A Review of the Current Global Status and Future Challenges for Management of Lobster Fisheries

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Abstract

The management of *Panulirus ornatus* in Torres Strait, *Panulirus argus* in the Bahamas and also in Florida, *Panulirus cygnus* in Western Australia and *Panulirus interruptus* in Baja California shared by the USA and Mexico is assessed. These major lobster fisheries have survived the last 7 years without major collapse, and Indonesia's catch is continuing to increase. The world of fisheries management is now at a much more complicated place than it was 10 or more years ago. Modelling of data from catches in the fishery, effort and sales prices of product and costs of fishing is now common. Other items also encountered by scientists, managers and industry managing the fisheries include ecosystem-based fishery management, management performance reviews, MSC reviews, productivity commission inquires, status of the stock assessments for permission to sell product overseas, bioeconomic modelling to improve harvest strategies, cost–benefit analysis and significantly the effects of climate change.

Keywords

Management · Fisheries · *Panulirus* · Challenges

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8.1 Introduction

In 2013, we published a detailed review of the commercial fishing for lobsters of the genera *Panulirus* (Phillips et al. 2013). This chapter includes some of that material but in a shortened form. For addition information, the reader is referred to the 2013 publication.

(a) The Management of the Tropic Rock Lobster Fishery *Panulirus ornatus* in Torres Strait, Australia

The artisanal fishery on *P. ornatus* is located in the Torres Strait and the east coast of Papua New Guinea (PNG). The fishery is an important source of livelihoods since the access is mainly restricted to the indigenous people (Phillips et al. 2010). The resource is shared by Australia's Torres Strait Protected Zone (TSPZ), PNG's area of the TSPZ and Gulf of Papua and the State of Queensland (south of TSPZ). Lobsters are caught by fishers while freediving to about 4 m or using hookah to around 20 m. Trawling is banned permanently in both countries (Moore and MacFarlane 1984). Within the Australian TSPZ, non-indigenous fishers may fish from dinghies associated to a mother vessel.

The TSPZ was officially created in 1984. Fisheries management in the TSPZ is undertaken under the Torres Strait Fisheries Act 1984 that put in place catch sharing arrangements. The fishery has effectively been managed by input controls. Catches have fluctuated inter-annually (Table 8.1). Australia endorses PNG boats to fish in Australian waters (Williams 2004). Most volume is exported to China.

A plan of management is being developed for the Fishery to transition the management arrangements to output controls through the allocation of TRL quota units to the two sectors. The plan pursuant to section 15A of the Torres Strait Fisheries Act 1984 will:

- Determine a total allowable catch (TAC) each season.
- The TAC will be determined by the PZJA in line with requirements of the industry (Patterson et al. 2017).

Many different fishery scenarios and management measures were tested through a management strategy evaluation (MSE) for the Torres Strait Tropical Rock Lobster Fishery (TSTRLF) (Plagányi et al. 2012). MSE included a bio-economic model to estimate subsector profits. This model and updates now provide a method of assessment and prediction on the effects of management arrangements and economic performance of the fishery.

The TSTRLF management objectives consider economic performance, but also social and cultural factors. They include the objectives of protecting the traditional way of life and livelihood of traditional inhabitants, particularly in relation to their traditional fishing rights and appropriate controls on fishing gear and fishing effort to minimize impacts on the environment (Patterson et al. 2017; Prescott and Steenbergen 2017). Fishery governance has progressively improved as a result of stakeholders'

Table 8.1 Landings (t) of *Panulirus* spp. for 2009–2015 (from FAO 2016 and "from some other sources")

Location	Species	2009	2010	2011	2012	2013	2014	2015	2016
Western Australian spiny lobster	*P. cygnus*	7634	7260	6327	6988	7379	7077	7156	6087
Caribbean spiny lobster	*P. argus*	23,521	27,432	28,668	30,116	27,325	26,664	30,239	
USA, Florida	*P. argus*	2063	2567	3350	3213	2557	3617	3208	3425
Bahamas	*P. argus*	7138	9482	8505	9761	6088	6509	6525	
Brazil	*P. meripurpuratus*	7268	6866	6776	7451	6726	6787	6100	
California spiny lobster (USA and Mexico)	*P. interruptus*	2139	3213	3335	2895	2952	4118	3093	
*Torres Strait Australia ornate spiny lobster**	*P. ornatus*	444	940	951	678	613	913	476	
Indonesia Tropical spiny Lobster	*nei*	5892	7651	10,541	13,549	16,482	10,062	16,750	

*The FAO data are best considered indicative of the scale commercial catches of each species from each area rather than being accurate representations. Brazil is no longer *Panulirus argus* but now *Panulirus meripurpuratus* (Giraldes and Smyth 2010)

engagement (Prescott and Steenbergen, 2017), advocacy and participation in advisory groups and decision-making in PZJA. Overall, steady progress in this fishery is being made as it moves towards a quota allocations system (Pascoe et al. 2017) incorporating social and economic objectives together with ecological sustainability.

