North Coast Bioregion

REGIONAL MANAGEMENT OVERVIEW

The north coast bioregion extends from Onslow to Kununurra and is dominated by the production of pearls from the species *Pinctada maxima*. This industry is reported separately in the following pages.

Other aquaculture management initiatives in the north coast bioregion were focused on assisting the Department of Land Administration with the development of an expression of interest for prawn farming on the Dampier Peninsula. This is aimed at attracting investment in prawn aquaculture involving local indigenous communities.

Through the Kimberley Aquaculture Research Project initiated by the Kimberley Development Commission, hatchery technology of *Penaeus monodon* was successfully transferred to the multi-species hatchery in the Broome Tropical Aquaculture Park. Assistance by Aquaculture Development Officers in identifying black tiger prawn broodstock locations played an important part in what is now considered a good basis for prawn farming in the region.

The services provided at the Broome Tropical Aquaculture Park were upgraded and a 12-month promotional campaign aimed at attracting further investment was launched this year.

North Coast Aquaculture Figure 1 shows the major licensed aquaculture and pearl farming sites in this bioregion.

REGIONAL DEVELOPMENT AND COMPLIANCE OVERVIEW

The principal development activities focused on public enquiries and planning for future aquaculture expansion in the north coast bioregion. Indigenous aquaculture expanded, with Aquaculture Development Officers assisting with feasibility studies in several locations across the Kimberley covering aquarium fish, cherabin (*Macrobrachium rosenbergii*), redclaw (*Cherax quadricarinatus*) and barramundi (*Lates calcarifer*). The recently completed multi-species hatchery is set to produce trochus (*Tectus niloticus*), which will provide benefits to Aboriginal corporations with aquaculture licences for reef-top molluscs.

Compliance activities in this region are dominated by pearling, which is reported separately. In addition, Aquaculture Development Officers carried out site inspections for new licence applications and to ensure compliance with existing licence conditions.

REGIONAL RESEARCH OVERVIEW

During 2001/02, research staff took a lead role in commissioning the Aboriginal-owned multi-species hatchery at Broome. This hatchery will provide stock for enhancing reefs near King Sound. Research staff also completed an international project funded by the Australian Centre for International Agricultural Research, the Aboriginal and Torres Strait Islander Commission and the ADF. It showed that hatchery-reared trochus, when released on some reefs, can increase densities of larger trochus.

A major study of salt field biota, including *Artemia* (brine shrimp) resources, has been completed in one major salt field. The Department of Fisheries has helped fund broodstock and hatchery production trials with marine prawns at the Kimberley College of TAFE and the multi-species hatchery at Broome. Research on disease status of wild prawn stocks used for broodstock has provided encouraging results and is continuing. Research staff also helped identify very large, coastal land-based sites with potential for aquaculture (see Gascoyne Regional Research Overview, p.171) as well as a range of large sites with potential for prawn farming on the Dampier Peninsula (by agreement with Aboriginal communities). A modelling study has been initiated with the University of WA to predict water temperatures in prawn farming ponds, depending on location and farm design.

PEARL PRODUCTION

Management Summary

Activities within the Western Australian *Pinctada maxima* pearling industry range from the hatchery production of oysters suitable for the seeding of round pearls, to the fishing of wild-stock oysters for the culturing of pearls on a large number of pearl leases situated in the State's northern waters. Management of the industry in accordance with the *Pearling Act 1990* is focused on ecologically sustainable development principles, ensuring a sustainable catch from the wild, minimising the impact of pearling on the marine environment and optimising the returns to the State through controls on hatchery production to maintain high pearl prices. The Department of Fisheries' research program conducts annual stock assessment and ongoing disease monitoring programs to ensure the industry remains in a healthy condition. These management arrangements have been developed over the years in conjunction with the Pearling Industry Advisory Committee (PIAC), a Ministerial management advisory committee established under the *Pearling Act*.

The wild-stock pearl oyster fishery is managed on a system of individual quotas with a total allowable catch. The status of stocks is reviewed each year by the Department of Fisheries in liaison with pearling licensees and PIAC. There are 16 pearling licensees, who hold between them 572 units in the wild-stock fishery and 350 hatchery units.

