is not included as part of the proposed Ngari Capes Marine Park. However, the proposed Eagle Bay Sanctuary Zone of the proposed marine park fully encompasses the area and complements an existing fishing closure order administered under Section 43 of the *Fish Resources Management Act 1995.*

still to be realised with the City of Rockingham reporting a total recreational dive permit income of $454 for the period 1 July 2007 to 13 May 2008 (City of Rockingham, 2008).

It should also be noted that the tyre and crayboat AR in Warnbro Sound (discussed in Section 5) was in place prior to the establishment of the SIMP. This AR site is within the General Use Zone of the SIMP and as such fishing is permitted. It could be concluded, upon considering: that tyres and crayboats were dumped in Warnbro Sound prior to the establishment of the SIMP; that there was no management plan in place for the SIMP at the time the *Saxon Ranger* was scuttled; and that the proposed Ngari Capes Marine Park was not established when the *HMAS Swan* was scuttled, that these AR lie within marine parks purely by default rather than intent.

HMAS Swan Dive Wreck 2008

Dunsbourgh, Western Australia

9. Production versus Aggregation

In Western Australia, a number of deliberately deployed, long-life ARs have been declared no-take areas resulting in the protection of marine life which inhabit it. However, there are many ARs that do not have this protection and are the focus of fishing activity. The tyre ARs in Geographe Bay and Warnbro Sound, the *Cheynes III* in King George Sound and the D9 in Cockburn Sound are relevant examples. Interestingly, in Western Australia, the recreational

fishing sector is supportive of the deployment of ARs where they benefit fishing opportunity, whether they are protected from fishing or not (Recfishwest, 2006). This position may reflect a widely held notion that there is limited understanding of the function of ARs in regard to fishery enhancement and therefore caution must be exercised to avoid using ARs simply as fishing devices to heavily exploit species attracted to them (Seaman, 2007).

A basic question revolves around the issue of whether ARs locally enhance sustainable production or just aggregate resources already present in an area (Brock, 1994; Szedlmayer & Shipp, 1994). Increasing productivity is clearly the most desirable outcome, as it results in increased overall fish stocks (Pears & Williams, 2005). However there is very little direct evidence for this (Bohnsack, 1989). There is concern that ARs work to aggregate the last few remaining fishes, increasing their susceptibility to being caught, thus contributing to the decline or collapse of the resource (Brock, 1994). Of course, interest in production would be greatest where the AR was in place to enhance fishing opportunity. However, it would be reasonable for there to be interest in production levels in ARs placed within no-take areas also, to determine if production is happening, and what impact it might be having on surrounding areas and species.

In general, fished ARs pose more risk than unfished ARs to surrounding natural environments, because in many circumstances, available evidence suggests that ARs tend to aggregate existing fish stocks, rather than enhance overall fish production (Pears & Williams, 2005). Studies have found that fish colonise ARs quite rapidly, sometimes within hours of reef material being deposited (Bohnsack & Sutherland, 1985; Bohnsack *et al*, 1994). A fish tagging study in California revealed that substantial movement of fishes occurs, in some cases up to 1.6km, from natural reefs onto ARs (Matthews, 1985) and some researchers have suggested that a separation of at least 600m is necessary to maintain the identity between natural reef and an AR (Bohnsack & Sutherland, 1985). Attraction to AR is not considered to be a problem where: fishing effort is low; a large stock reservoir exists; fish density is too low to be efficiently fished; high rates of immigration exist; or little natural reef habitat exists (Bohnsack, 1989).

Increased production is most likely at locations isolated from natural reefs; and for habitat-constrained, demersal, philopatric, territorial and obligatory reef species (Bohnsack, 1989). Production would also be dependent to some degree on the number of larval recruits finding suitable habitat on AR, or for that matter natural reef ‘vacated’ of marine life after being attracted to a nearby AR. In many areas it has been suggested that ARs are unlikely to increase biomass for intensely exploited or overfished populations without other management actions (Bohnsack, 1989) and it is believed by some that ARs do not increase biomass, but merely move biomass (Matthews, 1985). Productivity of ARs may not be an issue where the purpose of the AR is to enhance tourism opportunity, however, high numbers of fish can certainly add to a diving experience.

