



The rocky path to sustainable fisheries management and conservation in the Galápagos Marine Reserve

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ABSTRACT

Human activities in the Galápagos Marine Reserve are managed by a two-tier system involving a multi-stakeholder local participatory forum and a national inter-ministerial decision-making body. Despite efforts to achieve sustainable fisheries, the two main resources, spiny lobster and sea cucumber, have shown alarming signs of deterioration. The reasons for the management failure may lie in the design of the system, as Galápagos appears not to fulfill many of the critical enabling factors which facilitate successful common property management.

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1. Introduction

The sensitive nature of certain marine areas has been recognized since the early twentieth century [1]. However, in recent years, there has been a change in the perception regarding the resilience of exploited marine species, from a view that little more than limits on commercial takes are required in order to maintain populations [2], to a growing awareness that many of the world's fishing resources are showing signs of serious decline, with real risks of extinction of certain species [3,4].

Marine Protected Areas are now commonly used as tools for the protection of species or habitats [5–7] and as fisheries management tools for the recovery and sustainable use of overexploited stocks [8–11]. Multi-use marine reserves permit certain human activities within the boundaries of the conservation objectives behind their creation.

In contrast to the traditional view that common property resources tend towards overexploitation – the ‘tragedy of the commons’ [12] – and that only state control or privatization offer solutions, there are a growing number of examples where communities have shown to be capable of managing common property sustainably (e.g. [13]).

This paper explores the participatory management regime of the Galápagos Marine Reserve, a multi-use reserve, in relation to its attempts to reconcile small-scale commercial fishing and conservation.

1.1. The Galápagos Archipelago

The Galápagos Archipelago, made up of 18 major islands and over 100 islets [14], is situated in the Eastern Pacific Ocean, approximately 1000 km from continental Ecuador. The Galápagos

Marine Reserve (GMR) created in 1998, and included on the list of UNESCO Natural World Heritage Sites in 2001, extends 40 nautical miles from the coastal baseline surrounding the island group (Fig. 1), making up a total area of around 138,000 km² [15].

The unique nature of the GMR lies in its position, at the confluence of three major ocean currents: the Panama current, bringing warm water from the north, the Humboldt current, bringing cooler waters from the south, and the upwelling sub-equatorial (or Cromwell) current, with highly productive cold waters which surface to the west [16].

These currents and their interactions drive the coastal and oceanic dynamics of the entire archipelago, and are responsible for the variety of native and endemic species and different marine communities present in such a relatively small area [17]. Nowhere else do cold water species such as fur seals and penguins mix with warm water species such as hammerhead sharks and corals [18].

1.2. Local community

Four of the islands are inhabited – Santa Cruz, San Cristóbal, Isabela and Floreana. The communities are mainly dedicated to tourism, agriculture and fishing. The population has increased dramatically in recent years, from only 6119 inhabitants in 1982 to 16,109 in 1998 [19]. After 1998, strict immigration rules were set in place; however, despite these, population estimates for 2006 place the current figure at around 28,000 (INGALA, personal communication).

Tourism in Galápagos plays an increasingly important role [20]. There are designated visitor sites around the Archipelago, mostly accessible only by sea, so tourism is generally carried out by means of cruises or day tours from ports. Tourist figures are currently over 120,000 visitors (75% foreign) each year and rising (Fig. 2) [20].

The dramatic population increase has led to increased pressure on resources and a high level of social conflict [21,22]. The local