The research data for 2001 showed that wild pearl oyster stocks in Zone 1 had been slow to recover from past cyclone events, therefore the TAC from Zone 1 for the 2002 season was reduced from 115,00 to 55,000 shell in 2002 to further relieve pressure on the stocks. Zone 1 licensees are permitted to substitute hatchery-produced oysters for wild captured oysters to maintain their annual pearl production. A maximum size limit of 160 mm was maintained for shell taken in Exmouth Gulf to protect the breeding stock.

The TAC in 2002 in Zone 2/3 was also reduced marginally from the previous year's level of 1,100 oysters to 1,050 oysters per unit. This reduction was made in response to the catch rate data, which indicated that a past peak in recruitment had now moved through the target size class and the shell stocks were returning to their more normal sustainable levels of 1,000 shell per unit.

The seeding of hatchery-produced oysters continued during 2001/02, with most companies having now demonstrated an adequate commitment to hatchery technology to enable the conversion of their hatchery options to hatchery quota.

Pearl oyster farms are predominantly situated in sheltered waters and range from Exmouth Gulf to the northern waters of the Kimberley. There are presently 94 pearl farm leases, covering a total area of 184 square nautical miles.

Assessment of pearl farm lease applications through a public consultation process continued to be a major activity throughout 2001/02. The Executive Director of Fisheries considered nine lease applications and the Minister determined two appeals. Meetings were held with the pearling industry, tourism charter boat operators, the Wyndham/East Kimberley Shire Council and environmental groups to discuss concerns about access to sheltered bays and perceived loss of wilderness opportunities in the Kimberley.

Overall, 2001/02 was a difficult year for the Western Australian pearling industry. The industry experienced a decline in pearl prices resulting mainly from the general economic downturn, particularly in Asia, and over-supply of low- to medium-quality pearls on the global market. Consequently, several pearling companies rationalised their operations to improve competitiveness. The annual value of production of the Western Australian pearl industry in 2000/01 was estimated to be around $150 million, compared to previous years' figures which fluctuated between $180 million and $220 million.

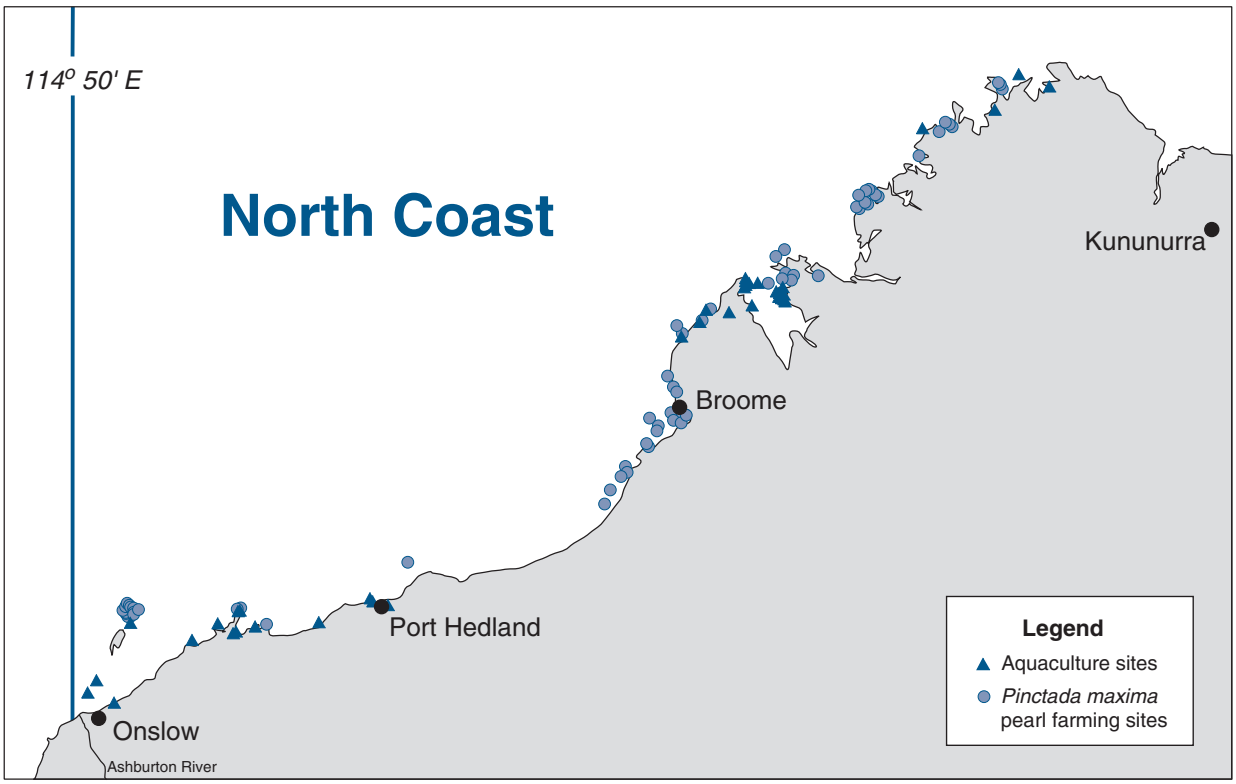
PIAC met on three occasions, with an extraordinary meeting held in February 2002 to consider the strategic direction of the industry, given the economic climate.