Newly deployed ARs, regardless of size, shape, materials or siting all have one thing in common, they are unoccupied by resident fishes. The rapid redistribution of fishes to AR may be the result of the limited availability of suitable habitat for increases in the population of habitat-constrained species (Alevizon & Gorham, 1989). However predicting which species are habitat-constrained, and therefore likely to increase in number, may prove difficult particularly given the limited amount of detailed research that occurs on fish ecology and the functionality of reef systems and

surrounding waters as a whole. Any AR will accumulate species, but these species may not be those desired nor may desired species persist for long periods (Pratt, 1994). It may also be more ethically preferable for 'new' fish to inhabit an AR than fish drawn from nearby natural areas.

In the United States, some AR managers were concerned that there was limited effort going into enhancing nursery or estuarine habitat and that too much emphasis was being placed on improving habitat used by fish only during adulthood (Murray & Betz, 1994). In addition, AR size was found to be an influencing factor in Florida where it significantly influenced total numbers of species, individuals and biomass. Smaller ARs had greater fish density while larger ARs had higher biomass density from large, but fewer, individuals. Multiple ARs supported more individuals and more species than one large reef of equal material (Bohnsack *et al,* 1994).

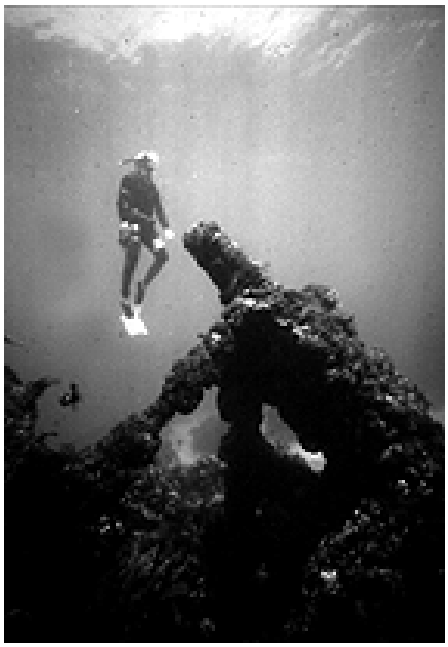
Enhanced fishing success, or an increase in fish numbers in the immediate vicinity of newly created AR may represent a redistribution and not an overall increase in fish stocks for the surrounding area (Grossman *et al,* 1997; Jebreen, 2001; Bohnsack & Sutherland, 1985, Polovina, 1990; Lindberg, 1997; Polovina & Sakai, 1989; and Pickering & Whitmarsh, 1997), and while catch rates have been high around AR in the GBR Marine Park, reviews of international literature related to the aggregation versus production debate have found very little reliable evidence of increased overall productivity of target fishes due to AR creation (Pears & Williams, 2005). In general, creation of AR does not appear to benefit overall fish stocks/populations where extractive use is permitted (Jebreen, 2001). The Queensland Department of Primary Industries has concluded the potential for overfishing following aggregation and the increased availability of already depleted fish stock is a serious risk of AR deployment (Jebreen, 2001). The abundant and large fish often seen at unfished AR, such as SS Yongala in the GBR Marine Park, is thought to reflect both aggregation and protection from fishing (Pears & Williams, 2005). This wreck, accidentally sunk in 1911, is located in an area devoid of reef and exposed to good current flow, and has become over many years a refuge for marine fauna and flora where it would not once have occurred.

While there are few clear conclusions in the production versus attraction debate, it may be necessary that an open mind be maintained to ensure yet unknown benefits and impacts can be fully explored. As an example, one such potential benefit in Western Australia involves the western rock lobster fishery which is partly constrained by the finite amount of natural reef upon which lobster recruitment can take place. The addition of ARs to areas devoid of natural reef, and designed specifically to enhance settlement rates of rock lobster, could have significant economic benefit for fishers and associated industries and may present a new mariculture opportunity for the State.

