



5th Western Australian State

COASTAL CONFERENCE 2009

*Whose Coast Is It?
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2C:

Planning Marine
Environments for
the Future:
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Thursday 8th
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Pleiades Room

Management Strategies for Future Sustainability of Fisheries and Biodiversity in Western Australian Coastal Waters

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Abstract

Protection of fish stocks and biodiversity in coastal marine environments is becoming an issue of increasing public concern, and frequently results in calls for improved Government management of coastal waters. Much of this debate flows from international media reports about the degradation of coastal habitats and the collapse of fish stocks, particularly along the north Atlantic coastlines, where relatively uncontrolled fishing by multi national fleets has occurred.

A popular response on how to deal with this issue, is to suggest that large sections of coastal waters should be closed to fishing in marine protected areas, in the expectation that this simple, but often controversial management strategy will provide permanent protection for fish stocks and biodiversity. This concept flows from the successful terrestrial conservation strategy of creating reserves (national parks), to protect residual natural habitats and threatened species resident in these areas. This approach however has serious shortcomings in the marine environment, where legislated boundaries have no practical effect on the majority of marine species, which are highly fecund and mobile at one or all stages of their life history. For this and other reasons, effective fisheries and marine protection strategies require more complex management systems than those used on land.

In Western Australian coastal waters a range of fisheries controls, have been implemented over several decades to ensure the sustainability of the State's fish stocks and supporting habitats/ecosystems. These successful strategies have also had the benefit of providing a very high level of protection for marine biodiversity in WA waters, compared with other parts of the world. As a consequence, the State's marine biodiversity generally remains in essentially pristine condition, apart from a small number of estuaries and small coastal bays, where the terrestrial runoff has altered local biodiversity.

The purpose of this paper is therefore to examine the potential threats to marine resources in WA and assess the potential effectiveness of MPAs based sanctuaries in meeting the *Fisheries Resources Management Act (FRMA)* objectives of sustaining fish stocks and their habitats and therefore biodiversity generally in our coastal waters.

Introduction

Protection of fished stocks and biodiversity generally in the marine environment has become a topic of increasing public and media debate and frequently results in calls for increased Government management of coastal waters. Much of this debate is linked to international examples of degradation of coastal habitats and the demise of fisheries, particularly along the north Atlantic coastlines, where there has been a history of relatively uncontrolled fishing by multi national fleets. Locally these examples of degradation of marine environments and fishery decline tend to be linked in the media to any Government decision to regulate fishing.

A popular response from lobby groups on how to deal with fishing impacts on coastal waters, is to suggest that large sections of the state's coastal waters should be subject to 'marine protected areas (MPAs)' or green zones in the expectation that this simple, but controversial management strategy will both ensure the sustainability of fished species and at the same time protect biodiversity. This logic for this concept, that a series 'green zones' will provide permanent protection for coastal marine resources, appears to flow from the well established terrestrial management strategy of creating reserves (e.g., game reserves, national parks), to protect residual natural habitats and therefore the threatened flora and fauna resident in these areas. However this approach, although appearing sensible to the public, has serious shortcomings in the marine environment, where legislated boundaries have no practical effect on the majority of marine species, which typically produce thousands/millions of offspring and are generally highly mobile at one or all stages of their life history. For these and other reasons, effective strategies to maintain populations of both fished and unfished species (or biodiversity generally) are often counter-intuitive and typically require more complex management approaches than are used in the better-understood terrestrial environment.

The issues of managing coastal fish stocks in WA is further complicated by both State and Federal Government policy initiatives to implement protect representative areas to meet biodiversity objectives, which overlay an array of spatially based fisheries controls. Locally the public debate on the need to protect coastal waters also tends to discount the relatively healthy state of WA's fish stocks (Fletcher and Santoro 2008) and the long standing controls which limit threatening processes off the WA coastline. Given the range of opinions of what constitutes a fish stock and what is meant by biodiversity, it is also possible that many of the apparent disagreements have been generated by inconsistencies in terminology used, spatial scales examined and differing (often unmeasurable or undefined) objectives of the stakeholders involved.