The Government announced its decision in relation to the National Competition Policy review of the Pearling Act in March 2002. Implementation of the recommended outcomes will be ongoing throughout the coming year. The review of the legislative framework for pearling also continued during 2001/02, with significant progress made towards the development of a new Pearling Act. Legislative provisions to implement the NCP outcomes will be considered during this process.

The pearl oyster fishery was subject to an ESD assessment to meet the Commonwealth Government's export approval requirements. Industry members, conservation groups and Departmental staff contributed to an environmental risk assessment workshop for pearling, which provided the basis for the ESD assessment report. The draft assessment, which is still to be considered by Environment Australia, indicated that pearling is an environmentally benign industry and the environmental risks surrounding fishing for pearl oysters or farming pearls are insignificant.

Other issues, including budget development and management, operational planning and management of pest incursions, continued to be a focus of attention during 2001/02.

An unknown parasite was detected in pearl oyster spat on a pearl farm in Zone 1. The Department's emergency response plan was invoked to ensure that the parasite was not spread



NORTH COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture and pearl farming sites of the north coast bioregion. Note that aquaculture operations may also encompass the culture of non-*Pinctada maxima* pearl oysters.

throughout the fishery while investigations were under way to determine its possible impact on the industry. While the source of the parasite has not yet been determined, it appears that the parasite only affects young shell and poses no significant risk to pearl production or the environment.

Governing Legislation/Fishing Authority
Pearling Act 1990

Consultation Process
Pearling Industry Advisory Committee
Department–industry meetings

Compliance and Community Education Summary

During 2001/02, Fisheries Officers based in Broome, Karratha and Exmouth undertook compliance monitoring across all zones of the pearl oyster fishery, from Exmouth Gulf (Zone 1) to the Kimberley development zone (Zone 4). Fishing operations in Zone 1 of the fishery are now all monitored by VMS.

During the year, officers accompanied pearl catcher boats to sea to monitor fishing activity on a daily basis and also to investigate ways of reducing compliance costs to industry.

Companies have continued to increase production of hatchery-reared shell, and the compliance focus has shifted to the monitoring and control of this product. Compliance issues involving the verification of shell numbers, plus the movement of hatchery shell within and between farms, have been made a higher priority. Regular farm and nursery site inspections were conducted to monitor hatchery shell growout and to ensure that farms and leases were appropriately marked with navigational markers to approved standards.

All but two companies have now converted their hatchery options to quota and there has been an increase in the quantity of hatchery-reared shell being used for seeding operations in lieu of wild stock.

Wild-stock quotas continued to be monitored through a combination of quota tags and a paper audit trail using catch, dump, transport and seeding operations logbooks submitted by licensees to the Department. The production and translocation of hatchery-produced pearl oysters is also monitored by the system of hatchery and transport logbooks combined with a system for disease testing, quarantine and health certificate clearances from the Department's Fish Health section. As a result of a routine pathology test of pearl oysters grown in Zone 1, an unknown parasite was discovered requiring quarantine procedures to be introduced for the movement of all pearl oysters from two pearl farms in this zone. Fisheries Officers were required to ensure that strict quarantine restrictions were complied with.