10. Maritime Heritage

In Western Australia, the *Maritime Archaeology Act 1973* makes provisions for the preservation of the remains of ships lost before the year 1900, including their relics and the sites upon which they lie. This Act would not apply to the AR ships deployed recently in State waters. However, in future years these ships could potentially act as important archaeological reference sites for

ship types used during the mid-late 20th century for defence purposes. Those gone to scrap on land would, obviously, be unable to provide this reference.



Snorkeling the Highland Forrest shipwreck – Becher Point, Warnbro Sound (WAMM)

The Commonwealth *Historic Shipwrecks Act 1976* also provides protection for shipwrecks in Western Australian coastal waters where the Commonwealth Minister has declared, by a notice in the *Government Gazette*, that the remains and/or relics of a ship are of historic significance. This Act mainly applies to shipwrecks greater than 75 years old, but can apply to contemporary vessels where considered appropriate. However, it can not apply to military vessels wrecked in recent years. While it precludes the potential protection of military vessels as historic shipwrecks, it does not preclude the potential for protecting other types of scuttled vessels that may be considered to have heritage importance in future years.

The first vessel scuttled to form an AR in Australia was in 1967 and since then an increasing number have been placed in shallow water around the country (Plunkett, 2003). In Western Australia, a strong trend towards the use of contemporary steel vessels as AR emerged over recent decades with the sinking of the *HMAS Swan*, *HMAS Perth*, *Saxon Ranger* and a number of other smaller vessels all within a 10-20 year period. These vessels may be expected to have a 'bottom life' of up to or over 100 years, partly due to the protective paint coating their hull, their relatively large size and the strength of their hulls.

The scuttling of the *HMAS Swan* in 1997 and the *HMAS Perth* in 2001 has provided the WAMM with an opportunity to obtain biological, physico-chemical and corrosion data from the time of 'wrecking'. Collected data is being used to better understand the deterioration of historic shipwreck sites. This will ultimately assist in the development of appropriate *in situ* management

strategies for underwater cultural heritage sites (MacLeod *et al,* 2004). Thus the WAMM sees the deliberately scuttled hulk as a useful asset (WAMM File MA 12/93).

In the past WAMM has provided support for the sinking of vessels (WAMM File MA 12/93), however this is no longer the case as the museum now essentially remains an observer in relation to the scuttling of vessels (M. McCarthy, Pers. Comm.). WAMM does however, advocate that scuttling vessels as AR should be carefully coordinated and carried out in full consultation with relevant and interested authorities (WAMM File MA 12/93).

WAMM has also suggested that when the 'last jack-up rig is scrapped, the *Key Biscayne* off Lancelin will become a unique and one day, historic relic' signaling the potential heritage value contemporary shipwrecks may have in the future (WAMM File MA 12/93).

11. Research and Monitoring

Marine ecosystems were once thought to be immune from human impacts, but are now widely recognised to be vulnerable to many of the same threats as terrestrial ecosystems (Vanderklift & Ward, 2000). This recognition has largely developed because of the practice of research and monitoring.

The most extensive research and monitoring undertaken in regard to AR in Western Australia has occurred for the *HMAS Swan Dive Wreck* (Morrison, 2003). This research and monitoring was undertaken throughout a 5-year period and provides an indication of the range of marine life that may establish on a steel vessel AR in temperate waters. Some of the key findings include:

- A total of 92 fish species were recorded on the vessel during the five years of monitoring;
- Approximately 86% of fish abundance at the site was represented by 10 species, with Tarwhine (a target species) accounting for 33% of the fishes encountered;
- The species richness and abundance of fishes on *HMAS Swan* is beginning to approximate that of other natural reefs in the region, however, the species composition on the vessel is still distinctly different.

It is expected the monitoring being undertaken in regard to three AR types in Dampier Harbour, by Pilbara Iron, will also furnish information that will contribute to knowledge of AR value (see Section 6.0). At this time, however, it is too early for firm information to be provided on the success or failure of the coral translocation, or coral settlement.