The purpose of this paper is therefore to examine the potential threats to marine resources in WA and assess the potential effectiveness of MPAs based sanctuaries in meeting the *Fisheries Resources Management Act (FRMA)* objectives of sustaining fish stocks and their habitats and therefore biodiversity generally in our coastal waters.

Existing WA Marine Management controls

A range of WA Government controls currently exists to manage the impact of fishing and protect marine biodiversity in WA under the *Fisheries Resources Management Act (FRMA)*, and under the *Conservation and Land Management (CALM) Act*. In addition the Federal government requires all export fisheries to undergo environmental assessment, including biodiversity impacts under the EPBC act.

Under the *FRMA*, the Department of Fisheries controls most fishing activities out to the edge of the continental shelf, and in some cases to the limit of the 200-mile fishing zone. These requirements cover all fish and the habitats that support fish stocks. Note: 'Fish' in the *FRMA* context covers all marine life (including plants), except reptiles, mammals and birds, which are specifically covered by the *CALM Act*.

Existing *FRMA* management systems involve biological controls, eg size limits, an array of spatially based controls and annual assessment processes.

(a) Direct limits on either total catch or fishing effort (to target a catch level)

For commercial fisheries, these controls through fishery management plans, limit each fishery to a specific section of the coast (Fletcher and Santoro, 2008). These arrangements were introduced for the states major fisheries in the 1960s when limits on numbers of commercial vessels were introduced. More recently buy

backs and unit adjustments have reduced vessel numbers to compensate for technology-based increases in vessel efficiency. This process has resulted in the Western Australian commercial fishing fleet being reduced from >4000 vessels (1960s) to less than 1300 vessels in 2008, while catches have been maintained. In addition to these controls the types and sizes of fishing gear used by each vessel is tightly regulated under Fishery management plans.

Similar processes are used to limit recreational catches to sustainable harvest levels involve the use of bag limits and licences and where necessary explicit recreational catch limits are imposed (e.g. Inner Gulf Shark Bay snapper).

(b) Gear and species based closed areas

The primary category of fishery closures, are commercial 'gear' related, and are designed to protect marine habitats from the physical impacts of fishing gear such as trawling (note: dredge fishing is prohibited in all WA waters). These closed areas cover the majority of WA's continental shelf and directly protect most of the marine habitats from direct physical damage from fishing gear (Fig. 1) such that about 90% of continental shelf waters are protected (Penn and Fletcher, in Press). These gear based closure systems provide significant protection for the WA marine habitats, and biodiversity as well as harvested fish stocks. For more detailed information on this system see (Fletcher & Santoro, 2008). For both commercial and recreational fisheries, species based closures are also used extensively to assist in controlling catches (usually at some specific stage in the life cycle), i.e. to protect spawning aggregations or to protect aquatic habitats important to sustain the relevant fish stock. Many of these closed areas covering most of the states coastal waters would qualify under the International Union for the Conservation of Nature (IUCN) criteria (IV, V, VI) as Marine Protected Areas.

(c) Habitat protection and special purpose closures

Fish habitat protection areas (FHPAs) are created to in marine areas (other than in marine parks) to protect special habitats usually for reef or fish observation purposes FHPAs may vary in scale and typically involve the local community as well as the Department of Fisheries in ongoing management of the area. Fisheries closures are also created to provide protection of special areas, from fishing to enhance their use for tourism purposes i.e. closures around the HMAS Swan and the Busselton jetty.