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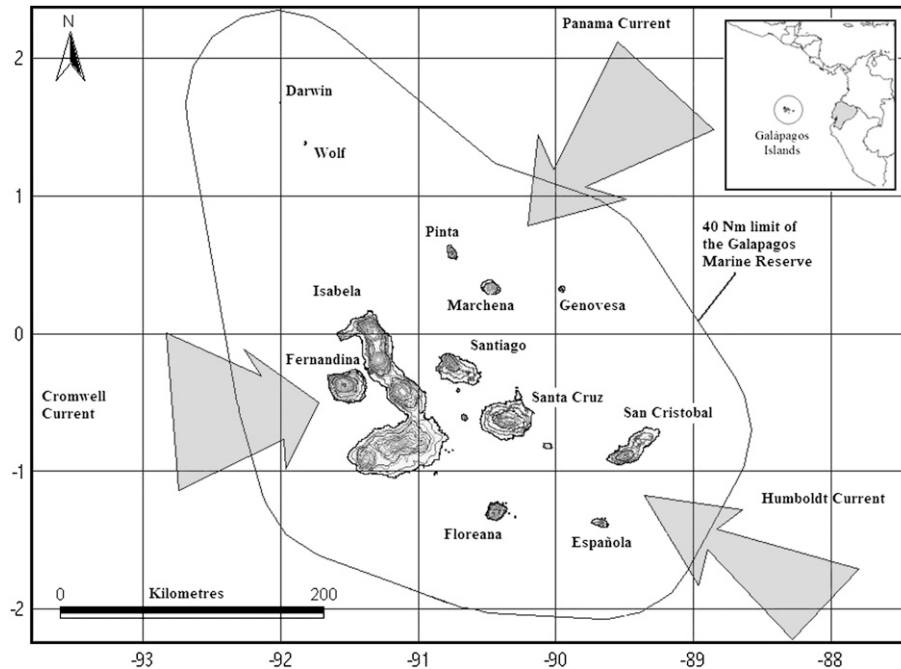


Fig. 1. The Galápagos Marine Reserve (GMR) showing baseline and 40 nautical mile limit.

community is characterised by a marked sectorial attitude, with perceived inequities about the distribution of costs and benefits arising from the protected areas in the islands [23].

1.3. Characterization of the fishing sector

Until 1998, industrial fishing vessels from continental Ecuador and abroad were common sights around the islands. Now, industrial fishing is banned in the GMR, and fishing rights are granted exclusively to the local fishing sector, defined as 'artisanal'. This sector has expanded greatly from under 500 registered members in the early 1990s to 1003 in 2005 (Fig. 2) mainly due to the development of the sea cucumber fishery [24].

The fishing fleet is made up of 446 registered vessels, 85% of which are wooden (*pangas*) or fiberglass (*fibras*) vessels up to 9.5 m in length, with outboard engines. Larger vessels (up to 18 m) serve as mother-boats, towing the pangas to distant fishing grounds, storing the catch, and serving as living quarters.

Fishing is mostly carried out in coastal waters, the main resources being the spiny lobsters (*Panulirus penicillatus* and *Panulirus*

gracilis) and the Galápagos sea cucumber *Isostichopus fuscus*, all of which are caught by divers using surface supply gear. The lobster fishery developed from a subsistence activity to a commercial fishery in the 1960s, but with the retirement of the last industrial vessel in 1984, it became the most important resource for local fishers [25]. The sea cucumber fishery began as an illegal activity in the early 1990s as a response to the collapse of the resource in continental Ecuador. This brought many migrant fishermen to Galápagos, and was largely responsible for the increase in numbers of the fishing sector over this period. Despite an experimental fishing season in 1994, it was not until 1999 that the fishery was legalized and regulated on an annual basis [26–29].

Other benthic invertebrate resources include the Galápagos slipper lobster, octopus, and a number of molluscs. The most important fishery 20 years ago was for demersal fish [30], such as the endemic Galápagos grouper *Mycteroperca olfax*, but this has dwindled, partly because of overexploitation and partly due to the much higher market value of lobsters and sea cucumbers. Open water fishing, targeting yellowfin tuna and swordfish, is carried out on a small scale, due to the lack of a market for the catch.

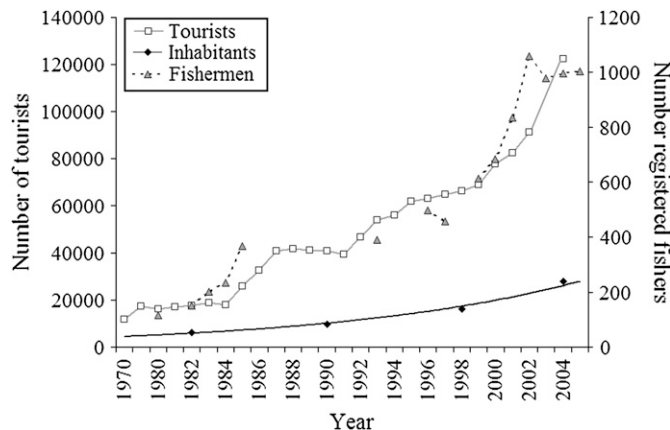


Fig. 2. Galápagos population size, number of registered fishers and tourist influx from 1970 to present. The population size for 2004 is an estimate from INGALA.