In the early 1970's two series of 8 experimental ARs were established in the lagoon at One Tree Island Reef in the south Great Barrier Reef. The ARs were introduced to provide a reference for reef colonisation across differing seasons. It was shown that the AR established in spring showed a more rapid recruitment of fishes (species richness and abundance) compared to the reef constructed in winter, which took more than 4 months to attain the same level of species richness and abundance (Morrison, 2003 after Russel *et al,* 1974).

Artificial reef research programmes exist in Italy, Spain, Portugal, the UK, the Netherlands, France, Greece, Norway, Israel, Monaco, Russia, Poland, Turkey and Finland. Denmark has an

interest in artificial reefs, although no structures have yet been placed. European reef research is varied; from biofiltration through habitat protection to fishery enhancement. The European Artificial Reef Research Network (EARRN), consisting of 51 scientists from 36 laboratories was formed in 1995 to enable a sharing of research outcomes throughout Europe, and encourage regional collaboration on AR research programs (Jensen, 2002; EARRN, 2008). Europe's seas are under a high degree of pressure in comparison to Australian seas and as such it may be difficult to draw on European findings, particularly where research has occurred in areas of the sea that are vastly different in function than our own. There can be no doubt that local research and/or monitoring is necessary to determine the beneficial or detrimental impacts upon marine ecosystems before and after the establishment of an AR, protected from fishing or not. It has been suggested that where the processes that maintain the biodiversity of an area are poorly understood, then the risk of failing to maintain biodiversity could be great (Vanderklift & Ward, 2000).

There needs to be realisation that there is little understanding of the benefits or function of natural reefs within or outside of marine protected areas, and that we have poor understanding of the relative importance of various processes in maintaining biodiversity (Vanderklift & Ward, 2000). While there is some research and monitoring of targeted fish species, there is very little information available on non-target species regardless that this information may be essential for understanding the impact of extractive activities. The general paucity of information and the relatively universal constraints on resource allocation for research and monitoring begs the question: could a marine management body justifiably shift resources from research and monitoring of a natural reef to research and monitoring of an AR, particularly in marine parks and reserves?

It may also be necessary to monitor newly introduced AR for introduced marine pests (IMPs) although the risk of establishment away from Port areas is considered relatively low. However, when a new habitat is created in a disturbed area, it is colonised by a variety of organisms. IMPs may be able to gain a foothold, at least partly because of the open space. It is much more difficult to colonise a habitat that is already occupied by other species (F. Wells, Pers. Comm.).

As discussed in Section 10.0 of this paper, research and monitoring of contemporary scuttled vessels can have benefits for maritime heritage.

It may, however, be interesting to note that some research methods utilise small areas of artificial substrate. In a recent proposal submitted to DEC, independent researchers propose to gather baseline data on invertebrate settlement using a large number (~80) of suspended artificial platforms each with an area of approximately 0.5 square metres. The introduction of these platforms may result in some localised disturbance of the benthos, and a change in fish behaviour in the vicinity where they are established, basically acting as small fish aggregation devices (FADs). While these impacts may not be desirable, the acquisition of baseline knowledge regarding invertebrate presence/absence and settlement rates may be. Similarly, DoF biologists use artificial seaweed as collectors to monitor the puerulus which return from the open sea to settle in coastal waters. This information allows the size of the rock lobster catch to be predicted three and four years in advance (DoF, 2008). These collectors may also act as FADs, and are required to be moored in place for long periods. While the two examples presented here do not

represent permanent AR fixtures, they open an avenue of discussion that may be required in assessing the value of ARs to research and monitoring.

12. Liability

ARs can exist for a great length of time, perhaps beyond corporate and community memory or will. The placement of the tyre tetrahedrons in Geographe Bay in 1987 is a relevant example where Commonwealth and community interest has lapsed resulting in no management of the site being affected for some time.

While the Commonwealth is responsible for issuing permits under the Commonwealth Sea Dumping Act for the establishment of AR, they pass the responsibility for liability onto the permit holder who is required to secure appropriate insurance. In the case of decommissioned naval vessels, the Commonwealth 'gifts' the ships to the State for disposal. The State may be represented by a corporate body, such as a local government or community group. The Commonwealth then has no further interest in the vessel, except in the issuing of sea dumping permits.

