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Sustainability of the Western Rock Lobster Fishery: Past Progress and Future Challenges

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Sustainability of the Western Rock Lobster Fishery: Past Progress and Future Challenges

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Contents

Abstract

The Western Rock Lobster Fishery has 594 boats operating about 57,000 pots. Their average annual catch of 11,000 tonnes is valued at around US$150-300 million. In addition to the commercial catch, recreational fishers take about 600 tonnes a year. Sustainability in this fishery is maintained by analysis of a comprehensive fisheries database, some of which dates back to the 1960s (e.g. catch, effort, length-frequencies, fishery-independent breeding-stock surveys, puerulus settlement monitoring, recreational catch monitoring); an extensive set of management controls (including a limited fishing season and legal minimum and maximum sizes); and an effective compliance program. Effort in the fishery is controlled by input restrictions on the number of pots allowed and number of days fishing, which are implemented after considerable consultation with industry. The principal method of ensuring the sustainability of the fishery is by monitoring the size of the breeding stock, using data from both a commercial at-sea monitoring program and an annual fishery-independent breeding-stock survey. When the breeding stock fell to low levels in the early 1990s, management initiatives succeeded in returning it to what are considered to be safe levels. Catches are currently high, but fishers have acquired sufficient scientific knowledge to understand that catches will fluctuate for environmental reasons and to take this into account in their fishing operations. Environmental effects have been shown to drive the level of settlement in a particular season. These settlement levels are in turn highly correlated with catches three to four years later, which provides a means of predicting future catches and managing the fishery accordingly. There are issues to be considered in assessing the sustainability of this fishery in the future. The fishery may be overly reliant on egg production from the Abrolhos Islands; catching power of the commercial fleet is increasing due to improvements in gear and technological equipment; growth in catches made by the recreational sector are currently unconstrained; pueruli may be harvested for aquaculture in the near future; and regulations protecting the female brood stock more than the male population could lead to reproductive issues. These potential threats are considered to be low, but will need to be monitored. The fishery was awarded Marine Stewardship Council certification in March 2000, the first in the world to receive this imprimatur.

1.0 Introduction

The western rock lobster *Panulirus cygnus* occurs on the western seaboard of Australia and is found in commercial quantities from Augusta in the south to Shark Bay in the north (Fig. 1). The fishery is Australia's most valuable single-species fishery; landings are currently valued at US$150-300 million per annum. The commercial fishery dates back to the 1890s, when rock lobsters were caught for the local market. Before World War II, relatively small quantities by today's standards were caught and canned for export. However, the fishery expanded greatly after the war, when catches climbed from less than 500 tonnes to over 8,000 tonnes by the end of the 1950s (Gray 1999). Commercial catches since the 1980s have fluctuated between about 8,000 and 14,400 tonnes, but on average have yielded around 11,000 tonnes (Fig. 2).

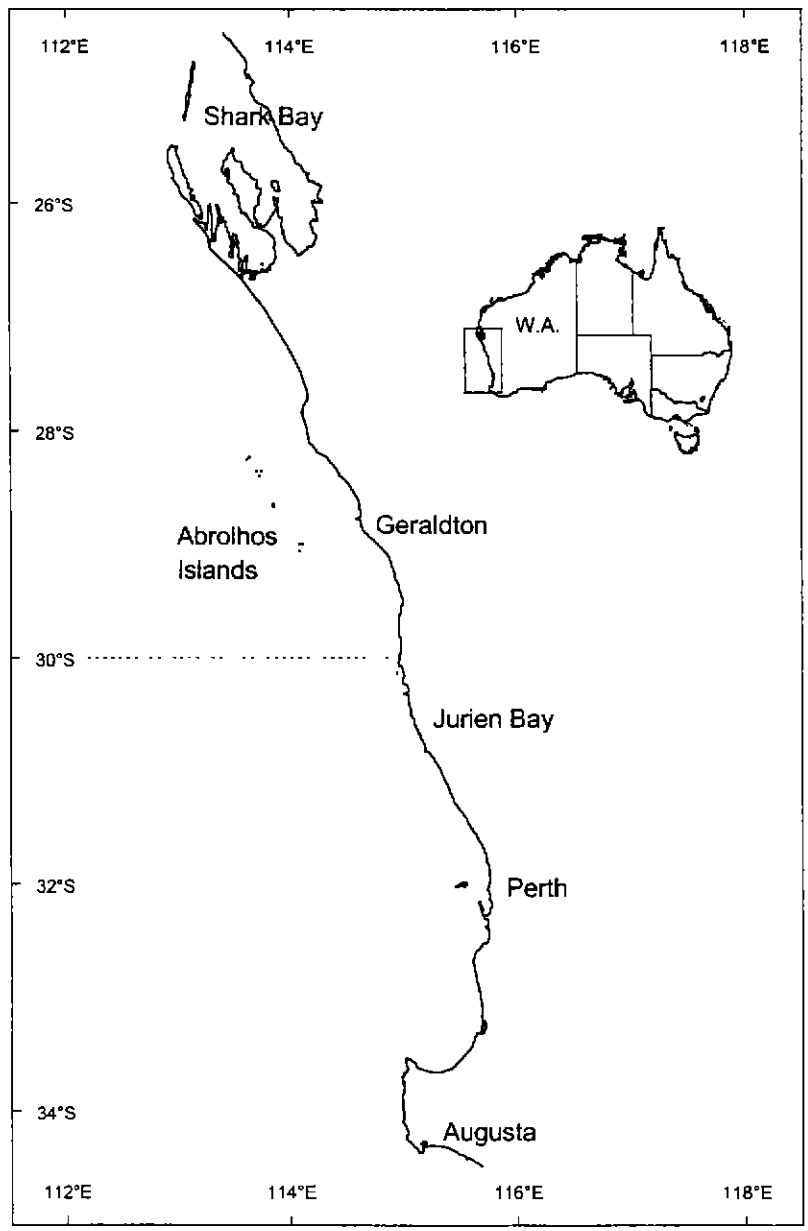

Figure 1. The western rock lobster commercial and recreational fishery off Western Australia.