Patrols to verify compliance with tagging and associated logbook systems utilised diving inspections, aircraft, both large and small agency patrol vessels and industry boats. The majority of at-sea inspections and patrols were carried out using the Department of Fisheries' ocean-going patrol vessel *Walcott*, with small agency vessels being used as dive platforms.

Research Summary

Research for managing the pearl oyster stocks utilises detailed diver logbook records (catch and effort), at-sea sampling of catches and information gathered during research projects. This information is used to monitor the status of the stocks and to review and set catch quotas each year.

An FRDC project, which began in 2000, seeks to determine an index of recruitment for the pearl oyster fishery by assessing settlement of spat of *Pinctada maxima* on adult oysters (piggyback spat). The Division's fish pathology group also provides a comprehensive disease testing program to monitor pearl oyster 'health' issues within the industry.

In addition to these Departmental projects, significant research and development on the pearl production cycle is undertaken directly by industry.

PEARL OYSTER FISHERY STATUS REPORT

Prepared by C. Skepper

FISHERY DESCRIPTION

Boundaries and access

The pearl oyster fishery of Western Australia accesses silver-lipped pearl oysters, *Pinctada maxima,* in shallow coastal waters along Western Australia's North West Shelf. There are currently 16 licences operating in the fishery, with a total of 12–16 vessels fishing for pearl oysters in any given year. The fishery is separated into four zones (Pearl Figure 1), and each licence is allocated an individual shell quota as part of an overall TAC.

The four management zones of the pearl oyster fishery are as follows:

Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30' E. 5 licensees.

Pearl Oyster Zone 2: East of Cape Thouin (118°20' E) and south of latitude 18°14' S. 9 licensees.
Note: full access for Zone 2 licence holders to Zone 3.

Pearl Oyster Zone 3: West of longitude 125°20' E and north of latitude 18°14' S. 2 licensees.
Note: partial access for Zone 3 licence holders to Zone 2.

Pearl Oyster Zone 4: East of longitude 125°20' E to WA/NT border.
Note: although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not viable. However, pearl farming does occur.

Main fishing method

Diving.

RETAINED SPECIES

Commercial production (season 2001): 571,415 shell

Landings

In 2001 the total allowable catch for the pearl oyster fishery of north-western Western Australia was 617,500 shell (including a 2,000 shell special allowance for tourism purposes).

The Zone 2/3 TAC for 2001 remained at the level set in 2000 (502,500 shell), which was 10% greater than the TAC set in 1998 and 1999. This total allowable catch was allocated because average catch rates within Zone 2 for the previous season were at least 50% greater than a pre-defined 10-year average. The reported catch for Zone 2/3 for the 2001 season was 502,484 shell (Pearl Table 1).

Zone 1 of the pearl oyster fishery had a TAC of 115,000 shell in 2001. The reported catch of 68,931 shell (Pearl Table 2) was similar to 2000 but well below the allocation, as some licensees chose to use hatchery-reared shell in preference to wild stock during the 2001 season, effectively resulting in a TAC of 70,000. This conversion to hatchery stock is due to a decrease in economic viability of harvesting wild-stock culture shell in Zone 1 through lower availability of culture-sized shell and the increased effort required to fill wild-stock quotas in recent seasons.

Fishing effort

Total effort in all zones was 21,534 dive hours, within the acceptable range (15,331–22,599 dive hours) defined for all zones in 2001. The total effort for 2001 in Zone 2/3 was 12,054 dive hours (acceptable range 12,003–16,576 dive hours), which represented a 30% increase on the 2000 Zone 2/3 effort of 9,258 dive hours. This increase reflects a shift in effort towards a more traditional figure for Zone 2/3, as the effort in 2000 was the lowest ever recorded. The total effort in Zone 1 during 2001 was 9,480 dive hours, representing a 61% increase on the 2000 total effort of 5,893 dive hours, and well above the acceptable range (3,328–6,023 dive hours) defined for Zone 1. This increase in Zone 1 occurred despite there being only a slight increase in catch (Pearl Table 2), and may be attributed to three main factors: firstly, a lower abundance of culture-size shell (120–165 mm), particularly in the northern and southern sectors of the fishery; secondly, poor diving conditions experienced on traditional fishing grounds; and thirdly, loss of traditional fishing grounds in some areas of Exmouth Gulf due to cyclone damage.