The permit holder and leaseholder for the *HMAS Swan Dive Wreck* is the *Geographe Bay Artificial Reef Society Incorporated* (GBARS). This community-initiated body was formed specifically to promote the placement of the *HMAS Swan Dive Wreck* within Geographe Bay for tourism purposes. The lease issued by the State for the 'protection of the wreck site and recreational diving' requires GBARS 'to effect and maintain, throughout the term, a public risk insurance policy for an amount not less than $5 million for any one claim, and where the lessor [State of Western Australia] and the Minister [for Planning and Infrastructure] shall during the term be indemnified against all actions, suits, claims, demands, proceedings, losses, damages, compensation, costs, charges and expenses mentioned or referred to in the lease' (Department of Land Information, 1998). At the time of writing (2008), GBARS was ably maintaining its interest as the permit holder and lessee by sub-letting the lease area to two commercial dive operators for a nominal annual fee to assist with lease fees, insurance costs and the maintenance of moorings at the site (N. Taylor, Pers. Comm.). Even so, should the lease expire and not be renewed in 2019, or perhaps be forfeited, it may become necessary for the State Government to ensure responsible management of the wreck through the most appropriate marine manager. In this case the marine manager may be determined to be DEC under the auspice of the MPRA due to the ARs proximity to the proposed Ngari Capes Marine Park. This could also be the case with the *Saxon Ranger*, which is within the SIMP. Examples of this exist within the United States where permit holders have been unable to afford insurance premiums and as such many states have assumed the role of the permit holder (Murray, 1994).

The purpose for which ARs are established could also come into question in regard to liability if for instance a proponent makes the promise that an AR will enhance recreational fishing, and then it fails to do so. Should fishers not expect a publicly made promise be realised? Additionally, ARs invariably are permitted to be located on public 'land' (Crown land). As such it may be reasonable for the public to expect that land to be utilised as promised. If it is not,

should the public be compensated in some way? Or at the very least, should it not be expected that the AR is removed and the land upon which it lay rehabilitated?

It could also be construed that the issuer of the permit may retain some liability, particularly where the issuer does not appropriately monitor the permit holder's activities or reporting requirements. Legal opinion would be required to determine the level of liability if any the issuer of the permit has in this regard.

In the United States AR managers were seeking advice from their Attorney General, however most AR managers felt that even this would be vague and subject to interpretation until a case comes before a court (Murray & Betz, 1994).

13. Consultation within Western Australia

It is important that AR applicants discuss a proposal with all relevant state government agencies and peak interest bodies such as Conservation Council of Western Australia, Western Australian Fishing Industry Council and/or Recfishwest. The Department for Planning and Infrastructure (DPI) and Port Authorities should be consulted in relation to site selection so as to avoid areas required for safe navigation. The Office of Native Title and Department of Indigenous Affairs (DIA) should provide information on native title claims and claimants or traditional owners who should be notified of an AR application and given the opportunity to comment as per the requirements of the *Native Title Act 1993* (NT Act). Applicants should also be aware if the proposed area is protected under the *Aboriginal Heritage Act 1972.* The Department of Industry and Resources (DoIR) may have an interest in sea areas where an exploration permit has been issued, or where resource extraction is occurring and should be consulted in regard to the *Mining Act 1978* and/or the PSLA. Tourism Western Australia may wish to participate in the planning process to ensure the best tourism outcomes. The Department of Fisheries (DoF) should be consulted in regard to the potential impacts on fishery management and compliance costs if no-take protection is proposed, and heritage and museum organisations should be approached to ascertain the location of important heritage and archaeological features. Local government involvement may also be necessary in relation to planning for land-based infrastructure that may be required in the short and long term to support use. It is also be important to discuss the application with the local community to ascertain whether it is an acceptable proposal to those that utilise the area regularly. Importantly, the MPRA and DEC should be formally approached to provide comprehensive advice and comment on ARs that are proposed to be located in marine parks and reserves or areas of interest to the MPRA in relation to the CALM Act, the *Wildlife Conservation Act 1950* (WC Act) and the EP Act.