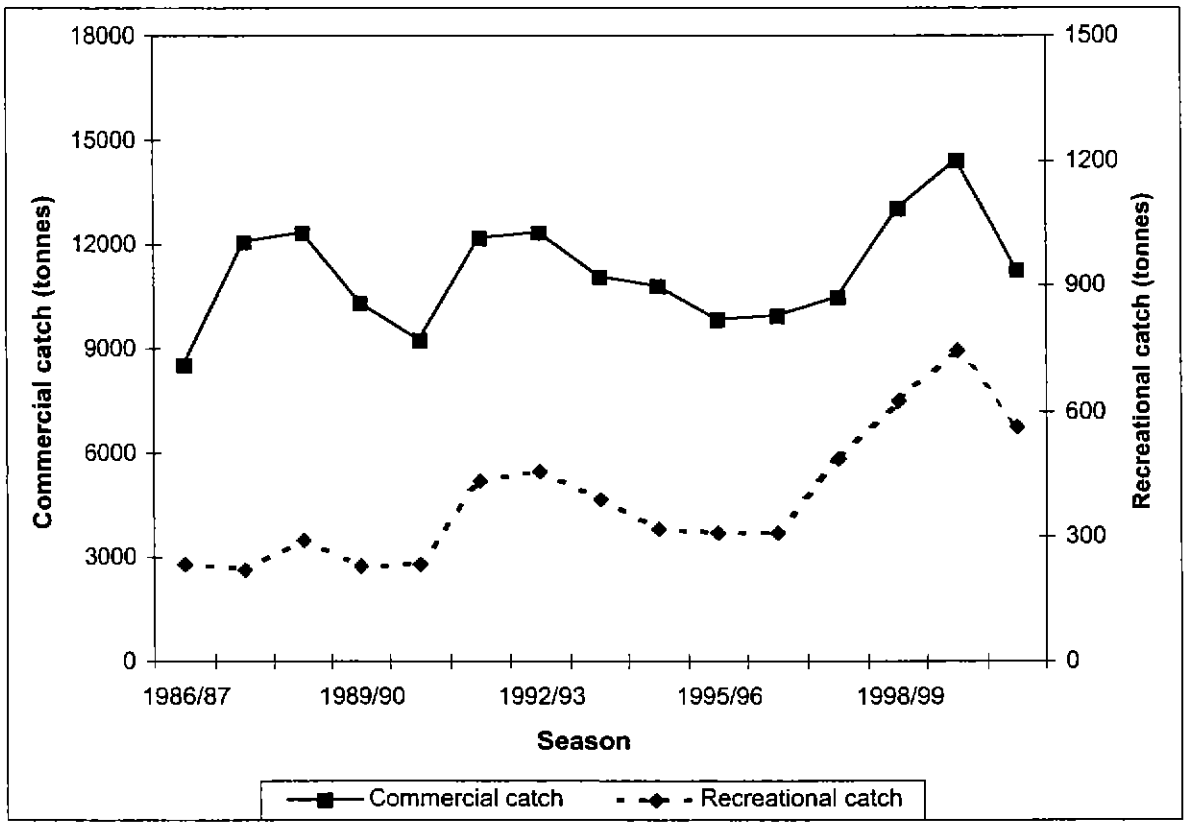

Figure 2. Time series of recreational and commercial western rock lobster landings. Recreational catches are estimates from mail surveys, which began in the 1986/87 season. Commercial catches are from fishers' monthly returns.

Increased catches over the years have in part, been due to modernisation of the fishing fleet over time (Fig. 3). Currently, 594 boats in the commercial fishery operate some 57,000 pots (Fig. 4) over the season (mid-November to the end of June), totalling an estimated 10.75 million pot lifts each season.

There is also a large recreational catch component to this fishery. Licensed recreational fishers are permitted to catch lobsters by diving, or by using up to two pots per person per day over the same season as commercial fishers and can keep up to eight legal-sized lobsters per person per day. Since the late 1990s, recreational fishers have accounted for between 450 and 750 tonnes each season (Fig. 2), or 4 – 5% of the total western rock lobster catch (Fig. 5). This figure has been growing in recent years as increasing numbers of recreational fishers take up the unrestricted access to the recreational fishery (Melville-Smith *et al.* 2001) (Figs. 5 and 6).