Catch rate

The catch rate for the pearl oyster fishery (all zones) was 26.5 shells per dive hour (shells/hr) in 2001. This represents a 29% decrease on last season's overall catch rate (37.5 shells/hr).

Catch per unit effort in Zone 2/3 in 2001 was 41.7 shells/hr. Although this was lower than the rates recorded in 1999 and 2000 (when CPUE at 54.2 shells/hr was the highest ever recorded), it still represented a 41% increase on the 10-year (1988–1997) average of 29.5 shells/hr (see Pearl Table 1). As in 2000, the high catch rates in Zone 2 were not as evident in Zone 3. In Zone 2, the catch rate was 42.5 shells/hr, while in Zone 3 it was 31 shells/hr.

The Zone 1 CPUE in 2001 was the lowest ever recorded at 7.3 shells/hr, which represented a 36% decrease from 2000 (Pearl Table 2). Effort in 1998–2000 shifted across Zone 1, from the historically significant southern sector (Exmouth Gulf) to the northern sector (including the buffer zone extension) around Port Hedland. In 2001 effort shifted again, with the southern sector yielding just 4% of the catch (compared to 50% of catch on average since 1990), while the northern sector contributed only 10% of the catch (32% of catch on average since 1990, and 64% since 1998).

Previously under-utilised areas in the middle sector of Zone 1 provided 86% of overall landings in 2001. The catch rate in the northern sector has steadily decreased from 26.4 shells/hr in 1998 to 6 shells/hr in 2001, while in the southern sector catch rates fell to 3.3 shells/hr, continuing the rapid decline in this area which has been affected by cyclone damage. Although significant catches were taken from the middle sector in 2001, the catch rate in this area fell to 7.9 shells/hr.

Recreational component (2001): **Nil**

Stock assessment completed: **Yes**

Zone 2/3: In Zone 2/3 the high level of catch rate recorded in recent years (1994–1996 and 1999–2001) had previously only been experienced during the late 1970s and early 1980s when the pearling fleet was fishing both culture and mother-of-pearl (MOP) shell. When comparing catch rates over the history of the fishery, however, the technological changes related to the introduction of GPS in the early 1990s need to be taken into account. The increase in diver efficiency resulting from this technology had probably stabilised by the mid-1990s, such that catch rates since that time can be directly compared, but are likely to be biased upwards when compared with those prior to 1990.

The high catch rates recorded in 1999–2001 are undoubtedly due mainly to a large pulse of recruits passing through the size range targeted by the fishery. A similar pulse was recorded previously in 1994–96, when the total allowable catch was also increased in response to a high level of recruitment. This increase in recruitment abundance can be partially attributed to the presence of environmental conditions enhancing larval and juvenile survival in the preceding two years. Increases in recruitment have been observed one to two years after ENSO events, with the latest event occurring in 1997/98. Weather patterns and underwater visibility in Zone 2/3 were again favourable during the main fishing periods in 2001, with the resulting good diving conditions and consequent increase in catchability also having a positive influence on catch rates.

The distribution of catch and effort in Zone 2/3 during 2001(as reported in 10 x 10 mile grid squares) was similar to that in 2000, with catches made in less than half the area that was utilised at the beginning of the 1990s. This decrease in effective search time and fishing area again reflects both increased stock abundance and the fleet's ability to target productive areas through the use of GPS and plotter technology. During recent seasons, favourable conditions have also allowed fishers to concentrate fishing effort in shallower water (< 12 m on average), which further increases efficiency by providing additional bottom time. During the last six years the average depth fished has generally decreased.

Assessment of the size of oysters fished in Zone 2/3 shows that around 60% of the catch comes from the 120–140 mm shell height size classes, which are the smaller, newly recruited oysters preferred for pearl culture. These results, together with the fact that an increasing proportion of the fishable area off the Eighty Mile Beach is not being fished annually, suggest that the overall exploitation rate in this sector of the fishery is decreasing.

Zone 1: The distribution of catch and effort in Zone 1 shifted considerably in 2001 when compared to 1998–2000.