2. GMR management framework

After a series of conflicts in the 1980s and early 1990s, the current management framework for the GMR was established after a long participatory process involving the major stakeholders [31]. This resulted in the *Special Law for the Conservation and Sustainable Use of the Province of Galápagos* and in a collaborative management system.

The GMR Management Plan encompasses all activities carried out within the GMR, and is based on the Precautionary Principle and the principles of adaptive management, local participation and sustainable development [32].

As a multi-use marine reserve, the GMR is managed by a two-tier system involving the major stakeholders. On a local level, the Participatory Management Board (PMB) is made up of the tourism sector, naturalist guides, artisanal fishers, the conservation and science sector, represented by the Charles Darwin Foundation (CDF) and the Galápagos National Park Service (GNPS) as the administrator

of the GMR. The PMB functions on a consensus basis, and elevates management proposals to a national body for ratification.

The Inter-institutional Management Authority (IMA) is the maximum decision-making body of the GMR. Of its seven members, four are Ministers: the Minister of Environment (who presides the IMA) and the Ministers of Defence, Tourism and Fisheries. The remaining three seats are occupied by the Galápagos Tourism and Fishing Sectors, and the CEDENMA, a body which represents environmental groups within Ecuador. The GNPS acts as secretary and the CDF has an advisory role. Issues are decided by majority vote although generally, if consensus is achieved in the PMB, it is ratified directly by the IMA.

The GNPS is charged with executing decisions made by the IMA, and with the patrolling and enforcement of the GMR with the aid of the navy.

3. Fisheries management tools

The most important general tool of the GMR Management Plan is the Provisional Zonation Scheme, which was agreed upon by consensus in 2000. This scheme divides the GMR into three zones: coastal, open water and port areas. Within the coastal zone, fishing is permitted in 78% of the area, with the remaining 22% made up of several no-take areas and tourist visitor sites [33].

The main fisheries management tool is the Five Year Fishing Calendar (2002–2006), which provides regulations for the lobster and sea cucumber fisheries and sets research priorities for other fisheries where information is lacking. There are three main sets of regulations:

- A fishing season of 2 months for sea cucumber and 4 months for lobster.
- A minimum landing size of 26 cm total length for lobster, 20 cm for sea cucumber.
- A ban on landing ovigerous female lobsters.

The Fishing Calendar also makes reference to the possibility of a catch quota for lobster from 2004 onwards. Although not mentioned in the Calendar, quotas were set for sea cucumber every season except for 2002. These were global quotas with the exception of 2001, when individual transferable quotas (ITQs) were set.

Although lacking management objectives, the Fishing Calendar identifies some indicators with threshold values below which corrective measures must be taken. These are

- For sea cucumber: closure of areas which fall below a threshold adult density of 0.4 ind m^{-2} , or display a continuous (3 years in a row) decline in catch per unit effort (CPUE).

- For lobster: closure of areas, reduction in effort, and a global quota not greater than 31 tonnes of lobster tails when overall CPUE drops below a threshold of $5.8 \text{ kg diver day}^{-1}$.

An onboard fisheries observer program was set up to comply with the fisheries monitoring obligations set by the Fishing Calendar. Fisheries independent surveys are also carried out before and after each sea cucumber fishing season by both scientists and fishers.

4. Current state of main fishing resources

4.1. Sea cucumber

The sea cucumber fishery peaked in 2002 with a catch of 8 million individuals, after which catches declined steeply, with uncompleted quotas in 2004 and 2005, and a complete closure of the fishery in 2006. At the same time, CPUE followed a similar pattern, reaching a maximum value of $136 \text{ ind diver h}^{-1}$ in 2002, and falling to only 40% of this value by 2005 (Fig. 3). There is little information on the illegal catches of the early 1990s, but De Miras et al. [27] estimate that up to 12 million sea cucumbers were fished during the 6-week experimental fishery of 1994.

Fisheries independent surveys showed densities falling after each fishing season, with high levels of recovery until the 2002 fishing season, after which populations failed to recover and densities dropped to less than 10% of the maximum values recorded (Fig. 4). However, in absolute values, total density (including juveniles) never reached the minimum threshold value of 0.4 ind m^{-2} (IMA Resolution 003-2002).