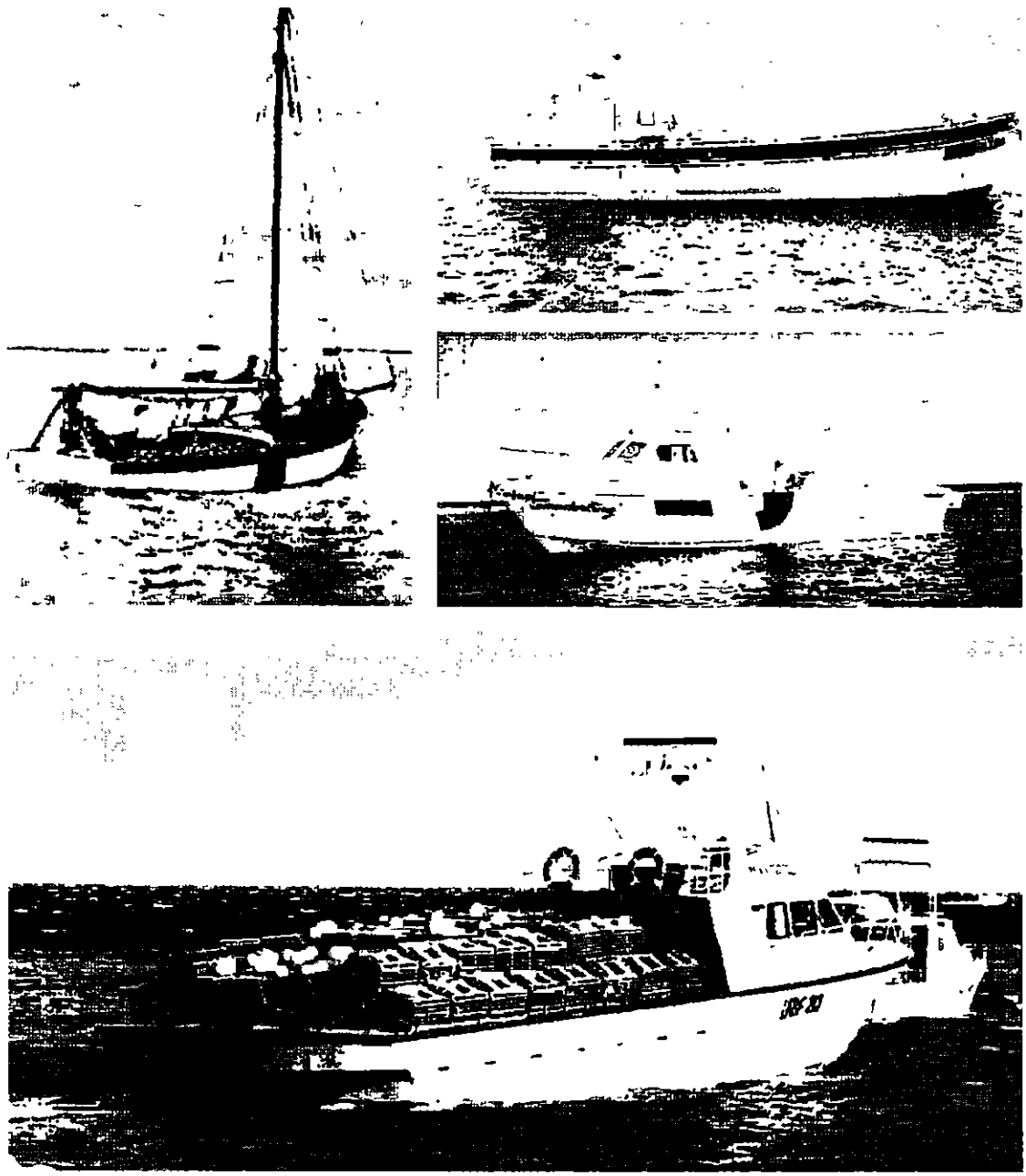

Figure 3. Typical western rock lobster boats used in 1950s; 1960s; 1970s; and 1980/90s (clockwise from top left) 9taken from Caputi et al. (2000) with kind permission of Blackwell Science Ltd.

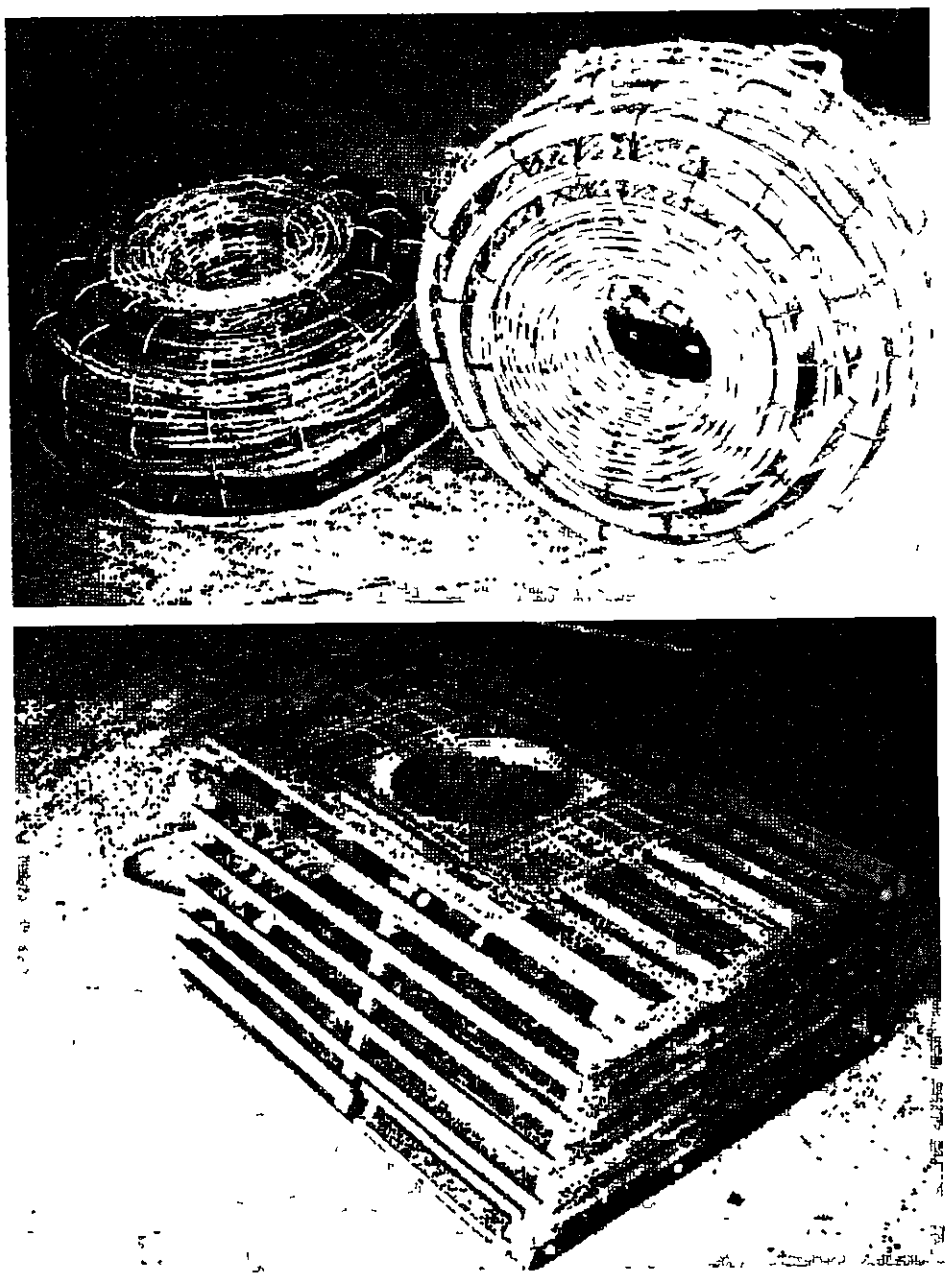

Figure 4. Lobster pots used in the western rock lobster fishery. Top, stick or cane beehive pots; bottom, batten pot.