To ensure these management arrangements are effective the Department of Fisheries undertakes annual performance reviews of all fisheries (Fletcher and Santoro 2008). Formal ecological risk assessments are also used at regular intervals to determine which fishing impacts or issues require direct management action or supervision (Fletcher, 2005) and to meet the environmental certification requirements under the Commonwealth *EPBC Act*. This involves structured workshops with stakeholder involvement, which identifies potentially negative impacts across three ecological areas i.e. on the retained species, non-retained (by-catch) species and the broader ecosystem for each fishery. This 'ecologically sustainable development' (ESD) process specifically deals with fishing threats to marine biodiversity and the development of performance indicators for relevant fisheries, to ensure biodiversity is maintained (eg Kangas et al 2007)

As a result of this process and the high level of natural variability in marine populations, management interventions by the Department, are typically required on regular often annual basis. In most instances the variability in the annual productivity/recruitment level of species is often unconnected to the harvesting levels that are occurring. For this reason the management systems for fisheries generally need some level of adjustment annually which in some cases is interpreted as a failure of the management system. However, such interventions reflect the normal operation of a fisheries management system as it successfully adapts to changing stock levels or fishing activities.

Under the provisions of the *CALM Act* the primary management process for protection of marine environments is through the use of marine protected areas. These are created under the New Horizons policy through the *CALM Act*, with all such marine reserves created being vested with the Marine Parks and Reserves Authority (MPRA) and managed under the direction of the MPRA by DEC. Three categories of marine reserves are possible:

Marine nature reserves: This is the highest protection category of reserve and is effectively a sanctuary area, with the primary purpose is to protect areas or habitats of high conservation value. Limited tourism based activities are permitted but no extractive activity is allowed eg Hamelin Pool Marine Nature Reserve.

Multiple-use marine parks: These are implemented and managed by DEC with the Department of Fisheries providing complementary management of fish stocks and fishing activities. Marine Parks are specifically to conserve representative sections of the marine environment. Commercial and recreational activities

compatible with these objectives are permitted, and all other controls on fishing developed under the FRMA still apply. Within marine parks sanctuary zones are the main strategy for maintaining biodiversity. While marine parks have broad conservation objectives their sanctuary zones have some potential to complement fisheries management controls if they are appropriately sited. Conversely the conservation objectives of marine parks can be enhanced by their positioning in areas subject to habitat protection areas created under fisheries management plans.

Marine management areas (MMAs): These areas are used to recognise particular areas which have high conservation values, but allow compatible commercial uses, such as seismic surveys, exploratory drilling for petroleum etc.

In practical terms there is a significant degree of overlap between the marine conservation objectives of the CALM and FRMA Acts. The main differences being in the smaller scale and primarily conservation focus of reserves under the CALM act, compared with the state wide fish and habitat sustainability roles of the FRMA.

Threats to Marine fish stocks and biodiversity in WA

The threats to fish stocks and biodiversity in WA waters have been reviewed in Penn and Fletcher (in press) who report that indiscriminate and destructive fishing practises eg reef blasting, use of cyanide, dredging and drift netting which have caused problems elsewhere are not permitted. The direct effects of permitted fishing activities on fished stocks are all subject to FRMA controls. Of these permitted activities demersal trawling and trapping are the only methods, which has significant potential to cause significant sea floor habitat damage and mortality of non-target species through by-catch discarding. Demersal fish trawling has potentially the greatest impact, and has been implicated elsewhere (e.g. the Gulf of Thailand) in biodiversity changes.

For these reasons demersal trawling has historically been tightly regulated in WA waters (see Figure 1) and is only permitted on restricted areas of the continental shelf. These FRMA controls have resulted in approximately 35% of coastal waters including all sensitive habitats are permanently closed and other controls limit trawling less than 10% of the shelf (Table 1 from Penn and Fletcher, in press). Additionally assessments of this activity for prawns and scallops, have not however found any significant benthic or community related changes in these fisheries (Laurenson *et al.*, 1993; Kangas, *et al.*, 2007). Similarly, finfish trawling is strictly limited to an offshore section of the NW Shelf and controlled by a complex fishing effort management system (Newman *et al.*, 2003). Other demersal gears i.e. fish traps and lobster pots used in WA have also been found to have negligible impacts on demersal habitats (Moran & Jenke, 1989; Chubb *et al.*, 2002).