(b) **The Bahamas Fishery for *Panulirus argus***

The spiny lobster fishery for *Panulirus argus* in the Bahamas is worth about US $90 million, employs about 9000 fishers and covers a massive 11,650 km^2 of ocean. Fishing is conducted using traps, condominiums (*casitas*) and diving.

In 2017, the Bahamian spiny lobster fishery has asked for assessment to the Marine Stewardship Councils Global standard for sustainable fishing. The MSC certification is a private governance company with a goal to create a market based on sustainable operations. It involves a third-party certification process and an environmental standard based on the following: (1) status of the target fish stock, (2) ecosystem impact of fishing and (3) governance system. The fishery performance is assessed against the MSC standard and conditions on improvements may rise as result of such process. Conditions are actions that the fishery must comply with within a set time. Certification has a limited 5-year duration; within this period, certified fisheries must submit to annual audits by evaluating conditions' progress. If the progress towards meeting conditions is not achieved, the certification may be suspended. The outcome of the MSC assessment will take about 18 months to be decided.

Of particular interest will be the assessment of the impacts of hurricanes including the recent effects of "Irma" in early 2017. Phillips et al. (2017) have determined that hurricanes have effects of decreasing the catch of *P. argus* in the Caribbean 2 years after they occur. The last few years have received a series of strong hurricanes in the Caribbean. Catches in the Bahamas (Table 8.1) have shown considerable reductions between 2013 and 2015, but the reasons are not yet explained.

An additional problem is the quality of the catch data on *P. argus* for the Bahamas. Smith and Zeller (2016) reported that "reconstructed total catches (e.g. reported catches and estimates of unreported catches) were 2.6 times the landings presented by the FAO for the Bahamas. This discrepancy was primarily due to unreported catches from the recreational and subsistence fisheries in the FAO data. The recreational fishing accounted for 55% of reconstructed total catches". There are obviously many problems to be overcome in this fishery.

(c) **An Updated Assessment of *P. argus* in Florida**

The Caribbean spiny lobster fishery allows both commercial and recreational fishing permits, providing income to coastal communities. Between 20% and 25% of the lobster catches come from recreational fishers.

In 2011, an amendment to the fishery management plan (FMP) for spiny lobster in the Gulf of Mexico and South Atlantic was approved. In addition to establishing annual catch limits, the amendment redefines biological reference points and

removes several other species from the FMP (Gulf of Mexico Fisheries Management Council 2011, Southeast Fishery Bulletin FB11-98, 2011). The new management arrangement includes an annual catch limit of 7.63 million lbs. (3468 t) and an annual catch target of 6.59 million lbs. (2995 t). These new arrangements are aimed at achieving sustainability of the Florida spiny lobster fishery.

At the conclusion of the review of the *P. argus* fishery in Florida in 2013, Phillips et al. (2013) commented on the fact that declines in the catch of the fishery were not explained. However, more recent catches (Table 8.1) clearly indicted good catch levels since that time to 2016.

The latest review of the fishery is given in a paper published by the Gulf of Mexico Fishery Management Council, "Modifications to Management Benchmarks, Annual Catch Limit, Annual Catch Target, and Prohibition of Traps for Recreational Harvest in the South Atlantic Exclusive Economic Zone" (http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_sa/spiny_lobster/documents/pdfs/gulf_sa_spiny_lob_reg_am4.pdf published in 2017). This review includes comments on future management considerations of:

1. The Deepwater Horizon MC252 oil spill in 2010. The full consequences are unknown, but the impact on the physical environment of the Gulf of Mexico are expected to be significant.
2. Climate change. Global climate change could have significant effects on the Gulf of Mexico and South Atlantic fisheries; however, the extent of these effects cannot be quantified at time. The most recent review of its impacts on lobsters is in Phillips et al. (2017).
3. Hurricanes. These remain an even present threat. "Irma" in 2017 may have caused damage to the Florida area, but no details are available.
4. Source of recruiting puerulus. The management system currently accepts that most of the recruits to Florida are from sources other than Florida. A paper by Kough et al. (2013) estimated that between 10 and 40% of larvae are from Florida and retained in Florida waters.
5. Stock assessment. Lack of definition of stock size and source makes an assessment status impossible using standard methodology.

Despite all these problems, the fishery in Florida for *P. argus* is well managed and produces good catches.

(d) Western Australian *Panulirus cygnus* Fishery

The western rock lobster *P. cygnus* is found only in temperate and subtropical waters off the west coast of Australia (Phillips et al. 2010).