Unfortunately, the level of consultation required by the Commonwealth in the issuing of a sea dumping permit for AR appears to have been relatively informal in Western Australia to date. It appears that agencies and groups that should have a strong interest in the placement of AR may not have exercised their right to be consulted. This may in part be due to them being unaware of the application or as in the case of the MPRA in relation to the scuttling of the *Saxon Ranger* in SIMP having no firm ground upon which to base advice or comment.

14. Requirement for an Inventory of AR in Western Australia

An inventory of vessels scuttled in Australia was compiled within a review of sea dumping in Australia (Plunkett, 2003). This inventory is inclusive of vessels sunk in both Commonwealth and State waters and provides the most comprehensive listing of known vessel AR. There is however, no single point of contact that provides information about non-vessel AR throughout Western Australia. This is in part because some ARs were developed prior to the Commonwealth Sea Dumping Act coming into force and in part to some ARs being developed without legal approvals.

An attempt has been made to compile a list of ARs along the Western Australian coast as part of the preparation of this paper. Information was mainly gained through enquiries within regional offices of DEC and DoF, and relied on local knowledge to a large degree. Unfortunately, a response from DEWHA in regard to sea dumping permits issued for Western Australian coastal waters was not available during the writing of this paper.

15. Potential Beneficial and Negative Impacts

The purposes of ARs around the world can be categorised into habitat creation, enhancement, restoration or protection. The motivations of different user groups to create ARs include:

- Fishing enhancement;
- Tourism/recreational opportunity enhancement;
- Science – experimentation and research;
- Mariculture;
- Mitigation/compensation;
- Conservation of biodiversity enhancement;
- Restoration of damaged habitat;
- Protection of habitat or control of fishing using ARs as physical barriers; and
- Fisheries restoration (Pears & Williams, 2005)

In the context of Western Australia, where the marine ecosystem is still in relatively good health overall, the first five may be of most relevance. Most deployments and studies of ARs have taken place in the context of degraded or overfished environments, where there is greater scope for beneficial outcomes (Pears & Williams, 2005). In contrast, the relatively healthy ecosystems of Western Australia may be vulnerable to negative impacts.

There are many reasons that can be put forward for the establishment of ARs and the potential **beneficial impacts** and **negative impacts** are many. The following listing has been developed with reference to as many points of view as possible, internationally as well as within Australia.

Potential Beneficial Impacts

Artificial reef:

- are likely to attract fish (Edwards & Gomez, 2007);
- can contribute to strategic shoreline defence;

- provide additional ‘reef’ habitat for colonisation of an array of marine life;
- increase availability of suitable habitat for reef species which have reached their upper population limits on natural reefs;
- may provide additional refuge for settling benthic organisms, thus allowing the establishment and persistence of a diverse and sustainable food source (Hixon & Brostoff, 1985);
- can act to aggregate fish species in a particular area for ease of management;
- can be built as multiple reefs of various design and be used to dilute user concentration and reduce conflicts (Bohnsack & Sutherland, 1985);
- can be placed to intercept migratory routes of juvenile reef fish to enhance recruitment (Nakamura, 1985);
- can be designed to act as nursery grounds (Nakamura, 1985);
- can be designed to enhance surfing;
- can be designed to be mobile, and be moved around to areas in need of habitat or fishery enhancement for short term benefit;
- can provide research opportunities;
- can be used as effective habitat protection devices to limit trawl access in areas difficult to regulate (Nakamura, 1985; Jensen, Collins & Lockwood, 2000; Edwards & Gomez, 2007);
- can help to mitigate the impacts of overfishing by providing additional habitat for population rejuvenation;
- may act to mitigate or offset detrimental development impacts on natural habitat;
- can provide additional habitat attractive to species under pressure, hence helping to enhance their viability;
- can provide protective habitat for species targeted by underwater and above-water fishers;
- may provide a platform for the translocation of species affected by climate change and/or sea level rise;
- provides a stable substrate for coral restoration (Edwards & Gomez, 2007);
- provides alternative dive sites in areas with high diving pressure on natural reefs (Edwards & Gomez, 2007);
- can be constructed of ‘waste’ material which may present a problem for disposal on land or may be expensive to dispose of on land (e.g. vessels, petroleum platforms);
- provide an instant increase in topographic complexity.