As a result of the tight controls on all of these demersal fisheries and the above assessments, these fishing practices are not considered to be having any significant impact on WA coastal waters.

Other potential fishing impacts from fishing including fish biomass removals from the ecosystem and removal of keystone species have also been assessed and not found to be having an effect under the existing FRMA controls (Penn and Fletcher, in press)

In addition to fishing related effects there are a number of other non-fishing impacts that have the potential to affect fish stocks and biodiversity. In WA coastal waters these include risks from Terrestrial run-off, the maritime transport industry, the petroleum/gas exploration industry and changes in climatic cycles. With the existing management systems in WA the main risk to fish and diversity is from terrestrial runoff in some SW estuaries and embayments where populations of estuarine dependent species have been affected and impacted on local diversity. Climate change is also likely to have an impact on regional diversity by cause a gradual southward shift in the distribution and abundance of most marine species.

In summary, there are relatively limited fishing related or environmental threats to fish stocks and ecosystems in WA waters compared with the threats reported for other parts of the world (Roberts *et al.*, 2002).

MPAs efficiency for managing fish stocks and habitats

As noted in the introduction, the general public perception of MPAs in Australia is that they are 'no-take' sanctuary areas, equivalent to national parks on land. Consequently, given this public perception of the role MPAs, this section will focus on the relative value of sanctuaries (including no-take FHPAs under the FRMA) as a strategy for achieving state-wide fishery and general marine sustainability objectives.

For WA in particular, the management arrangements already in place under the FRMA and annual monitoring of fished stocks, suggests that there will be few if any of the assumed benefits to overall fisheries productivity or stock sustainability. This is due to the following assumptions and misconceptions about the benefits of sanctuaries.

Misconception 1: Sanctuary areas will operate similarly in marine and terrestrial ecosystems

This misconception is largely a function of the general public's experiences with the way terrestrial reserves operate, where the protection of residual natural habitats (e.g. National Parks) is the primary method used to maintain biodiversity and ecological values. While sanctuaries can clearly protect any sessile/attached stages of marine species, there are a number of critical differences between the terrestrial and marine environments and the way that marine species interact with their environment, (Fletcher, 2003; Halse, 2003) which affects performance. The primary difference is that unlike most terrestrial species, virtually all marine species (including corals and plants) have relatively high levels of movement/dispersal during their larval stages, and most animals also move as adults or juveniles or both. Consequently there is much greater opportunity for the transfer of individuals of most marine species both into and out of any single area, including sanctuaries. That is, species cannot be fenced in or out in the marine environment and re-colonisation processes typically occur irrespective of the protection regime applied to a particular area.

A second fundamental difference between marine and terrestrial systems is that almost all human development activities in the terrestrial environment result in an extreme level of modification to the natural ecosystems/habitats i.e. through urbanisation, farming and grazing etc. Consequently, the total protection of residual natural terrestrial areas, through reserves (sanctuaries) is only method available for protecting vulnerable species and their habitats. In contrast to this terrestrial situation, sustainable commercial and recreational fisheries production is totally reliant on the natural marine habitats and ecosystems continuing to function. That is, if harvested fish stocks are to be maintained their habitats and supporting food webs must be protected in their entirety rather than just in small reserves.

Misconception 2: More eggs produced automatically means more recruitment to a fish stock

One of the common arguments used for the concept of marine sanctuary zones, is that the fish in these reserves will become more numerous, grow larger and produce more eggs/larvae. Increases in egg production are then assumed to 'automatically' increase the level of recruitment both inside and outside the sanctuary. This assumption that recruitment levels will directly increase with higher levels of egg production, is incorrect, except in the relatively rare situation where the spawning stock is severely depleted over its entire distribution.