Several research and models to predict the future catches have been developed. The level of puerulus settlement is mainly related to sea surface temperature and ocean currents. The settlement levels are highly correlated with catches up to 4 years later (Phillips 1986; Caputi et al. 1995, 2003). The seasonal fluctuations in puerulus settlement have led to high variability in catches but enforcement authority has set

properly management measures. Fishers also have understood seasonal fluctuations and take them into account in their fishing operations.

In 2006/2007, a significant decline in puerulus settlement started; the lowest level recorded since 1968 was shown in the 2008/2009 season (Department of Fisheries 2011). A risk assessment workshop was able to identify the changes in environmental conditions and the productivity in the eastern Indian Ocean as the most likely factors responsible for the low puerulus settlement (Brown 2009). Later, the level of puerulus settlement in 2010/2011 was above that of the previous three seasons (Department of Fisheries 2011).

The downturn in settlement may impact future landings, and with no action taken the downturn may also affect the state of the broodstock negatively. Effort reductions were applied into the fishery in several seasons (2007–2010). In the 2008/2009 season, a catch limit of 7800 t was set, and a TAC of 5500 t was introduced the next season. The fishery faced the transition to management by output control when individual catch limits (5500 t) were introduced. After 2010/2011, reference points focusing on maximum economic yield (MEY) rather than maximum sustainable yield (MSY) were adopted.

Melville-Smith (2011) reviewed factors affecting population resilience of temperate fisheries, including climate change, fishing activities, invasive species and coastal development. The conclusion was that it is tempting where fished populations fail to identify a single responsible factor. According to Melville-Smith (2011), several factors such as environmental, biological and economical factors and management are involved into the failure of fishing populations to recover. For the western rock lobster fishery, the combination of the factors mentioned earlier and the response of management by reducing effort at the time rebuilding broodstock have been positive in recovery fishery.

A major review by Penn et al. (2015) examined the development and implication of input- and output-based management systems using the *P. cygnus* fishery as a case study. Penn et al. (2015) concluded that linking biological controls with and evolutionary approach to management may allow sufficient fishery-based data for management decision to be effective. Price/earnings ratios could be used to analyse trends in license values and industry's economic viability over time under both output and input control management.

Another item of interest is an assessment of risk management for the Western Rock Lobster Council Inc. Risk is the effect of uncertainty on the ability of an organization to meet its objectives. A 2016 assessment for the council was undertaken by Peter Cooke of the company *Acknowledge.* A series of recommendation have been developed by Peter Cooke for the fishing industry to consider (Kim Colero, Western Rock Lobster Council Inc., Western Australia, personal communication).

The Western Rock Lobster Fishery was awarded MSC certification as a well-managed fishery in March 2000, the first fishery in the world to receive this imprimatur. It continues to maintain certification.

(e) **The Baja Red Rock Lobster Fishery (*Panulirus interruptus*)**

The fishery is operated in the North Pacific coast (28.6°N 115.5°W–26.6°N 113.2°W) by ten fishing cooperatives that hold exclusive access to benthic highly valued species in geographic adjacent areas defined by the federal government. Lobster is caught with baited traps, and 90% of the annual catch (~1300–1500 t) is exported to Asia. Market conditions, financial capacity of the cooperatives and sense of community made the lobster fishery vital for local livelihoods (McCay et al. 2014).

The cooperatives are vertically integrated in a regional federation (FEDECOOP) that has capacity to organization, management and marketing, bridging users with local and government levels. The fishery is defined as "multi-level co-managed" (Finkbeiner and Basurto 2015) since its management is carried out by both centralized (National Commission of Aquaculture and Fisheries, CONAPESCA) and decentralized (National Fisheries Institute, INAPESCA) governmental agencies, their respective regional delegations and the FEDECOOP. In addition, since 2003, there is a subcommittee functioning as an inclusive representation of fishery stakeholders. The subcommittee exposes the challenges faced by the fishery to design strategies and foster decision-making. Thus, some management measures are top-down fixed, and other measures come from bottom-up processes, through negotiation between FEDECOOP and CONAPESCA (see McCay et al. 2014). Two main instruments regulate the lobster fishery: the National Fisheries Law and the Mexican Official Standards (NOM-006-PESC-1993 modified in 2007).

As part of the exclusive access granted, the cooperatives are exhorted to get involved into the production of resource knowledge. FEDECOOP employs fish biologists to provide technical assistance to its members and record information. FEDECOOP members use transect surveys and are familiar with the importance of record feasible data to assess their fishing resource. Cooperatives actively participate in scientific monitoring with the regional delegation of INAPESCA and have funded scientific research in educational institutions. The remote location of exclusive fishing areas as well as the stringent internal vigilance rules set by the cooperatives may prevent poaching (Pérez-Ramírez et al. 2012; McCay et al. 2014).