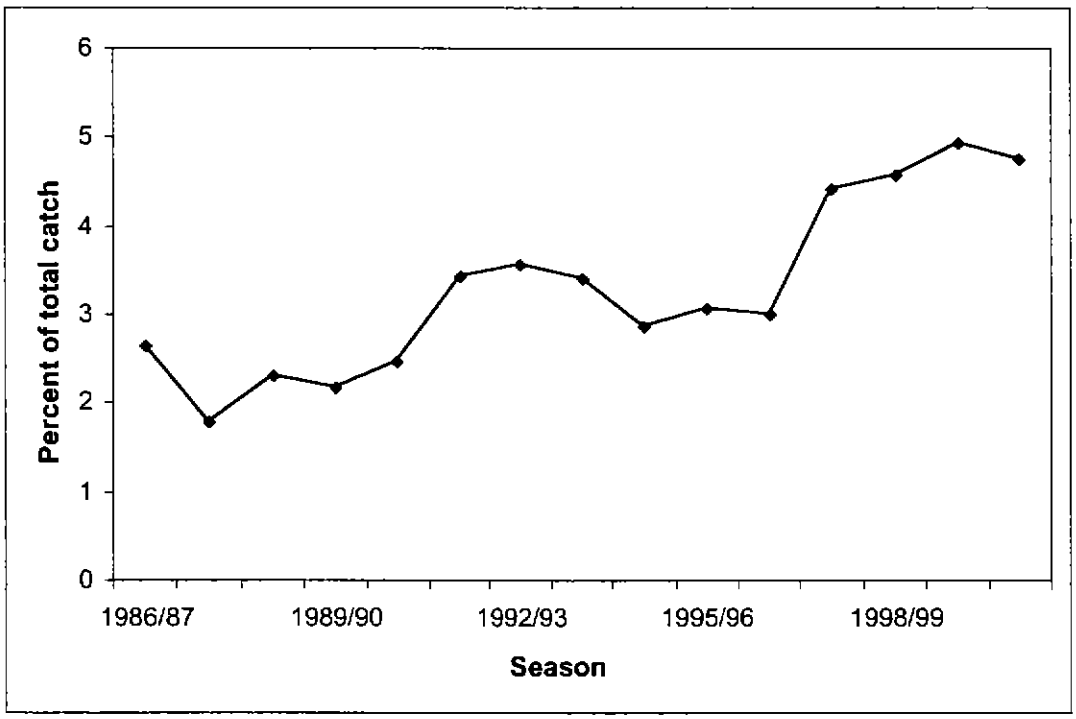

Figure 5. Western rock lobster recreational catch as a percentage of the total landings made by the commercial and recreational sector between the 1986/87 and 2000/01 fishing seasons.

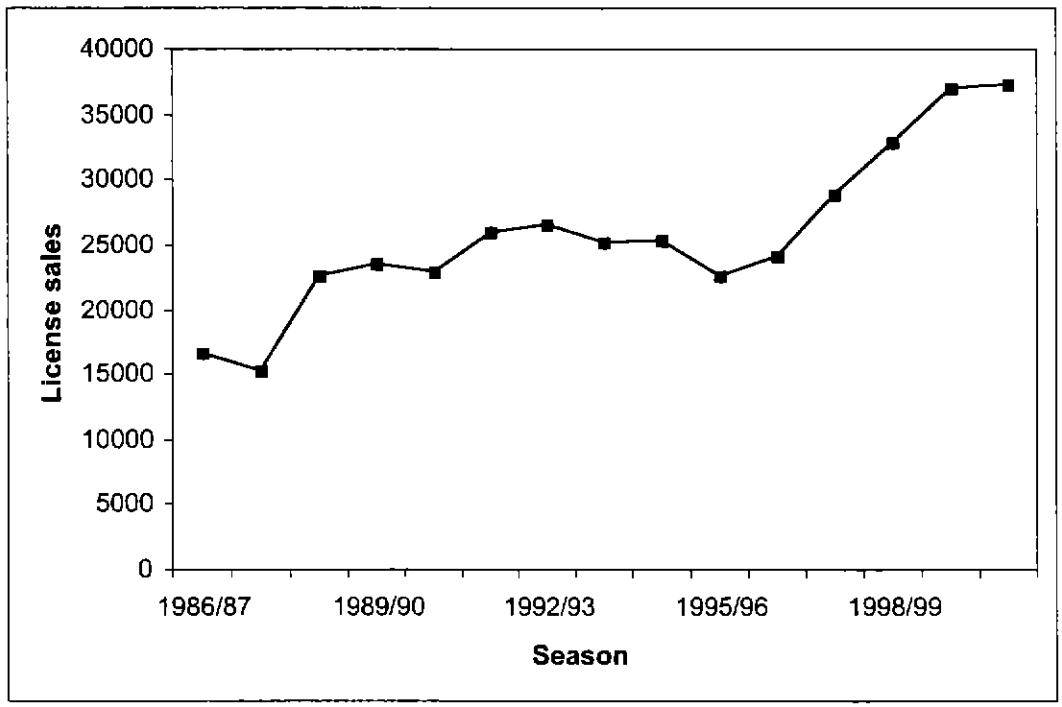

Figure 6. Recreational rock lobster, licence sales (adapted from Melville-Smith et al. 2001).

Because of the long history and importance of the fishery, numerous reviews have examined aspects of the biology of the species and its management (*inter alia* Hancock 1981, Phillips and Brown 1989, Brown 1991, Gray 1992; 1999, Phillips 1981, Phillips *et al.* 2000, Melville-Smith and Anderton 2000, Hall and Brown 2000, Caputi *et al.* 2000 and Caputi *et al.* in press). The object of this paper is build on these earlier reviews by documenting the progress that has been made in maintaining the sustainability of the Western Rock Lobster Fishery, and suggesting what challenges face the fishery in the future. The fishery's management regime today concentrates on controlling the exploitation rate via fishing effort and maintaining a specified breeding-stock size. Environmentally sustainable development (ESD) indicators in this fishery are a recent initiative and while some of these more general sustainability issues will be discussed, this review focuses on issues specific to management of the resource, rather than the effects of its fishing on the environment and socio-economic elements.

2.0 Threats to sustainability

- Since at least the 1970s, management of the Western Rock Lobster Fishery has been guided by five principles, which can be summarised as:
- Acquiring reliable catch, effort, and length-frequency data to monitor the effects of fishing pressure on the exploited population.
- Setting a legal minimum size, protection of females, and gear restrictions with adequate inspection and legislative backing.
- Controlling fishing effort to protect the breeding stock and maximise the benefit from the resource.
- Understanding the stock/recruitment/environment relationship.
- Communicating effectively and regularly with both commercial and recreational fishers to ensure the objectives and methods of management are well understood.

The management arrangements have been developed with these principles as a guide. Together with a strongly directed and comprehensive research program, this approach has resulted in the Western Rock Lobster Fishery achieving recognition as one of the best-managed fisheries in the world.