A survey of sea cucumbers carried out in the western part of the archipelago in the early 1990s provided density estimates of 6.24 ind m^{-2} [34], suggesting an overall decline in density of up to 99% by 2005. Other indicators point to similar conclusions:

- There was a spatial shift in the sea cucumber fishery towards exploiting No-Take Zones from 2004 onwards [21], coinciding with the depletion of permitted fishing grounds.
- Average diving depth increased from 14 m in 2001 to 25 m by 2004 [21].
- Since 2004, an illegal fishery for the sea cucumber *Stichopus horrens*, of less value than *I. fuscus*, has developed [35].

Typically of a boom–bust fishery, the price of individual sea cucumbers rose from US\$0.33 in 2002 to US\$1.21 in 2005 as the resource became more scarce [29], further driving the pressure to fish by making it profitable while catches declined.

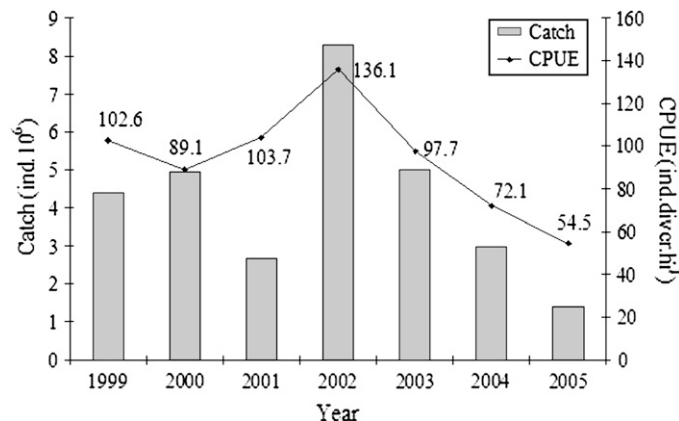


Fig. 3. Catch (in millions of individuals) and catch per unit effort (individuals caught per diver per hour) of sea cucumber *Isostichopus fuscus* in fishing seasons 1999–2005. Source: CDF-GNPS Fisheries Database.

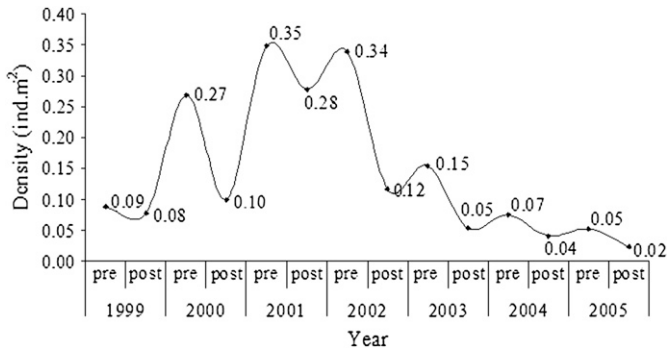


Fig. 4. Density (ind m⁻²) of sea cucumbers (all sizes) pre- and post-fishing seasons 1999–2005, from participatory surveys carried out by scientists and fishers. Source: CDF database.

4.2. Lobster

The lobster fishery experienced its worst year during the 1997–1998 El Niño event, when CPUE dropped to its lowest historical value (5.8 kg diver day⁻¹) and total catch was 31 tonnes of tails (see Fig. 5). However, subsequent years displayed a significant recovery, so the 1998 values were adopted as precautionary threshold levels for future seasons. After 2001, catches and CPUE declined steadily each year until 2004, when CPUE dropped to 4.6 kg diver day⁻¹. The corrective measures set out in the Fishing Calendar were not taken and CPUE dropped further in 2005. (The reduced catch in 2004 is due to an overlap of 6 weeks with the sea cucumber season, resulting in less effort targeted at lobsters for that period [36].)

Other indicators also point to declines in the resource:

- Size structure of lobster landings has shifted 4 cm towards smaller sizes between 1978 [30] and 2005 [36].
- The percentage of undersized lobsters landed in the catch has increased and now exceeds 30% [36].
- A significant amount of ovigerous females are landed during the fishing seasons [36]. Although this is prohibited, there is widespread practice of scrubbing (removing the eggs from the pleopods).