Potential Negative Impacts

Artificial reef:

- can displace naturally occurring habitat and species;
- may be placed in an ad hoc manner, and not be strategically guided unless policy or legislation is in place;
- may break down over time causing materials to be strewn across the benthos causing damage to natural habitat and limiting bottom fishing opportunity;
- may become unstable and represent a liability problem for ‘owners’;
- may attract fish away from natural reef areas resulting in a change in ecological function of that reef;
- may provide habitat for species not normally found in the localised area resulting in a change in ecological function of that area;

- may attract predatory species not normally found in an area resulting in decimation or decline in prey species in the vicinity;
- may focus fishing effort in marked and/or easily accessible locations;
- may not increase biomass, but merely move biomass from another location (Matthews, 1985);
- can be long-term, if not permanent, perturbations of benthic habitat (Buckley, 1989);
- may cause a redistribution of fisheries; (Buckley, 1989);
- may trigger the aggregation and production of resources at locations which are atypical to the natural balance in the ecosystem (Buckley, 1989);
- may be inappropriately designed and placed while there is limited understanding of reef and fish ecology;
- can be expensive to prepare, deploy and maintain;
- can cause conflict between users over sharing access;
- may result in a loss of area to recreational fishing if zoned as no-take;
- may result in greater fishing pressure being placed on natural habitat;
- tend to aggregate fish into one area, which may allow fishers to catch these fish more easily (Branden, Pollard & Reimers, 1994);
- placement can be reactionary rather than strategic resulting in poor location choice;
- materials can be opportunistically obtained;
- may facilitate targeting of 'bottlenecks' in species biology or distributions (e.g. Spawning, aggregation, migration) potentially resulting in rapid depletions of fish populations (Polovina, 1990);
- use can increase pressure on rare or vulnerable species;
- may have the potential to change the surrounding natural ecological function for some distance, depending on their scale and extent;
- creation intrinsically involves the loss of pre-existing habitat (Pears & Williams, 2005);
- may remove or deplete mobile species from surrounding areas (Matthews, 1985; Bohnsack *et al*, 1994; Golani & Diamant, 1999);
- have the potential to create permanent 'haloes' of over-grazed or altered habitat of unknown extent due to a spillover of predators, competitors or grazers onto surrounding areas (Alevizon, 2002); and
- placement may result in rapid decline in target species if regulation of fishing is not commensurate with fishing impacts (or yields).

16. Conclusions

The discussion regarding ARs has many facets. It is an area of discussion which is only just beginning to be explored seriously in Western Australia and has the potential to cause angst within the community if not appropriately and formally dealt with. It is necessary for marine managers, in particular, to participate in a proactive process to fully discuss the issues relevant to their areas of interest in regard to deployment of ARs and to determine a way forward.

As the Commonwealth regulate the issuing of permits for deployment of ARs in State and Commonwealth waters seemingly without giving a high level of attention to environmental impacts beyond the requirements of the EPBC Act and not partaking in strategic siting of ARs in

coastal waters, it may be necessary for the Western Australian State Government to discourage the placement of ARs in Western Australian coastal and inland waters until the State establishes a policy or legislated position on AR deployment.

Such policy or legislation could potentially articulate the objectives under which an AR can be deployed and define the State's requirements in relation to AR proposals in areas such as environmental impact assessment, monitoring of structural integrity and user safety, monitoring and evaluation of objectives, consultation requirements, site specifications, decommissioning or removal requirements, site restoration in the event of AR removal, and an explanation of liability issues.