2.1 Reliable catch, effort, and length-frequency data

The Western Rock Lobster Fishery has an extensive database extending over more than 30 years that includes commercial catch returns, voluntary log books, processor returns, and abundance estimates of pre-recruits and breeding stock from on-board monitoring of the commercial catch and recreational catch surveys.

Extensive databases such as these were vital components to Walters *et al.'s* (1993) spatio-temporal model and in more recent times Hall *et al.*'s (2000) size-structured model. Both models have been used at different times to assess the status of the stock and to forecast the impact of proposed management strategies on the breeding stock.

2.2 A legal minimum size and gear restrictions with adequate inspection and legislative backing

2.2.1 Legal size

The legal minimum size for the fishery was set in 1900 at 2.75 inches (76 mm). It has essentially remained unchanged since that time, although after the 1993/94 season it was increased by 1 mm to 77 mm for the first two-and-a-half months of the seven-and-a-half month fishing season.

2.2.2 Compliance

A very obvious threat to the sustainability of any commercial fishery, namely compliance with regulations, was addressed early on in the development of the fishery. In the 1960s, effort limitations were introduced; it was probably not a coincidence that illegal fishing activity became pandemic. At that time there is much evidence of blackmarket sales being rife on the local market and in markets on the eastern states of Australia, and of undersized animals and egg-bearing lobsters stripped of their brood being processed (Gray 1999, Caputi *et al.* 2000).

Management introduced measures to counteract the problem: legislation was brought in to restrict processing to licenced establishments; more inspectors were appointed; fines for rock lobster fishing offenses were increased; convictions were recorded against the vessels rather than their skippers; and licenses could be cancelled after the third offense — the measures helped to make this an exceedingly (by fisheries' standards) compliant industry. Even today, much effort goes into ensuring that compliance is of an exceptional standard and that research into improving the efficiency of compliance in the industry is cutting-edge (McKinlay and Millington 1999). Currently as few as 1 to 2 animals are illegal in every 1000 checked by

enforcement officers (McKinlay, Western Australian Department of Fisheries, *pers. comm.*). An attempt has been made to adjust the less reliable historic catch data for illegal activities and under-reporting of catch (Caputi *et al.* 2000).

2.2.3 Damage and mortality to the discarded catch

During the 1980s it was recognised that large numbers of undersized lobsters were being killed unnecessarily, exposed to predation, or having their growth affected by poor handling practice on board fishing vessels. These practices involved needlessly exposing undersized animals to the air for lengthy periods before sorting them from the catch, excessive handling that resulted in limb loss, and release away from their home reefs often on unsuitable benthic substrate (Brown and Caputi 1983; 1984; 1986, Brown and Dibden 1987). In response to this a minimum of three escape gaps (formerly only one) were required to be fitted on each pot from 1986/87 onwards. Furthermore, codes of fishing practice have been introduced into the industry (Stevens *et al.* 1995) and are continually being updated and communicated at every opportunity.

Despite the progress that has been made, it is recognised that there is still room for improvement with regard to loss of appendages by lobsters through poor or prolonged handling. Researchers are exploring the possibility of stunning the catch with cold water for a few seconds before it is sorted, so as to minimise appendage loss (Davidson and Hosking 2001).

2.3 Fishing-effort control systems

Effort in the fishery has been controlled since 1963, when a maximum was fixed for total pot numbers (for a comprehensive review of catch and effort in the fishery, including regulations and controls used to limit effort, see Phillips *et al.* 2000). These effort units are transferable. In more recent years, when other lobster fisheries in Australasia turned to output controls, management considered adopting that approach (Bowen 1994). However, both fishers and managers of the fishery have strongly supported retention of input control in the form of total allowable effort (TAE) and transferable effort units; it seems unlikely, therefore, that this form of management will change in the foreseeable future.

The reasons for output controls being rejected by western rock lobster fishers are outlined by Fitzharding (1999). He lists the quota system's inability to deal adequately with natural variations in abundance, problems with enforcing quotas, lower economic returns, higher costs

of administration, less flexibility in the management rules to capitalise on market changes, and centralisation of ownership resulting in owners of the quota placing unacceptable controls on the fishers.

2.4 The stock/recruitment relationship

Although there are very significant peaks and troughs in the annual catch (Fig. 2), they are not due to fishing pressure. Rather, they are mainly due to environmental perturbations that drive the success or otherwise of settlement of the puerulus (the settling stage of rock lobsters). This in turn affects recruitment levels into the fishery.

2.4.1 Catch prediction

Studies in the 1980s of the levels of puerulus settlement on collectors at sites along the coast of Western Australia showed a good correlation between the numbers settling and the catches in the fishery three and four years later (Phillips 1986, Caputi *et al.* 1995a, 1995b). This has been developed into a comprehensive regional and seasonal predictive system that is recognised by industry, government and the community as being a reliable indicator of future catches. This is separate from the models that have been developed for the fishery (Walters *et al.* 1993 and Hall *et al.* 2000) which are not used to predict catches.

The strength of the Leeuwin Current (which is influenced by ENSO events, as well as the frequency and strength of westerly winds, have been established as key factors responsible for determining the level of puerulus settlement in a particular season (Pearce and Phillips 1988, Caputi *et al.* 1995c).

One of the major benefits of this ability to predict catches up to four years in advance, is that management changes can be made before fishing takes place on a year class which has yet to recruit to the fishery. By contrast, other fisheries without this ability can only react to the effects of a poor year-class passing through the fishery, after it has been fished.

2.4.2 Protecting egg production

One of the most serious threats to the fishery in the past — and one that still requires vigilant attention — is that the brood stock should become over-exploited. Western rock lobsters live along many hundreds of kilometres of coastline (Fig. 1). Although a single stock, they do have regional differences in their biological characteristics; for example, females (and probably also males) mature at a much smaller size at the offshore Abrolhos Islands than at the coast, and even on the coast there are substantial differences in size at maturity (Table 1).

Table 1. Size at 50% maturity (in mm) of western rock lobsters sampled at five sites in the fishery. Female maturity is identified by proportions in different size categories carrying eggs and male maturity by the state of their gonads (data adapted from Grey 1979 and Chubb 1991).