5. Analysis of common property resource management framework

Despite the existence of a comprehensive monitoring programme, the dissemination of results to all stakeholders and

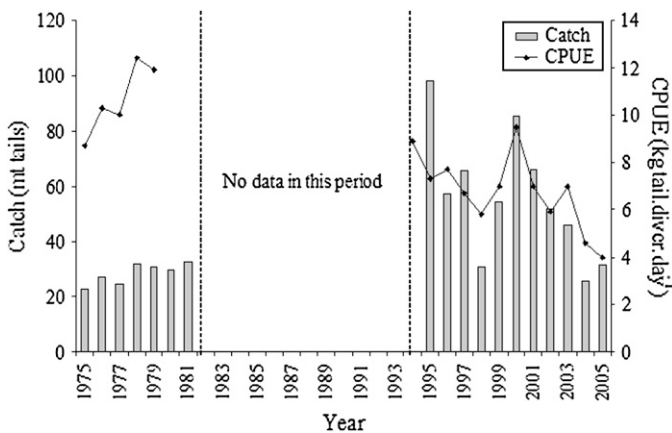


Fig. 5. Catch (in tonnes of frozen tails) and CPUE (kg tail per diver day) of spiny lobster (*Panulirus penicillatus* and *Panulirus gracilis*) in the GMR (data from Reck [30] and Hearn et al. [36]).

authorities, a consensus-based stakeholder decision-making process based on the precautionary principle and the principle of sustainable use, and a series of management tools designed to ensure the sustainability of the resources, the fisheries management system has clearly failed. The optimism which characterised the early years of the participatory management system [37] has been eroded as resources have declined and collapsed. But what are the reasons behind this failure?

Ostrom [13] proposed a set of eight design principles which are important for the successful self-organization and sustainable management by users of a common property resource. Agrawal [38] combines this proposal with others by Wade [39] and Baland and Platteau [40] and presents 33 factors, nested in four main categories (resource system, users, institutional framework, and externalities), which are critical enabling conditions for sustainability of the commons (Table 1).

5.1. Resource system

Of these conditions, the only one fulfilled in the GMR is the limited mobility displayed by benthic resources. The resource system, taken to be the entire coastal area of the GMR, is large and complex, and spans several distinct biogeographic regions [17]. Both lobsters and sea cucumbers, whose distribution is limited to the shallow coastal zone around islands, display only localised movement in adult form. However, boundaries are less clear when relating to patterns of larval recruitment and connectivity between areas and from outside the archipelago [41]. The Galápagos Islands are frequently affected by the poorly understood El Niño and La Niña events, which have large, long-lasting effects on the marine ecosystem [16], and which affect the predictability of resources.

5.2. Resource users

Galápagos society is relatively young and is increasing rapidly. Rather than an oceanic island community aware of social ecology and resource limitations, the local population behaves more like a frontier community, characterised by a vicious cycle of rapid expansion, overcapitalization and overexploitation of natural resources, and sectorial rather than community loyalties, which further exacerbates migration from the mainland [42]. There is no shared vision for sustainable use of island resources. In several instances, leadership positions in the fishing cooperatives have been used as political springboards, and there is a widespread feeling of mistrust among members. In a survey carried out among boat owners, 81% considered that leadership was inadequate [22].

Over 1000 people are currently registered in one of the four fishing cooperatives, spread over three islands. Many of the new fishers arrived after having participated in the collapse of the sea cucumber resource along the coast of continental Ecuador, so that, rather than having past successful experiences, they had a history of sequential depletion.

The current make-up of the local fishing sector is highly heterogeneous. A study carried out with the Santa Cruz cooperative in 2003 identified several subgroups, including boat owners, fiberglass vessel owners, divers, line fishermen, politicians, mechanics, public servants and taxi-drivers [43]. Additionally, several fishers were found to live in continental Ecuador, and only to travel to Galápagos for the sea cucumber fishing seasons.

There is little information on the income patterns of members of the fishing sector. However, in a study by Murillo in 2002 [44], he estimates that the average gross income for sea cucumber fishermen over the 2-month fishing season was several thousand dollars. However, this has declined as the resource collapsed. It is difficult to separate perceptions of real poverty from those of comparative poverty when related to the sea cucumber boom years or related to

Table 1

Critical enabling factors for successful commons' property management suggested by Agrawal [38], applied to fisheries management in the Galápagos Marine Reserve