In 2004, FEDECOOP was certified by the MSC. Addressing the conditions raised in the first certification (2004–2009) strengthened the cooperation between FEDECOOP and the local fishing agency but also the involvement of fishing scientists. Conditions pointed out to evaluate the ecosystem impacts of fishing and to develop appropriate harvest strategies. After celebrating a stakeholder workshop and a joint research project between public research institutions, conditions were achieved (see Bellchambers et al. 2015). After a long assessment process, recertification (2011–2016) conditions were placed on stock assessment and a reporting system for bycatch and bait was developed. Providing an accurate method for stock assessment remains open and behind target during the 2015 surveillance audit. The cooperatives and the local fishing agency introduced a logbook to quantify bycatch and bait to address the reporting system condition.

(f) Future Research for Management

The data in Table 8.1 suggests that the lobster fisheries worldwide have survived the last 7 years without major collapse, and Indonesia's catch is continuing to increase. We cannot find publications to support and describe the fisheries in Indonesia. However, we are advised that the catches shown in Table 8.1 do not include spiny lobster aquaculture data.

The world of fisheries management is now a much more complicated place than it was 10 or more years ago. Modelling of data from catches in the fishery, effort and also sales prices of product and costs of fishing are now common. Some of these important models are those of Plagányi et al. (2011, 2013, 2014a, 2014b). Other items now encountered by scientists, managers and industry are ecosystem-based fishery management, management performance reviews, MSC reviews, productivity commission inquires, status of the stock assessments for permission to sell product overseas, bioeconomic modelling to improve harvest strategies and cost–benefit analysis, to name just a few.

It may lead to better management of the fishery, but they all increase management costs and in some cases contradictive information. A constant problem is ensuring the quality of the basic catch and effort data and its accuracy over time. India does not provide catch statistics to FAO. However, in Chapter 7, there is a good review of catches and fishing operations for lobsters in India and the history of the lobster fisheries over time.

No one knows the full extent of changes that climate change may bring to the fisheries worldwide. However, in a recent book, Phillips and Pérez-Ramírez (2017) have reviewed the situation globally. A chapter is specifically devoted to lobsters. A number of *Panulirus* species have already been identified as being affected by climate change including *P. cygnus, P. argus*, *P. interruptus*, *P. marginatus* and *P. japonicas* (Phillips et al. 2017). Hobday and Cvitanovic (2017) have reviewed the reasons why there has been a delayed response to the implications of climate change in Australia. There conclusions were "implementation of management and policy responses (to climate change) have lagged because societal and fisher awareness of climate change have lagged" (Hobday and Cvitanovic 2017). This may also be the reason in many other countries.

Regarding certification, the process requires continual knowledge generation, collaborative problem-solving and learning. The certified lobster fisheries mentioned earlier have realized that certification may promote new collaborative partnerships to support the process and to address conditions (Bellchambers et al. 2015). These collaborative actions between stakeholders at different levels of organization are related to stakeholders' objectives, skills and capacities. Nevertheless, some developments are still required to facilitate coordination: (1) develop a strategic risk framework to address investment and time frame and (2) institutional building for improve assistance supporting the longevity of certification. Enabling public policy on fisheries certification may be also critical. As a learning process, it should attempt negotiation and reflection actions in such way that the stakeholders learn from each other and reflect what they have learned to improve resource management.

Challenges that some lobster fisheries in Australia are facing include an ongoing programme to identify and capture costs and benefits of certification, improvements in community acceptance and license to operate and the changing market dynamics including commencement of Australia/China free-trade agreement in 2019 (Kim Colero, personal communication). An excellent review of opportunities and the outlook for the Australian spiny lobster fisheries has been made by Plagányi et al. (2017).

8.2 Conclusions

The management of the spiny lobsters *Panulirus ornatus* in Torres Strait, *Panulirus argus* in the Bahamas and also in Florida, *Panulirus cygnus* in Western Australia and *Panulirus interruptus* in Baja California shared by the USA and Mexico all appear to be adequate at this time, as measured by catch levels. The rapidly increasing catch in Indonesia remains to be explained. Many spiny lobster fisheries are now certified and this has led to a necessity for a significant increase in data gathering from the fisheries. Western Australia, which was the first fishery certified, is now undergoing a programme to identify and capture costs and benefits of certification, as well as improvements in community acceptance of the fishery, and license to operate as well as changing market dynamics. Some of these aspects, and others, are likely to affect other lobster fisheries worldwide.

Not discussed in this chapter but mentioned in some other chapters in this volume is the effect of rapid development of aquaculture of spiny lobsters. Achievements in Australia, which are not published because the research results are considered *commercial in confidence*, indicate that the studies are close to finality, which will result in the development of new spiny lobster industries in competition with wild lobster fisheries.

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