	Size at maturity (mm)				
	Fremantle	**Two Rocks**	**Dongara**	**Geraldton**	**Abrolhos Is.**
Female	97	97	93	96	66
Male	99	no data	no data	102	no data

Fishing a population below or around the size at maturity during the rapid somatic growing phase generally optimises the catch that season. However, unless properly managed, this is a risky management strategy because it could overexploit the parent stock, which in turn could lead to overfishing of recruits.

The size of the brood stock of the western rock lobster in the early 1990s was estimated to have shrunk to disturbingly low levels (Walters *et al.* 1993). The postulated reasons for the decline were that exploitation rates were higher because licences were being fished more intensively and efficiently, and that fishers could target isolated deepwater reefs in the offshore breeding grounds more efficiently when electronic fishing aids (particularly GPS) were introduced (Brown *et al* 1995, Caputi *et al.* 2000). Modelling results (using the model of Walters *et al.* (1993)) suggested that egg production had been reduced to 15-20% of pristine levels (Anon. 1993). Furthermore, a decline in Abrolhos Island puerulus settlement from 1984 was considered to possibly be due to the reduction in spawning stock as it could not be explained by environmental effects. The first signs of recruitment overfishing appeared to be emerging in the fishery (Caputi *et al.* 1995c).

Alarm about the depressed state of the brood stock and the signs that recruitment was possibly being affected led management to introduce of a suite of measures aimed at rebuilding the brood stock to the levels of the 1980/81 season — a time when it was considered that interannual differences in puerulus settlement were influenced by environmental conditions and not the size of the spawning stock. These management changes, which were supported by industry, were introduced in the 1993/94 season. The changes were:

(i) An 18% reduction in the number of pots allowed to be used in the commercial fishery. Nominal fishing effort had increased through the 1980s with uptake of latent effort in the fishery, combined with greater efficiency targeting lobster reefs using electronic and other fishing aids. Consequently, fishing mortality had increased substantially. A 10% pot

reduction was imposed through the mid- to late-1980s at a rate of 2% per season, but this stabilised the increase in effort over this period rather than significantly decreasing it. The 18% 'temporary' (although nine seasons on there has been no lifting of its temporary status) pot reduction was aimed at reducing that additional fishing effort and the pressure on the breeding animals.

(ii) The introduction of what has become known as the 'setose rule', which required fishers to return to the sea any female lobster bearing ovigerous setae and/or a tar-spot (i.e. carrying an external spermatophore). This was additional to existing legislation that required fishers to return egg-bearing animals back to the sea. The commercial and recreational fishing seasons start in mid-November. Mature females, while not necessarily carrying eggs, generally have ovigerous setae during the spawning season (September – December) and until February or March, when many moult into a non-setose phase. They remain non-setose until May or June, when they moult back into the setose state in preparation for the breeding season, which starts around September. Therefore, while the setose rule has not excluded all mature females from capture, it has largely limited their exploitation to the proportion that moult to the non-setose stage in the period between February and May.

(iii) The introduction of a legal maximum size for female lobsters: 115 mm carapace length (CL) in the southern zone (south of 30°S; see Fig. 1) and 105 mm CL in the northern (including the Abrolhos Islands) zone of the fishing grounds. This rule was aimed at protecting the large females in the population. Although these animals make up only a small part of the population, they are thought to make a large contribution to egg production. Chubb (1991), for example, showed that large female western rock lobsters are capable of producing multiple broods each season and can carry hundreds of thousands more eggs than small females.

(iv) An increase in the legal minimum size by 1 mm CL from 76 to 77 mm from November 15 – January 31 (i.e. for the first two-and-a-half months of the seven-and-a-half month fishing season, which extends from November 15 to June 30). Most western rock lobsters around the legal minimum size migrate offshore around the start of the commercial fishing season in December and January. They are targeted by the commercial fishery, which takes large numbers of them. Once in the deeper offshore waters, fewer are caught, and it was therefore expected that increasing the minimum size during the migrating phase would enable more animals to survive to ultimately become part of the breeding population.

The obvious question to follow from these management changes is to ask how successful they have been in rebuilding the brood stock.

The state of the brood stock is currently measured by two different methods. The first, described by Chubb *et al.* (1995), uses commercial monitoring data from the northern and southern coastal management zones of the fishery. The shortfall of this index is that it does not automatically take increases in fishing efficiency, which are inherent in the use of commercial catch-and-effort data, into account. Although these data can be adjusted to make up this deficiency (as described by Brown *et al.* 1995), there is inevitable uncertainty about the modified figures. In the case of the western rock lobster fishery the monitoring data are adjusted by about 1 to 2 percent per annum to take into account efficiency increases.

The fishery-independent method of establishing an egg-production index was established for the western rock lobster fishery in the early 1990s (Melville-Smith *et al.* 1998). In brief, a survey is conducted each year at the same GPS positions on a number of sites covering the full extent of the commercial fishery. Standardised fishing gear, bait and lunar phase are used to limit the variables that could influence catch rates. Regional egg production is calculated from the number and size of breeding females caught in the pots, taking into account size-fecundity relationships. The short-fall of this approach is that uncontrolled environmental factors such as temperature and swell at the time of sampling can affect the catch rates.

The overall impact of the above management measures on the state of the brood stock since their introduction in the 1993/94 season can be seen from the fishery-dependent and fishery-independent egg production indices in Figs. 7a and b. Irrespective of which index is used, the results clearly indicate a doubling in egg production within the last decade.