Category	Attributes	Situation in GMR
Resource system	1. Small size	No
	2. Well-defined boundaries	No
	3. Low levels of mobility	Yes
	4. Possibility of storage of benefits from the resources	No
	5. Predictability	No
Users	6. Small groups	No
	7. Clearly defined boundaries	No
	8. Shared norms	No
	9. Good leadership	No
	10. Past successful experiences	No
	11. Interdependence between group members	No
	12. Similarities in identities and interests	No
	13. Low levels of poverty	Probably yes
	14. Overlap between user group residential location and resource location	Low
	15. High levels of dependence on the resource system	No
	16. Fairness in allocation of benefits from common resources	No
	17. Low levels of user demand	No
	18. Gradual changes in level of demand	No
Institutional framework	19. Rules are simple and easy to understand	To some extent
	20. Locally devised access and management rules	To some extent
	21. Ease in enforcement of rules	No
	22. Graduated sanctions	Inappropriate sanctions
	23. Availability of low-cost adjudication	No
	24. Accountability of monitors and other officials to users	No
	25. Match restrictions on harvests to regeneration of resources	No
Externalities	26. Low-cost exclusion technology	No
	27. Time for adaptation of new technologies related to the commons	No
	28. Low levels of articulation with external markets	No
	29. Gradual change in articulation with external markets	No
	30. No undermining of local authorities by central government	No
	31. Supporting external sanctioning institutions	No
	32. Appropriate levels of external aid to compensate local users for conservation actions	Not always
	33. Nested levels of appropriation, provision, enforcement, governance	To some extent

the local tourism sector. Fishers perceive that it is the tourism sector that reaps the benefits of conservation and participatory management. Elsewhere, such as in the Bay Islands of Honduras [45], marine reserve initiatives showed a degree of success with local communities, especially when alternative employment was provided for fishers in the tourism sector. However, in Galápagos, the tourism sector is well-established, permits are limited and fishers cannot compete. Low-scale tourism such as snorkelling and bay tours has yet to be regulated.

With almost the entire population of Galápagos concentrated in the ports of Santa Cruz, San Cristóbal and Isabela islands, there is little overlap between the user group residence and the resource location. Daily fishing trips are limited to the inhabited islands and those within a 30 nautical mile range from port, whereas fishing trips to the northern or western parts of the archipelago last several days and generally involve a mother ship.

The level of dependence on the resource system varies between subgroups within the fishing sector, as does the allocation of benefits. Whereas traditional fishers depend on the resource system for a living, there has been little effort to sustain the resources themselves; rather the focus has been on developing new resources as existing resources are depleted. In this sense, a feasibility study for sea cucumber exploitation in the early 1990s identified this resource as an 'alternative source of income' for a fishing sector faced with declining lobster and Galápagos grouper catches at the time [34]. With the subsequent collapse of sea cucumber populations, alternative resources (sea urchin, longlining, other sea cucumber species, shark finning) or activities are being demanded.

The theme of 'alternatives' has greatly damaged the governance process of the GMR. Authorities and NGOs are both partly responsible for building expectations by making promises of alternative employment or resources for the fishing sector which they

have been unable to keep. The possibility of exchanging fishing permits for tourism permits, or for buy-out schemes to be established, has inflated the sector with opportunists seeking to make easy money. Lack of leadership within the fishing cooperatives has made it impossible to carry out a filtering process to remove non-fishers.

5.3. Institutional framework

Prior to 1998, there was no institutional framework in place which allowed for commons' property management of the GMR. Fisheries cooperatives existed, but were disorganized and membership was low. Once the participatory management system was set in place, mandatory membership of cooperatives was implemented for all fishers.

The Fishing Calendar did not stipulate the mechanisms by which management decisions were to be made, such as how to estimate a total allowable catch, or what conditions are required in order to re-open a fishing ground after closure. This resulted in conflicts between users, which on occasion erupted into scenes of civil unrest [21].

The provisional coastal zoning scheme has not yet provided benefits to local fishers or conservation. However, the scheme was neither enforced nor physically demarcated until 2006 and thus not implemented throughout the 2002–2006 period. In addition to this, leaders of the fishing sector publicly rejected the zonation scheme as they perceived the consensus to have been reached in exchange for the promise of alternative employment for the sector – a promise which has not been fulfilled.