The relationship for most fish species between the level of egg production and the recruitment that this generates i.e. the spawner-recruitment relationship (SRR), follows a pattern whereby recruitment only increases with egg production levels until it reaches an asymptotic level (see Fig. 2a). This asymptote is typically reached at spawning stock levels of between 10–60% of unfished levels, depending upon the life history characteristics of the species (Fletcher et al., 2003). Once the spawning stock size level is in this asymptotic region (or egg saturation zone; Fig. 2a), any additional egg production will not increase the average number of recruits surviving to add to the population the following year. The appropriate breeding stock levels for marine stocks is further complicated for some species; where the recruits inhabit the same space as the adults, and exhibit 'Ricker' style SSR relationships (see Fig. 2b). In these situations increasing the stock of adults beyond moderate levels can actually reduce average recruitment levels, due to increased competition for space (e.g. abalone) or even direct predation of the eggs/juveniles by the adults (Valdes-Szeinfeld, 1993). Secondly, even where breeding stock increases are needed, the mobility of most marine species usually limits the effectiveness of sanctuaries for this purpose.

Within WA few marine species are currently assessed as being recruitment overfished (Fletcher & Santoro, 2008), therefore any increased egg production generated by management processes are unlikely to noticeably increase the level of recruitment of juveniles to these stocks. In WA species with depleted breeding stocks include a number of highly migratory shark species for which small sanctuary zones would provide little benefit. Other species where breeding stocks are low are already subject to direct controls on catches including some species-specific breeding area closures. These SSR principles above also apply to unfished populations and those taken as by-catch, such that sanctuary closures are unlikely to change biodiversity generally.

Misconception 3: Increased local abundance equates to increased productivity at a population level and will generate spill over to adjoining areas

The increases seen in the local abundance of some species within sanctuary zones is often cited as being proof that these areas have generated increased fisheries productivity. This was elaborated in theoretical detail by Ward *et al.* (2001), and is mostly based on research on changes in the local densities of fish stocks within marine protected areas in locations such as the Philippines (e.g. Russ and Alcala 1996; Russ *et al.*, 2004) and Florida (Roberts *et al.*, 2001), where normal fisheries management has been lacking or ineffectual and fish stocks and habitats outside the sanctuary have been severely depleted. There is, however, little empirical evidence for more widespread, whole-of-stock benefits resulting from such local increases.

Thus Russ (2002) concluded that:

‘The current literature on marine reserves as fisheries management tools is dominated by papers reviewing or modelling what marine reserves could [emphasis in original] do as fisheries management tools. There seems to be a remarkable paucity of good empirical studies...’

Subsequent to this review a number of studies have outlined benefits for fisheries from the establishment of sanctuaries. These were, however, still relatively small-scale, being restricted to the regions immediately surrounding the sanctuary (e.g. Russ *et al.*, 2004; Roberts *et al.*, 2001), not stock-wide benefits. Such improvements in local productivity are often categorised as ‘spill over’ benefits. These benefits will clearly depend on the mobility of the species involved, which need to be resident in the sanctuary long enough to for numbers to build up/grow, but also migrate. Few species fit these criteria and these are co-incidentally more easily researched. The second factor often present where ‘spill over’ effects are observed is a high level of depletion in adjacent waters open to fishing. In such areas spill over will be easier to observe and may significantly increase local catches but is unlikely to enhance the depleted stock as a whole.

Whilst there is some evidence that increases in local densities of some WA species may be generated in sanctuary areas (Westera *et al.*, 2003; Nardi *et al.*, 2004) the effect at a species or stock level is quite variable. For example in the Abrolhos Is study, long term FHP closures over 17% of the Abrolhos shallow coral reef habitat showed no build up for baldchin grouper (*Choerodon rubescens*), while the more sedentary coral trout (*Plectropomus leopardus*) took about 5 years to show an increase. Production from the baldchin grouper stocks which dominate local catches, have remained relative constant from the mid 1990s to 2006 (Wise *et al.*, 2007) despite large sanctuary areas.