Management decisions designed to reduce fishing pressure in Exmouth Gulf were implemented in 1998, and involved setting a separate TAC of 40,000 shell for Exmouth Gulf, and extending the Zone 1 buffer zone 30 miles east to allow operators access to previously under-utilised grounds in the southern areas of Zone 2. Further management arrangements were introduced for the 2001 season, with a TAC of 25,000 shell applied to the northern sector (which includes the buffer zone extension) of Zone 1 in an attempt to control fishing pressure in this area. In addition, the northern sector was divided into three sub-areas, with a TAC for each sub-area also introduced.

During the period 1998–2000 the northern sector had provided 52–75% of the Zone 1 catch, although catch rates decreased every season. The catch from the northern sector decreased significantly during the 2001 season, with a sharp decline in catch rate. Catch monitoring during this period has revealed that fishers are reliant on taking a percentage of catch from larger, less sought-after shell sizes (150–165 mm shell height). In addition, trial 'piggyback' spat collection results were low relative to those recorded for Zone 2/3 of the fishery. The generally low spat collection results are in line with the general assessment that recruitment in Zone 1 is lower and less regular than in Zone 2/3.

Fishing grounds in the middle sector of the fishery which were productive historically provided 86% of the overall Zone 1 catch in 2001, although the very low catch rates recorded must remain an area of concern. The significant increase in catch from this area follows steadily improving catches in recent years, and signs of increased recruitment based on length frequency sampling which shows a high proportion of recently recruited oysters. The middle sector had provided only limited numbers of pearl oysters during the 1990s owing to poor recruitment and unfavourable diving conditions, and consequently has been fished only lightly in recent seasons. The concentration of effort in this sector during 2001 has eased fishing pressure in the previously heavily fished northern and southern sectors of Zone 1.

Exmouth Gulf (southern sector) was lightly fished during 2001, with poor catch rates continuing the trend of declining catch rates in this area during recent seasons. In addition to the loss of productive ground through cyclone impacts on the sea floor, some traditionally productive fishing areas in the south of the Gulf are no longer being fished because they are contained within pearl farm lease boundaries.

The shift in distribution of effort towards the middle sector in 2001 highlights the concerns regarding productivity in Zone 1. While encouraging numbers of pearl oysters were taken from the middle sector, the other sectors have declined considerably in 2001 when compared to catches taken since 1998. Management controls in the southern and northern sectors will again focus on limiting effort and encourage the rebuilding of pearl oyster stocks in these areas (see 'Fishery Governance'). If there is a further decline in abundance indicators in 2002, further controls will be required in this fishery.

Exploitation status: **Fully exploited**

Pearl oyster stocks are considered to be fully exploited within the management parameters of diver safety and maximisation of the value of the pearl crop.

Breeding stock levels: **Adequate**

As *P. maxima* are protandrous hermaphrodites, oyster stocks do not have a full complement of females until shell sizes reach approximately 180 mm shell height. Pearl oyster fishers prefer to harvest oysters between 120 and 165 mm shell height, hence oysters larger than 165–170 mm remain in the fishery as breeding stock.

Zone 2/3: The fishery focus has moved away from deep-water pearling grounds that now remain unfished or only lightly fished. Research surveys of these areas confirm good abundance of larger mother-of-pearl shells. Stocks remaining on these deeper and more distant pearl grounds will be contributing to an increased abundance of breeding stock given the longevity of the species.

Zone 1: The breeding stock levels in Zone 1 are maintained by the upper size limit, but are of greater concern due to the high levels of fishing pressure on recruits. The setting of separate quotas for previously heavily fished areas such as Exmouth Gulf has been designed to generate flow-through to breeding stock. Breeding stocks in the south of Zone 2 are also expected to provide recruitment to the northern area of Zone 1.

NON-RETAINED SPECIES

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*) and do not inadvertently harvest any bycatch in their normal fishing activities. Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). Any such organisms are removed from the oyster and put back in the water prior to the oysters being placed in mesh panels. A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

ECOSYSTEM EFFECTS

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds, and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The more significant habitat contact is by pearl oysters held in mesh panels on holding sites following capture. These sites, however, cover a very small proportion of the habitat, and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats.