The ease of enforcement and the existence of applicable graduated sanctions are closely linked to compliance. Ostrom [13] suggests that in cases where stakeholders are involved in the

monitoring process, levels of compliance are likely to be higher. In the GMR, patrolling and enforcement is carried out jointly by the GNPS and the Ecuadorian Navy. However, levels of compliance among fishers are low [22]. The uninhabited islands, especially the remote islands (Darwin and Wolf), are difficult to access and patrol efficiently. The low probability of detection, low rates of sanctions, and inappropriate penalties all contribute to undermine locally devised rules. There is no mechanism by which the monitoring officials are made accountable to the users. Besides illegal incursions into the GMR by industrial vessels (mainly longliners targeting tuna and shark), local fishers also engage in illegal fishing for several other species of sea cucumber [35] and sharks for the fin trade [46].

Fisheries resources are still treated as belonging to the state, and fishing sector strategies centre around exploiting the maximum amounts possible, partly to fulfill high economic expectations, partly due to lack of confidence in scientific data and partly due to the lack of a realistic common image of the resource system and its production capacity. Heylings and Bravo [47] identify the need for greater internal consultation and feedback processes, and more involvement of the sectors (including tourism and guide sectors) at the grassroots level. Lack of training in consensus processes has resulted in the PMB becoming a focus for verbal brawling and polarised debate as the basis for interactions between users. Real collaboration, shared visioning and finding common ground have been hindered by poor sectorial leadership across the board and a weakening of the facilitation support system of the PMB in recent years.

Decisions for fisheries have often been trade-offs between different interests rather than responses to the principles of sustainable use. In this sense, catch quotas for sea cucumber greatly exceeded sustainable levels, and in the last 2 years of the fishery were irrelevant with respect to the final harvest [29]. In the same sense, recovery measures for the lobster resources were never implemented [36].

Fishing effort has focused on two species which were already heavily exploited before fisheries management tools were even discussed. Although the Galápagos National Park has existed since 1959, it was not until 1998, with the creation of the GMR, that serious efforts were made to regulate fisheries. By this time, spiny lobsters had almost disappeared from the intertidal habitat, where they were once most abundant [48], the industrial lobster fishing vessels had left [25], and large numbers of both local and continental fishers had spent several years harvesting sea cucumbers in the absence of regulations or control. The newly created PMB therefore had to create a fisheries management regime in the face of pressure from an overcapitalized fishing sector with declining resources.

5.4. External factors

The sparsely settled, dispersed nature of the islands implies that currently, there is no low-cost exclusion mechanism. Satellite tracking is being contemplated as one mechanism to enforce the coastal zonation scheme, but it is both costly and technologically demanding.

External markets have been the main driving force behind both lobster and sea cucumber fisheries. Particularly, in the latter case, the fishery arose suddenly as demand shifted from the coast of Ecuador, where the resource had collapsed, to the islands [27]. Asian merchants exerted their influence on the system to achieve their own short term interests using strategies such as lending money to fishers before fishing seasons were opened, and financing strikes [21,49] when the regulations implied any reduction in catch (closure of islands, quotas). This pressure has resulted in the maintenance of a status quo [50], with the veto by fishermen of any

measure designed to reduce overfishing, and the dilution of conservation-based agreements in order to placate all sides and attain consensus – so called ‘convenience overfishing’ [51].

Political instability both on a local and national level has weakened the institutions charged with the administration of Galápagos. This instability peaked in 2004, when there were eight different Directors of the Galápagos National Park Service (GNPS). To further complicate the situation, despite a rather small total population, Galápagos has two parliamentary seats, which are contested by door-to-door politics. In this context, the promise of unrestricted fisheries is a guarantee to obtain votes.

External aid has not always been appropriate. As a UNESCO World Heritage Site, the GMR has attracted attention from a range of NGOs and foreign cooperation agencies. These have not always coordinated their efforts, and fishing cooperatives have, at times, complained about unfulfilled promises. Overall, there is a danger that both the stakeholders and authorities come to see external aid as a right which must be satisfied on demand.

6. Options for the future

Prior to 1998, Galápagos fulfilled none of the design principles which Ostrom [13] or Agrawal [38] suggest are critical to the successful management of common property resources. However, since then, Heylings and Bravo [47] have shown that progress has been made, notably in the provision of an institutional framework, the delimitation of boundaries and the availability of scientific information to support decision-making. Despite this, they note a weakening of the process. Viteri and Chavez [22] point out that non-compliance, which is linked to monitoring and enforcement capacity, is an issue which must also be addressed.