Misconception 4. Declaring a sanctuary will automatically reduce the fishing pressure on fished stocks in the area.

When sanctuaries are implemented it is often assumed that they will reduce fish catches proportionally to the area protected. While the fishing within the sanctuary is clearly reduced (assuming full compliance) any closures will result in a redirection of some or all of the fishing effort being displaced into the remaining ‘open’ areas. This effort redirection problem is particularly acute for relatively sedentary species e.g. in abalone where the reduction in catch from a stock will be directly proportional to the area of reef protected. Under these circumstances, not reducing the overall catch to account for this loss of area can have serious implications for the sustainability of the remaining resource. Sanctuary zones for any purpose (or fishery closures) should not, therefore, be established in isolation from a review of other fisheries management arrangements operating in the region and must take into account the potential for effort redirection.

Discussion

There is considerable scientific debate worldwide about the relative value of marine protected areas and particularly marine reserves (or ‘no-take’ sanctuary areas) for use in the management of fish stocks (e.g. Hilborn *et al.*, 2004). Statements have been made that they are an essential part of any fishery management plan (e.g. WWF, 2002), whilst others suggest that they are not necessary to enable sustainable fisheries management (e.g. Halse, 2003).

Developing effective strategies for managing fish stocks and therefore maintaining biodiversity is further complicated by the largely counter-intuitive relationships between spawning stocks and recruitment, local fish abundance and total stock size, and the ability of fishers to respond to management noted above. These relationships are also the likely reason for the lack of empirical scientific evidence for overall benefits to fisheries productivity from sanctuaries. Secondly, given the vastly different geographic ‘footprints’ of most species, sanctuaries will always be a compromise in terms of the level of protection afforded to each species

(Fletcher, 2003). Because they can rarely be arranged to protect more than one species, any increase in local abundance of one stock may not exceed the loss of sustainable production for other sympatric species.

A good example of the management complexity required to effectively protect a range of species in an area, is the Shark Bay section of WA. More than half this area is permanently closed to trawling, with other parts of the region having seasonal closures (Fig. 3). Some other forms of fishing (e.g. beach seining) are, nonetheless, still allowed in these permanent trawl closures (Fig. 4). The use of sanctuaries alone to sustain the range of fish stocks in this situation is not feasible, as they would effectively cover most of the region. While the fisheries management arrangements in this region are of necessity very complex, they have proved effective over more than 40 years in sustaining an array of fish stocks, without compromising regional biodiversity.

Conclusions

In WA where comprehensive fisheries management controls were introduced early, the potential for fishing impacts on marine species and biodiversity has been relatively limited. As a result of these controls about 90% of WA continental shelf waters and habitats have levels of protection regarded as 'marine protected areas' in the IUCN context (Penn and Fletcher, in press). In this situation, additional sanctuary areas are unlikely to significantly increase protection for WAs marine fisheries and biodiversity.

Regarding the use of marine park based sanctuaries (or no-take FHPs) to meet the various policy objectives of Government, it is our assessment that they will be more valuable and less contentious, where they are scaled appropriately to their primary purpose of preserving representative examples of biodiversity; providing for no-take ecotourism uses, or sites for long-term scientific monitoring. While there is a clear basis for the establishment of marine sanctuaries to meet these Government requirements, there is, however, no scientific basis within the WA context to justify their use simply as a precaution against undefined 'bad practices' in fisheries management. It is further suggested that the planning process for future MPAs and sanctuaries within the marine waters of WA, would be more efficient and outcomes better if it were to follow the IUCN suggestion (Kelleher 1999) to recognise and build on existing protections for marine biodiversity, such as those provided by the FRMA.