SOCIAL EFFECTS

Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome down to Exmouth Gulf in the south. The 12–16 fishing vessels presently operating each have 10–14 crew involved with the fishing of pearl oysters

between January and July each year. These vessels also support a number of other pearl farm functions throughout the year. Fleet managers are employed by pearling companies to coordinate and support vessel operation.

ECONOMIC EFFECTS

Estimated annual value (to fishers) for year (2000/01): $150 million

The value of cultured pearls and by-products is considered to be approximately $150 million for the year 2000/01. However, a precise estimate of the value of product is difficult to achieve owing to the variable time lags which occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place.

FISHERY GOVERNANCE

Acceptable effort range: 14,071–20,551 dive hours

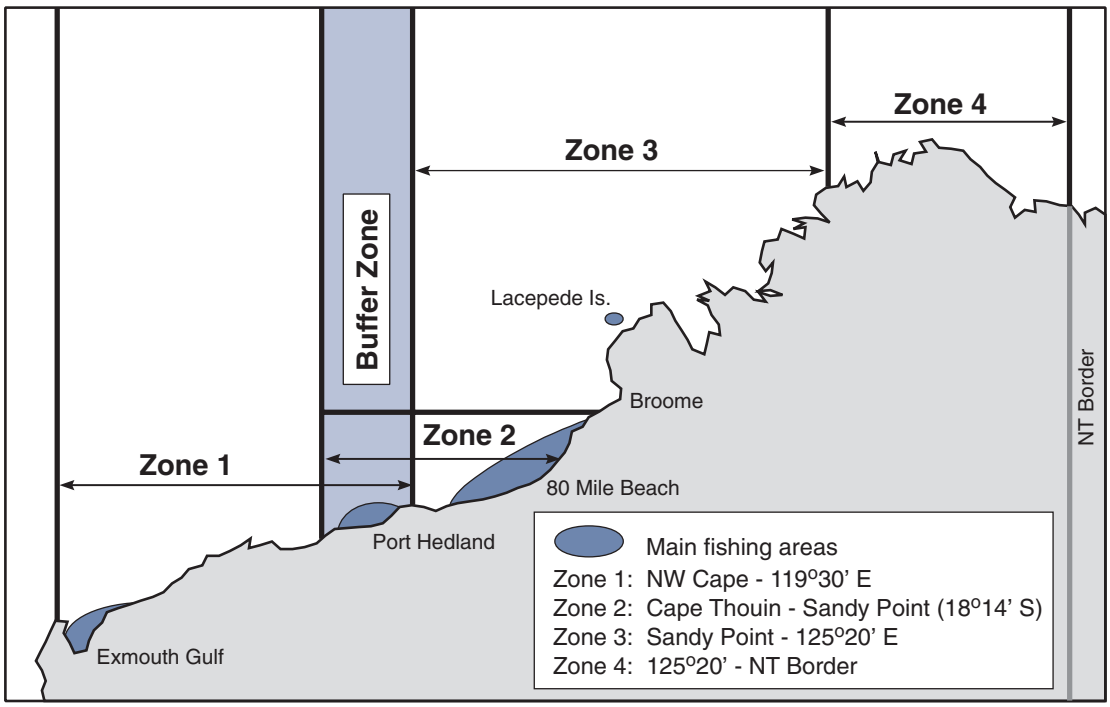
Catch figures in Zone 2/3 have shown significantly elevated catch rates in the last three seasons, above the agreed threshold that triggers quota considerations. Owing to this indication of increased stock abundance, the 2000 and 2001 quota for Zone 2/3 was increased from its traditional level by 10% to 502,500 shell. The 2002 quota has dropped back to 479,750 shell (an increase of 5% on the traditional level) as a precautionary measure reflecting the slightly lower abundance in 2001. It is expected that Zone 2/3 of the pearl oyster fishery should achieve its 2002 quota within the five-year range (1994–1998) of 11,456–15,819 dive hours, although catch rates may fall again if the previous level of recruitment is not maintained.