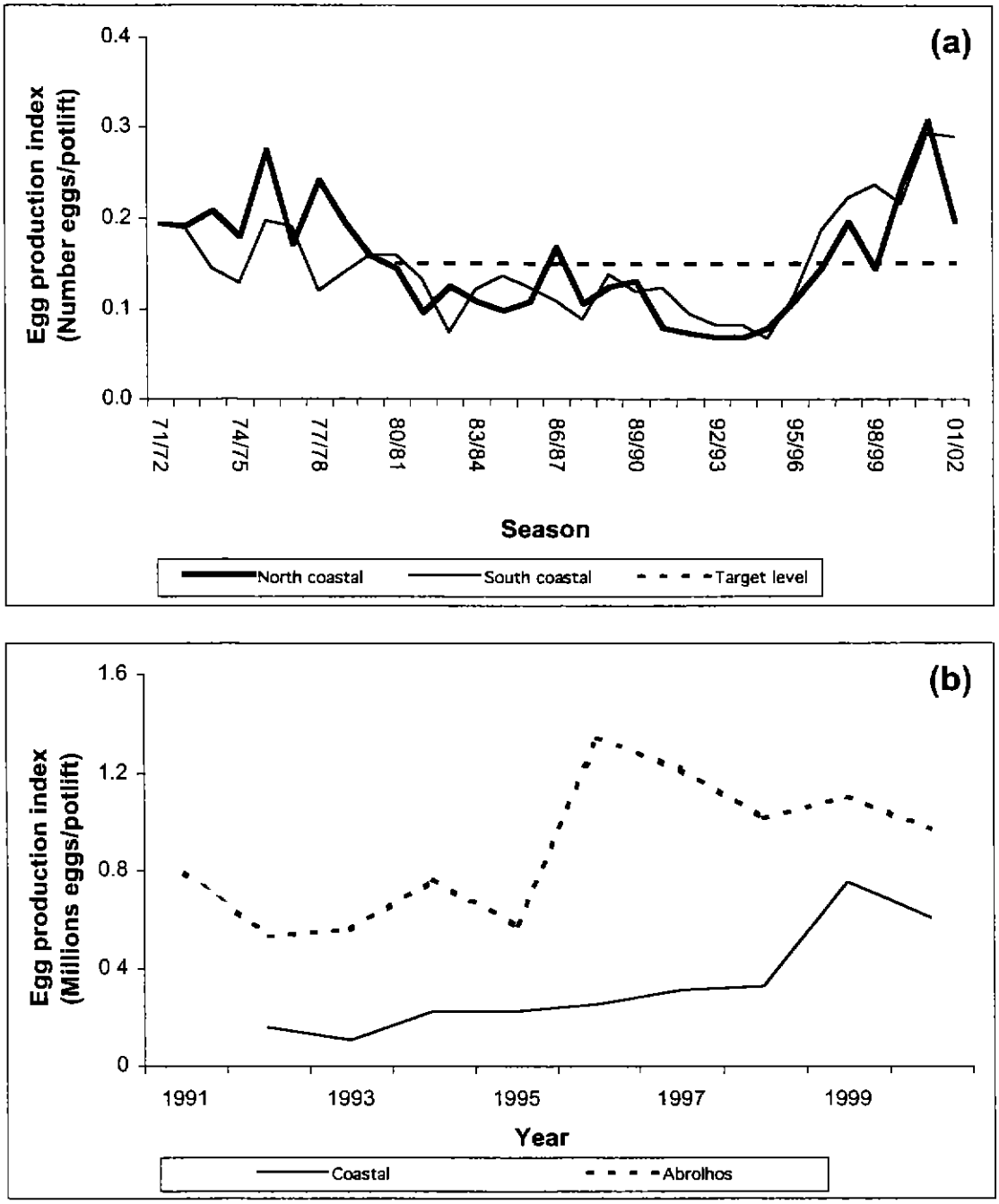

Figure 7. Western rock lobster (a) fishery dependent and (b) fishery independent spawning-stock indices.

At the time the management changes were introduced, there was little doubt they would increase egg production in the fishery, but the extent of protection they would offer could not be accurately predicted. The effectiveness of these 1993/94 changes have since been assessed by way of an age-structured model (Hall and Chubb, 2001). The model suggests that, by 1999/2000, egg production in the fishery was 134% of the target level (i.e. egg production in the 1980/81 season). It also estimates that the catch in 1999/2000 was 90.5% of what might have been taken had the management measures discussed above not been in place.

Furthermore, the model calculates that, if each of the four management measures had been applied separately and singularly, egg production in the 1999/2000 season would have been 76, 84, 94 and 102% of the target level for the minimum size, maximum size, pot reduction and setose regulations, respectively.

While management measures such as those introduced in the 1993/94 season are in place to protect the brood stock, there seems to be little likelihood of recruitment to the fishery declining in the future due to overfishing Managers have no wish to increase the size of the brood stock beyond the target level (of egg production levels at the beginning of the 1980s (Fig. 7a)) As landings in the forthcoming (2001/02) fishing season are predicted to be below average (Caputi *et al.*, in press), one of the 1993/94 management measures — the maximum size rule for females — is to be rescinded for that one season only, to bolster catches because the markets, principally in Asia, require a consistent level of supply. The effect of this will be closely monitored. With the breeding stock at levels which are considered adequate for the fishery, environmental effects will be the major factor driving future variation in catch abundance.

2.5 Effective and continuing communication with fishers

The principal method of consultation in the fishery is through the Rock Lobster Industry Advisory Committee (RLIAC), a statutory Ministerial Advisory Committee. The functions of the RLIAC, as set out in the *Western Australian Fish Resources Management Act 1994*, are:

- to identify issues that affect the rock lobster fishery;
- to advise the Minister on matters relating to the management, protection and development of the rock lobster fisheries, and
- to advise the Minister on matters relating to rock lobster fisheries on which the advice of the Advisory Committee is sought by the Minister.

Since its establishment in 1965, RLIAC has made communication and consultation with industry its first priority. RLIAC has been the forum in which issues (particularly those related to sustainability) have been debated and recommendations made to the Minister. The committee takes problems that affect the fishery and the industry generally, such as the dangerous decline in the size of the breeding stock before 1993/94, and by way of discussion and management papers and meetings with industry, initiates ways to resolve them.

The fishery management group has a very successful process of communicating with fishers by way of annual coastal tours to fishing communities and general information (e.g. Western Rock Lobster Commercial Fisheries Production Bulletins, which are produced three times a year). Commercial fisher involvement in the management of the fishery, which has until recently been by way of RLIAC and the West Australian Fishing Industry Council, will be enhanced in the near future by the creation of an industry peak body funded by the fishers, to be known as the Western Rock Lobster Council.

3.0 Threats to sustainability in the future

With egg production in the fishery being monitored, and with the previously described ways of adjusting exploitation rates to maintain breeding stock levels, the main biological threat to sustainability of the resource is under control. However, there are always other issues arising that, if left unattended, could affect sustainability in the future.

3.1 Regional contributions to egg production

An obscure threat from the perspective of managing egg-production in the fishery is the disproportionate contribution to egg production that is believed to be made by lobsters at the Abrolhos Islands. Chubb (1991) calculated this offshore group of islands contributed between 45 and 60% of the stock's egg production in the 1984/85 to 1988/89 seasons — a direct result of the high densities of lobsters and their small size at maturity in that region (Table 1). The large quantities of eggs produced in this relatively small and isolated region, and therefore the presumed dependence of the fishery on that part of the brood stock, does leave the fishery vulnerable in the unlikely event of a serious disaster (e.g. a major oil spill or localised disease outbreak).