Acknowledgements

The assessments and conclusions presented in this paper have been derived from a report by Penn and Fletcher (in press) which provides a more comprehensive assessment of the efficacy of sanctuaries for managing the fish resources and associated habitats on WAs continental shelf.

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Figure 1. Areas and boundaries for trawl fisheries and non-trawling areas in WA waters out to the 200metre depth contour or edge of the continental shelf. (from Fletcher and Santoro 2008).

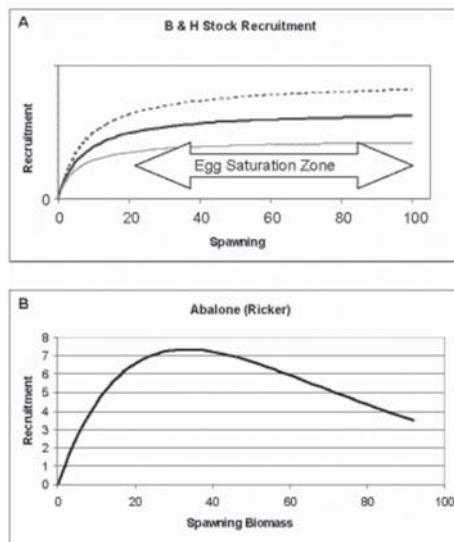


Figure 2. Basic Stock recruitment curves. A) The Beverton & Holt (B&H) curve is the curve mostly applied for finfish and many invertebrates. B) The Ricker curve applies to some species (such as abalone) where space for recruitment is limited and the density adults can affect survival of recruits at high breeding stock levels.

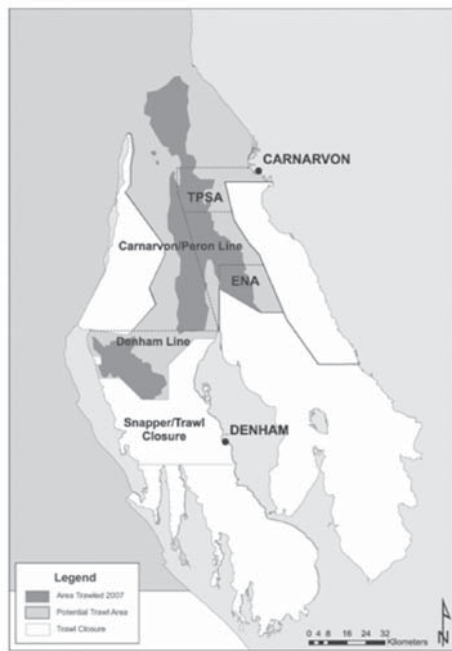


Figure 3. The Shark Bay prawn fishery area showing the permanent closed areas, the temporary extended nursery areas (ENAs), tiger prawn spawning area (TPSA) closure, snapper trawling closure and the actual areas trawled (from Fletcher and Santoro, 2008).

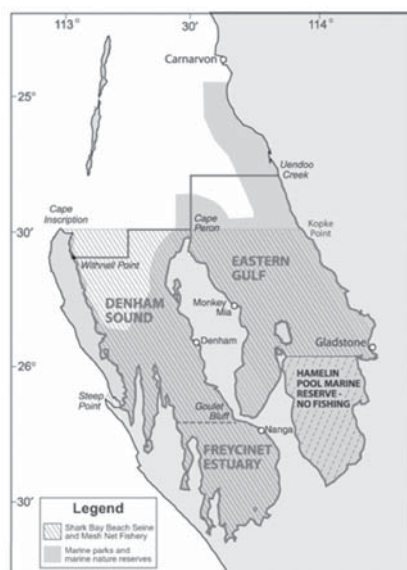


Figure 4. The Shark Bay area showing the boundaries of the Beach Seine and Mesh Net Fishery, the boundaries of the Shark Bay Marine Park and the Hamlin Pool Marine Reserve (from Fletcher and Santoro, 2008).