There is a growing awareness in the community that a shared vision for Galápagos is required. Although at present, much of the work is disjointed, the first steps towards a community vision have been taken. Leadership is being strengthened in all institutions, most notably with the merit-based selection process for the incumbent GNPS Director carried out in 2006, and there are initiatives to strengthen the organizational capacity of the fishing cooperatives. There is, however, still a need to find and train leaders, and to reduce external governmental influence on the GNPS.

The collapse of the sea cucumber fishery along with the departure of many merchants to other countries (such as Nicaragua or Panama) has removed much of the backing of those components of the fishing sector who resorted to strikes and direct measures. The leadership of the fishing sector is now actively working with authorities and NGOs to develop sustainable businesses related to fishing, such as the use of fish aggregating devices (FADs) to target tuna and wahoo in open waters, or pilot studies using oceanic handlines; both of which help to reduce pressure on coastal resources. Marketing initiatives such as agreements with tour operators to provide fish for tour boats, or selling processed products such as smoked fish have also proved successful for small groups of fishermen and their families. It has become clear to most actors that there is no single alternative for the entire sector which can satisfy the expectations created by the sea cucumber boom years.

A fisheries management plan is currently under construction, with the participation of the fishing sector, GNPS, Charles Darwin Foundation, the provincial planning authority (INGALA) and the National Fisheries Institute. This will contain specific management objectives, indicators, reference points and management measures based on the best available technical information and the lessons learned from previous fisheries. However, there is still a sense that fishermen are not being adequately represented by their leaders, who may use the sector for their own personal political or economic interests; and the issues of control and enforcement still remain.

In the context of ecosystem management, one of the key solutions to the resource management issue will be the success of the zonation scheme. This will depend mainly on two factors:

1. Participation and acceptance of the need for NTAs by fishermen, particularly of NTAs of high productivity and ecological importance for fisheries.
2. Adequate enforcement and patrolling capacity of authorities, which depends on funding and regained respect for governance within the framework of participation.

Although many of these initiatives will help strengthen the participatory management process, it remains to be seen whether common property management is a suitable model for Galápagos fisheries. An alternative approach to the current crisis may involve retaining elements of common property management in a multi-stakeholder sense, but to change the entire fisheries management component. Rather than attempt to fit the fishing sector into a cooperative-based, artisanal group description, it should be recognized that the fishing sector is a heterogeneous group of individuals, made up largely of recent migrants, with a commercial interest in marine resources, either for harvesting and export, or as a stepping stone for other privileged activities within the GMR.

The introduction of individual transferable quotas (ITQs) into such a system would provoke a debate on the allocation rules and encourage the fishing cooperatives to carry out a filtering process to remove all non-fishers from their lists. A reduced number of coastal resource users could then be issued with tradeable harvest rights in the form of a proportion of a total allowable catch. Tietenberg [52] suggests that communities can be affected if quotas are transferred to outsiders. In the case of Galápagos, trade of quotas should be restricted to members of the fishing community.

However, both private and common property management models will fail if the issues of non-compliance, poor enforcement and inadequate sanctions are not addressed. These require a profound re-structuring of the political structure of the GMR administration institutions and their relationship with central government.

7. Conclusions

The Galápagos Islands are facing a critical period, the outcome of which may determine their future. The lack of leadership, governance and a shared vision has led to rapid population growth and a frontier rather than an island mentality, which, combined with an inherent lack of understanding of marine resource dynamics, have resulted in the overexploitation of the coastal fisheries in the GMR and a crisis in the fishing sector.

The accumulated effects of these declines on the marine community are as yet unknown, but there are reasons to suspect that observed changes of benthic community structure in some areas might be related to the reduction of spiny lobsters [53]. The reduction of sea cucumbers in certain areas to less than 10% of their original biomass may imply that they are no longer fulfilling their role in those habitats, and the potential reduction in shark numbers from the illegal finning industry may have a cascading effect on the entire marine ecosystem [53].

For the fishing sector, the current resource crisis presents an opportunity to organize, filter out non-fishers, and decide whether to continue down the path of common property management or move towards private harvesting rights.

The Galápagos Marine Reserve is inherently dynamic – located in the pathway of three major ocean currents and directly affected by strong climatic events such as El Niño – from which the coastal resources appear to have the capacity to recover [41]. This suggests that a change in fishing practices can have positive impacts for the resources and the marine ecosystem in general.

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