Prior to the development of policy or legislation, it may be necessary for the State Government to invest in research to evaluate the environmental, social and economic benefits of ARs and to analyse the cost-benefit of AR deployment objectively, both within marine parks and reserves and all others areas of Western Australian coastal and inland waters where ARs currently exist. With the complexities that can accompany the deployment of ARs, their design probably being of most importance, it will be particularly essential that the life history requirements of species expected to inhabit an AR are understood and addressed (Pitcher & Seaman, 2000). Agencies responsible for sea areas, such as the MPRA and Port Authorities, would ideally provide input to policy by establishing positions of their own. It will be vitally important for liability issues to be explored fully by the State Solicitors Office to determine the potential for permit issuers and permit holders to be responsible for the AR, and what may constitute a liability.

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18. Acronyms

AR	Artificial reef
CALM	Department of Conservation and Land Management (WA)
CAMBA	China – Australia Migratory Bird Agreement
CAR	Comprehensive, adequate and representative
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of Environment, Water, Heritage and the Arts (Cwlth)
DRET	Department of Resource, Energy and Tourism (Cwlth)
EARRN	European Artificial Reef Research Network
EPA	Environmental Protection Authority (WA)
FAD	Fish aggregation device
GBARS	Geographe Bay Artificial Reef Society Incorporated
GBR Marine Park	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority (Cwlth)
IMO	International Maritime Organisation
IUCN	World Conservation Union
JAMBA	Japan – Australia Migratory Bird Agreement
MPRA	Marine Parks and Reserves Authority (WA)
MPRSWG	Marine Parks and Reserves Selection Working Group (WA)
NAR Plan	National Artificial Reef Plan (USA)
NRSMPA	National Representative System of Marine Protected Areas
PSG	Policy Stakeholder Group (WA)
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SIMP	Shoalwater Islands Marine Park
SIMP plan	Shoalwater Islands Marine Park Management Plan
UNCLOS	United Nations Convention on the Law of the Sea
WAMM	Western Australian Maritime Museum (WA)

19. Relevant Legislation and Policy

INTERNATIONAL

- *1996 Protocol for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972* (1996 Protocol, formerly the London Convention).
- *Convention on Biological Biodiversity 1993*
- *Convention on Migratory Species of Wild Animals* (Bonn Convention)
- *Convention on the Law of the Sea 1982* (UNCLOS)

- *National Fishing Enhancement Act 1984* (United States)
- *Artificial Reef Act 1989* (State of Texas, United States)

COMMONWEALTH

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Environment Protection (Sea Dumping) Act 1981*
- *Environment Protection (Sea Dumping) Regulations 1983*
- *Historic Shipwrecks Act 1976*
- *Native Title Act 1993*
- *Petroleum (Submerged Lands) Act 1967* (soon to be Offshore Petroleum Act)
- *Sea Installations Act 1987*
- *Seas and Submerged Lands Act 1973*

WESTERN AUSTRALIA

- *Aboriginal Heritage Act 1972*
- *Conservation and Land Management Act 1984*
- *Conservation and Land Management Regulations 2002*
- *Environmental Protection Act 1986*
- *Fish Resources Management Act 1995*
- *Maritime Archaeology Act 1973*
- *Mining Act 1978*
- *Petroleum (Submerged Lands) Act 1982*
- *Western Australian (Marine) Sea Dumping Act 1981*
- *Wildlife Conservation Act 1950*

SOUTH AUSTRALIA

- *Fisheries Act 1982*
- *Historic Shipwrecks Act 1981*

Appendix 1. CALM Act marine parks and reserves at 2008

- Walpole and Nornalup Inlets Marine Park (proposed)
- Ngari Capes Marine Park (proposed)
- Shoalwater Islands Marine Park
- Swan Estuary Marine Park
- Marmion Marine Park
- Jurien Bay Marine Park
- Shark Bay Marine Park
- Hamelin Pool Marine Nature Reserve
- Ningaloo Marine Park
- Muiron Islands Marine Management Area
- Barrow Island Marine Management Area
- Montebello Islands Marine Park
- Barrow Island Marine Park
- Dampier Archipelago Marine Park (proposed)
- Regnard Marine Management Area (proposed)
- Rowley Shoals Marine Park