THE NORTH COAST OF SÃO PAULO SEABOB SHRIMP FISHERY AS A SOCIO-ECOLOGICAL SYSTEM

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ABSTRACT

This paper applies a resilience thinking framework to examine the seabob shrimp fishery on the North Coast of São Paulo (Brazil) as a socio-ecological system (SES). It conceptualises the seabob fishery SES, describes the system dynamics and highlights some disturbances to its resilience. It is critical that future policy interventions acknowledge the complex and dynamic nature of fishery SESs if alternative pathways to sustainability are to be built.

INTRODUCTION

The development and implementation of policies to effectively cope with the degradation of marine ecosystems and their resources require a strong appreciation of the nature of linked social-ecological systems (Carpenter et al., 2009). In Brazil (and elsewhere), inadequate understanding of the interactions between ecosystems and human societies has largely constrained the capacity of management and governance initiatives to address pressing marine problems, such as overfishing. Indeed, in the 1960s, a Federal Government policy (see, Decree 221/1967) aiming to boost commercial fishing in Brazil resulted in overexploitation and collapse of several fisheries. Currently, the level of exploitation of many fisheries in the country is regarded as unsustainable. The seabob shrimp (*Xiphopenaeus kroyeri*), an important fishery resource, particularly in Southeast Brazil, is a representative case (Castro et al., 2005).

Resilience thinking is increasingly used as a systemic approach for understanding the dynamics of complex and interlinked social-ecological systems (SESs). Resilience thinking also seeks to inform policy interventions aiming to improve ecosystem services and human well-being (Walker et al., 2004; Folke et al., 2010). In addition, discussions of sustainability are increasingly linked to the concept of resilience, which is also highly relevant to sustainable fishery systems (Charles, 2001). In this context, this paper aims to examine the seabob shrimp fishery on the North Coast of São Paulo through the resilience thinking lens. Reframing the seabob fishery in terms of resilience thinking may allow for a better understanding of the system and for alternative pathways to sustainability to be envisaged.

The rest of this section introduces the North Coast of São Paulo. The next section outlines the analytical framework and the methods used in this study. It is followed by the conceptualisation of the seabob fishery as a SES, the description of the system dynamics and highlight of some disruptions to its resilience. The last section presents the concluding remarks.

Study site

The North Coast of São Paulo (commonly referred to as Litoral Norte) has a total area of 1,977 km^2. It encompasses the municipalities of Ilhabela, São Sebastião, Caraguatatuba and Ubatuba, and has a total population of 270,000 people. The North Coast is characterised by diverse natural resources. Tourism is a major contributor to the region's economy, which is highly influenced by the holiday season (SEMA, 2005). The fishery sector includes commercial fishing, of which shrimp fishery is an important component.

METHODS

This paper uses resilience thinking as the analytical frame. The resilience thinking framework recognises that ecosystems and human societies comprise an integrated system with reciprocal feedbacks and interdependence, emphasising a humans-in-nature perspective (Folke, 2006). Central to this framework is the concept of resilience, which refers to the "…the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure and feedbacks" (Walker et al., 2004). A heuristic model, known as adaptive cycle, which describes a four-phase sequence of social-ecological systems is also used. The study is based on documents and archival records, including technical reports from São Paulo Fisheries Institute (Instituto de Pesca de São Paulo), research papers and legislation and policies.

RESULTS AND DISCUSSION

The seabob shrimp fishery SES comprises the fishery resource (seabob shrimp), resource users (fishers, traders and consumers) and the governance system, which includes sets of formal (policies and legislation) and informal (social norms) rules that regulate the interactions between users and the resource (Anderies et al., 2004). In Brazil, the seabob shrimp is found in tropical and subtropical coastal regions. It is one of the most exploited shrimp species on the coast of São Paulo (Castro et al., 2005) (Figure 1 shows the production of seabob shrimp in São Paulo). On the North Coast of São Paulo, the seabob fishery comprises a small-scale fishery and is estimated to provide direct employment to 500-600 people. The seabob fishery fleet consists of approximately 365 small vessels (5-9 metres), which operate near the coast to depths of 10-20 metres and within coastal embayments (Santos et al., 1988). Regulation of access to seabob stocks includes licensing of fishing boats; an ecological economic zoning (State Decree 49.215/2004), which defines fishing areas; and the "defeso", the period between March and May when fishing is banned (IBAMA Normative Ruling 189/2008). In Brazil, fisheries governance is mainly responsibility of the Federal Government. However, decision- and policy-making may involve multiple organisations at different levels of social and administrative organisation (Table 1).

Table 1: Examples of organisations relating to seabob fishery management and governance.

Level	Organisation
Federal	• Institute for Environment and Renewable Natural Resources (IBAMA) establishes fishing bans/closures (e.g., Normative Ruling 189/2008)
	• Environment Ministry produces the national list of threatened species (e.g., Normative Ruling 5/2004)
	• TAMAR Project promotes education and awareness initiatives to reduce incidental capture of sea turtles
State	• São Paulo Fisheries Institute (Instituto de Pesca de São Paulo) produces technical and scientific information
	• Environmental Police monitors and enforces some environmental regulations
	• São Paulo Environment Secretary (SEMA) develops zoning schemes (e.g., ecological economic zoning)
Local	• Local Councils may provide support to fishing cooperatives
	• Fishing Cooperatives