The level of effort in Zone 1 was significantly above the acceptable range defined for the 2001 season. In response to concerns regarding the increasing level of effort required to take wild-stock quota in Zone 1, licensees have been allocated a reduced overall wild-stock TAC of 55,000 shell in 2002. The overall 115,000 shell TAC will be maintained by substituting the shortfall in quota with hatchery-reared stock. The wild-stock TAC is to be reviewed in May 2002, when any adjustment to the TAC will be made following analysis of available catch and effort data.

The acceptable effort range for Zone 1 to achieve a catch of 55,000 shell is estimated to be 2,615–4,732 dive hours (based on a pro rata effort estimation for 55,000 shell for the five-year period 1994–1998). If Zone 1 is not able to achieve this catch within this acceptable effort range, then additional management changes to the TAC for 2003 may be required to ensure adequate numbers of oysters flow through to the breeding stock in all sectors of Zone 1.

EXTERNAL FACTORS

The pearl oyster stocks underpinning the fishery in Zone 2 (83% of total pearl oyster catch in 2001) continue to provide an elevated level of production to support this major Western Australian industry. A current project (part-funded by FRDC) will determine whether there is a reliable relationship between numbers of spat of *P. maxima* on adult oysters (piggyback spat) and catch rates two to three years later. If this can be demonstrated, the relationship could be used to predict future abundance. In addition, the relationship between recruitment and environmental factors could be further evaluated to extend the predictions. This information would greatly assist managers in determining quota allocations, as there is currently a heavy reliance on retrospective catch data to determine TACs. In a fishery that targets pearl oysters for approximately three years once they reach legal size, projections based on past catch data can under- or over-estimate available stock.



PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.

PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3).

YEAR	QUOTA	NO. OF CULTURE SHELLS	NO. OF MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	MOP SHELLS/HR	TOTAL SHELLS/HR
1978		404,952	146,692	551,644	10,583	38.3	13.9	52.1
1979		371,806	355,599	727,405	16,068	23.1	22.1	45.3
1980		364,502	260,714	625,216	18,568	19.6	14.0	33.7
1981		481,193	210,649	691,842	23,320	20.6	9.0	29.7
1982	460,000	439,092	132,931	572,023	15,710	27.9	8.5	36.4
1983	520,000	365,381	87,049	452,430	19,019	19.2	4.6	23.8
1984	375,000	242,828	47,230	290,058	11,615	20.9	4.1	25.0
1985	342,000	272,869	53,831	326,700	12,423	21.0	4.3	26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5	0.7	21.2
1987	380,000	365,397	0	365,397	17,476	20.9	0	20.9
1988	445,000	379,657	0	379,657	14,600	26.0	0	26.0
1989	445,000	445,364	0	445,364	18,625	23.9	0	23.9
1990	457,000	453,705	0	453,705	23,263	19.5	0	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	0	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	0	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	0	31.0
1994	457,000	456,832	0	456,832	12,384	36.9	0	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	0	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	0	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	0	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	0	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	0	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	0	54.2
2001	**502,500**	**502,484**	**0**	**502,484**	**12,054**	**41.7**	**0**	**41.7**

Note: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies.

PEARL TABLE 2

Pearl shell catch and effort in Zone 1 since the 1993 quota increase.

YEAR	QUOTA	NO. OF CULTURE SHELLS	NO. OF MOP SHELLS	TOTAL SHELLS	DIVE HOURS	CULTURE SHELLS/HR	MOP SHELLS/HR	TOTAL SHELLS/HR
1993	115,000	79,465	0	79,465	2,395	33.2	0	33.2
1994	115,000	132,316	0	132,316	6,291	21.0	0	21.0
1995	115,000	121,312	0	121,312	6,247	19.4	0	19.4
1996	115,000	80,163	0	80,163	5,013	16.0	0	16.0
1997	115,000	110,348	0	110,348	9,494	11.6	0	11.6
1998	115,000	108,056	0	108,056	6,094	17.7	0	17.7
1999	115,000	90,414	0	90,414	4,789	18.9	0	18.9
2000	115,000	66,772	0	66,772	5,893	11.3	0	11.3
2001	**115,000**	**68,931**	**0**	**68,931**	**9,480**	**7.3**	**0**	**7.3**

Notes:

Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead. Licensees who utilised this option took a quota reduction in subsequent years.

Hatchery stock used during 1999–2001 reduced the need for wild-stock shell.