3.2 The impact of increases in fishing efficiency

The effect of effort creep æ the increase in the catching power of a rock lobster pot due to improvements in fishing technology æ will need constant vigilance in this input-regulated fishery. Caputi *et al.* (2000) showed, using the Walters *et al.*'s (1993) model for the fishery and without taking account of the management package introduced in 1993 to improve egg production, that a considerably more favourable scenario of the state of egg production in the fishery emerged when nominal fishing effort was used than when standardised effort was used. Furthermore, modelled future projections showed egg production to stabilise at about 20% of virgin biomass production using nominal fishing effort, but to steadily decline and ultimately affect recruitment when standardised effort was used.

While there are no plans in the immediate future to reduce the number of pots in the western rock lobster fishery, the efficiency of the fleet will inevitably increase in the future (previously estimated as being 0.5-2% per annum in shallow-water and 1-4% in deep-water (Brown *et al.* 1995)). There is little doubt, therefore, that some form of adjustment will be necessary in the medium to long term to maintain egg production at the target level.

3.3 Growth of the recreational fishing sector

One of the threats to the future sustainability of the commercial western rock lobster fishery that has yet to be addressed is the expansion of the recreational fishery. Since the 1986/87 season, recreational licence sales have increased roughly 150% (Fig. 6), and the increase in the recreational catch's share of the total landings over that period has been even greater (Fig. 5). Over 90% of the recreational rock lobster catch is made in the shallow inshore grounds in depths of less than 20 m (Melville-Smith and Anderton 2000) — well outside of the depths in which the brood stock of the coastal regions of the fishery are found. Therefore, while recreational fishers are competing with commercial fishers for a greater share of the inshore catch, particularly around large metropolitan areas, they are not considered to be directly affecting the brood stock.

The increase in the recreational catch is not just a catch-sharing issue between the two user groups. Although recreational fishers are subject to the same regulations as commercial fishers with regard to legal minimum size, prohibition of retaining setose animals etc., it is more difficult to enforce them in the recreational sector, which land catch almost anywhere along the wide stretches of coastline over which the species occurs. Strategies for developing an integrated approach for managing the recreational, aboriginal, conservation and commercial rock lobster catching sectors are being developed by a Ministerially appointed Integrated Fisheries Management Committee; its recommendations will be released in mid-2002.

3.4 Harvesting pueruli for aquaculture

The propagation of lobsters from egg to marketable-sized animals seems unlikely in the short-term, given the long and complicated larval life of rock lobsters. However, harvesting of pueruli and growing them on is a relatively simple operation that has been successful in a number of countries, most notably Vietnam (Tuan *et al.* 2000). The future possibility that western rock lobster pueruli will be harvested from the wild fishery for commercial-scale ongrowing at sea or ashore is, if not adequately controlled, a potential threat to both the fishery and the economics of fishing operations.

Research developing rock lobster aquaculture in Australasia is receiving substantial funding through the Fisheries Research and Development Corporation, an Australian Federal funding body. Licenses to capture and grow-on pueruli have been issued in New Zealand and Tasmania; we believe it is only a question of time before western rock lobsters are farmed. Concerns that harvesting western rock lobster pueruli might impact the sustainability of the fishery led to a modelling study of the impact of removing different numbers of pueruli on the subsequent catch in the wild fishery (Phillips *et al.*, in press). The model has estimated that effects are likely to be slight unless many millions of pueruli are removed, but any potential losses to the wild fishery could be countered by effort reductions linked to the number of puerlui harvested and the puerulus settlement strength.

3.5 Reproductive biology issues

The western rock lobster catch has become more male-dominated since females have received greater protection with the maximum size and setose rules. To this point there has been no evidence of sperm limitation (as described by MacDiarmid and Butler 1999 for *Jasus edwardsii*) or of other reproductive biology issues related to strongly biased sex ratios in the population caused by the setose rule. Research to monitor these issues is undertaken as part of the fishery independent breeding stock survey and the at-sea commercial monitoring program.

4.0 Widening the awareness of sustainable fisheries management

The western rock lobster fishery was the first fishery in the world to be awarded certification as a well managed fishery by the Marine Stewardship Council (MSC), an international organisation set up to assess and certify sustainable fisheries. Accreditation in March 2000 followed an extensive review conducted by an independent panel into the way that the fishery operated, taking into account its sustainability and its general impact on the marine environment.

A new development in Australia is a Federal Government initiative concerned with sustainability of fish stocks. Environment Australia, (the Federal department responsible for environmental issues) has determined that, from December 2003, only marine products from fisheries that are environmentally sustainable may be exported. The assessment of such fisheries is a similar process to the MSC assessment. The western rock lobster fishery has already made and submitted an application for export certification.

There are recommendations to establish marine national parks in several regions of Western Australia that will directly impact on western rock lobster fishing operations (Report

of the Marine Parks and Reserves Selection Working Group, 1994). Some recommendations of this working group have been promulgated (e.g. the creation of a Marine Reserve at Jurien Bay), and other Marine National Parks or refuge areas, which may affect fishing areas and activities, are likely to be created in the future.

5.0 New Developments

The attention of managers of the western rock lobster fishery is shifting away from the fishery's biological sustainability, which was believed to be under threat in the late 1980s, towards increasing the value of the catch and/or reducing the costs of taking the catch. A number of strategies are being considered; for example mechanisms to reduce within-and between-season variability in catch levels caused by different catchabilities within seasons and by inter-annual pulses of recruitment strength. The latter goal is to some small extent being addressed by removing the maximum size in the 2001/02 season, which is predicted to have a below average catch.

Other mechanisms being considered are temporary closures in the fishery during periods of low catch, such as for a few days each month over the full moon, and/or in that part of the season when a synchronised moult takes place.

6.0 Conclusions

The fishery is well positioned through the efforts of many years of collaborative management between stakeholders, supported by well-directed research and monitoring programs, to be able to enjoy future prosperity. Managing fisheries sustainably is a dynamic process. While some future questions in the western rock lobster fishery have been identified here, it is inevitable that other unforeseen ones will arise. The challenge for fisheries researchers, managers and industry, is to have the foresight to identify these potential problems and to have the continued means and ability to address them.

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