The seabob fishery SES can be understood as a dynamic system, which moves through four recurring phases describing an adaptive cycle (Figure 2) (Walker et al., 2004): phase 1 – shrimp stocks are recovered from the previous fishing seasons; potential for exploitation is high. The fishing season begins; as the system moves to phase 2, there is a relative rapid exploitation of the fishery resource (the production of seabob shrimp was 152 tons in 2005 [Figure 1]). The fishing season ends when the annual fishing ban enters into effect (1st of March). The system moves to phases 3 and 4; the species migrates off-shore for reproduction, juveniles grow in inshore areas (Castro et al., 2005); the stocks gradually recompose; biomass accumulates over time; the cycle is then replicated. It is important to notice that the dynamics of the seabob fishery SES involve cycles with differing, yet linked, temporal scales. The fishing cycle takes 9 months to complete (i.e., the period between fishing bans); penaeid shrimp has a short life cycle between 16 and 50 months, and seabob shrimp may take 6 months to reach maturity (Branco, 2005).

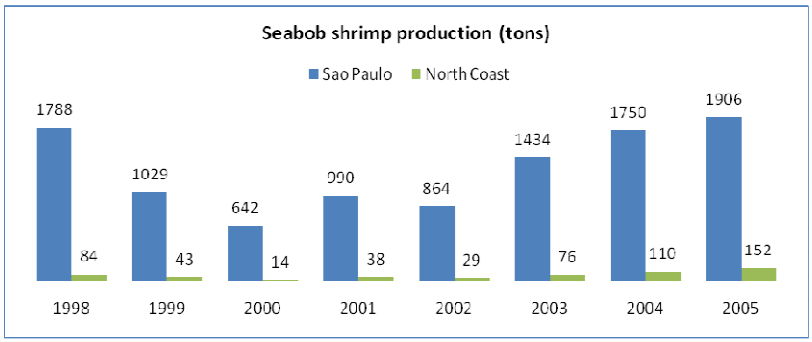

Figure 1: Production of seabob shrimp in the state of São Paulo and its North Coast between 1998 and 2005 (source: Instituto de Pesca).

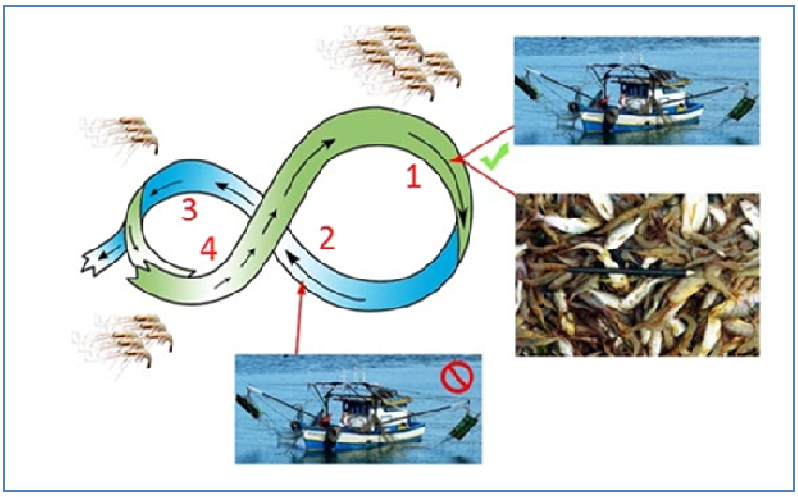

Figure 2: Adaptive cycle of the seabob shrimp fishery socio-ecological system.

SES dynamics can be affected by a number of environmental, socio-economic, political and institutional disturbances (Anderies et al., 2004). A resilient seabob fishery SES is one that, in face of change, is able to adapt, maintaining societal and economic benefits it is capable of providing. Factors that contribute to the resilience of the system include the fishing ban to protect the species during its reproductive period; the provision of compensation payments during the ban ("seguro defeso"), and the possibility for some fishermen to move temporarily to other fisheries or to other activities/industries (e.g., tourism). Nevertheless, these arrangements are yet to prove effective in restoring and maintaining the resilience of the system despite unlicensed vessel operations, inability to exclude non-local vessels from accessing the resource, and degradation of coastal and marine habitats. Not surprisingly, the seabob shrimp is in the national list of species of aquatic invertebrates and fishes endangered, overexploited, or threatened by exploitation (MMA, 2004). Disturbances to the system resilience add to the overexploitation trajectory, which may lead to the collapse of the SES with considerable ecological and socioeconomic consequences.

Traditional fisheries management and governance have proven unsuitable to deal with the interlinked nature of SESs. Because seabob fishery SES is complex and influenced by environmental, social (conflicts with other fisheries), ecological (habitat degradation, impacts of bycatch) and institutional (excludability issues, free riding) disturbances, novel approaches capable of coping with interacting processes, uncertainty and change and fostering adaptability and transformability are critical (Walker et al., 2004).

CONCLUSIONS

This paper examined the seabob fishery as a SES. As such, the seabob fishery included the resource, its users and the governance arrangements that define the interactions between the resource and resource users. The seabob fishery SES was conceptualised as a dynamic system moving through four recurring phases describing an adaptive cycle. Unlicensed vessel operations, inability to exclude non-local vessels from accessing the resource, and degradation of coastal and marine habitats are some of the threats to the SES resilience, which may lead the system to collapse. The use of the resilience framework highlighted the complex and dynamic nature of the seabob shrimp fishery, and some key disturbances to its resilience. It is critical that future policy interventions acknowledge the complexity and dynamics of fishery SESs if alternative pathways to sustainability are to be built.

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