Chapter 10
The Emergence of Recreational Fishing in the Galápagos Marine Reserve: Adaptation and Complexities

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Abstract In recent years a local experiential sport fishing industry, commonly known as *Pesca Vivencial* (PV), has emerged as a new type of activity in the Galápagos Marine Reserve (GMR). We analyze this new industry, which incorporates a surprising multitude of styles, using a *complex adaptive systems* (CAS) framework. We use CAS (a) to trace feedbacks between the ecological changes and social processes involved and (b) to frame the driving factors behind PV as extending beyond the fishing sector, which makes its logic as a response to the declining profitability of commercial fisheries over recent decades more understandable. The birth of this industry is a "response" and a bottom-up adaptation by fishers to changes in fishing but also tourism and overall GMR management. Focusing on the island of San Cristobal, this chapter will include historical analyses of the development of PV through its initial proposals and its changing forms of uptake. This article contributes to a thin area of research in this new activity so far, understanding the contested politics and livelihood struggles of the local residents involved. More broadly, our use of CAS is novel in that power dynamics within human interactions are part of feedbacks, often underplayed when applied to fisheries change.

Introduction

The nascent industry of *Pesca Vivencial* (PV), or experiential sport fishing, has stirred up both controversy and anticipation in the Galápagos Marine Reserve (GMR) since it gained momentum in 2005. Pesca Vivencial was first conceived as cultural tourism, a demonstrational activity where a visitor would spend a day with a fisherman or a fisherwoman (henceforth referred to as "fisher") and learn

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about their culture and practices (UCOOPEPGAL 2005; Reck pers. comm.). In theory fishers would not notably alter their practices or equipment, while being able to maintain incomes and reduce harvest levels. In practice, we will show that such aims have faltered while conventional high seas sport fishing has in effect become a controversial but increasingly common "type" of PV activity. Sport fishers have long sailed Galapagos waters unregulated (Molina 2005) but are now starting to color how PV license holders perform Pesca Vivencial, since both are being regulated under the PV term through legal modifications that allow targeting species outside of commercial fishing, namely, striped marlin (*Tetrapturus audax*; Schuhbauer and Koch 2013), and have led to acquisitions of new and costly luxury boats by PV license holders (Engie unpub. data).

Pesca Vivencial's implications have become symbolic of larger struggles over the future of this World Heritage Site: fears of ecological exploitation of new species that could diminish conservation effectiveness and of downgrading of the elite tourism market clash with local aspirations to greater access to the multimillion-dollar tourism industry. Taking an environmentally precautionary approach is needed, since fisheries conflicts have only recently become less chaotic than past decades (Ospina 2006; Epler 2007) where (select) environmental degradation was undeniable, particularly around sea cucumbers in the 1990s (Bremner and Perez 2002; Hearn 2008). However Galápagos institutions have struggled with finding alternate livelihood options for fishers that are mutually satisfying to all stakeholders, and political mistrust has set up confrontational dynamics that complicate their implementation (Stacey and Fuks 2007).[1] Pesca Vivencial's implications are clearly ecological, political, and socioeconomic all at once.

This article has two major research questions. First, we ask how the social and environmental impacts of this new economic activity can be understood, at present and into the future. Ideally, because PV's social and environmental implications are intricately linked, they should be jointly examined and contextualized within broader changes in Galápagos society. We do so by applying the concept of *complex adaptive systems* (CAS) to Pesca Vivencial's rapidly changing forms, including sport fishing. Although a highly abstract framework, its potential to serve as a bridging concept for assessing ecological and social change together is strong given its resolutely interdisciplinary philosophy and mechanistic rigor in showing how "entities" in a system can be human and nonhuman while sharing core adaptive dynamics (e.g., Keller 2005). Complex adaptive systems also help to frame PV's driving factors as extending beyond the fisheries sector. To give social dynamics equally serious consideration with ecological dynamics however requires a novel, expansive application of CAS that is the focus of our second research

[1] In just one example, early PV regulations over motor power put participants in ambiguous legal positions. Motors were not to exceed 135 horsepower (HP) for artisanal fishing. A boat with tourists must have two motors however, which would add up to 150 HP (75 HP each), making them illegal for artisanal fishing and therefore PV, at that time a type of fishing activity. Some fishers interpreted these complications in PV as "intended obstruction(s)" rather than growing pains (Stacey and Fuks 2007: 87).

question, how can power-laden human interactions be better fit within complex adaptive systems?

We recount Pesca Vivencial's social history to trace feedbacks between the ecological changes and social processes involved in its grassroots emergence. Building on work that has begun to describe PV's practices (Schuhbauer and Koch 2013), we connect the contested politics and livelihood struggles of local fishers to PV's potential ecological impacts. Knowledge of such struggles is still thin, although they will be fundamental to how the industry continues to develop. We begin by outlining the theoretical framework of complexity and complex adaptive systems. In section "Methods," we outline our methods. In section "Pesca Vivencial: A Very Brief Social History," we describe the early social history of PV, and in section "Pesca Vivencial: A Complex and Adaptive History," we interpret developments using the concept of complex adaptive systems.

Fisheries as Complex Adaptive Systems

Complexity science, first and foremost, sets itself resolutely apart from traditional reductionist research. Reductionist approaches have long dominated and led to insights in many sciences, epitomized by conducting experiments substantial where simplified conditions are imposed and objects assumed to be stable, non-changing, and independent for easier calculations with traditional statistics (Manson 2001; Michener et al. 2001). However, as environmental concerns grow so does the realization that ignoring the world's interrelatedness does not produce science that is fully prepared for the complexities of ecosystem changes. Massey (2005) has noted that complexity may be part of a larger impulse in twentieth-century science toward multiplicity, pluralism, and acceptance of ambiguity and away from certainty.

What exactly is a complex adaptive system? One variety out of a whole family of complexity theories, the CAS concept describes any system that follows a particular set of processes in terms of organization and behavior, where various diverse entities or agents interact in different ways and of their own accord. Small-scale fisheries have been conceptualized as resembling CAS's to a remarkable degree because of their diverse interacting "parts" (i.e., independent actors and animals), decentralized decision-making structures, and changing environmental conditions (Garcia and Charles 2008; Mahon et al. 2008). Complex dynamics form from the reactions of these independent, diverse entities (human or nonhuman) to varied selective forces, leading to emergence of a multiplicity of pathways. The most important implication of CAS is that there is no "grand plan" for change, recovery, and disturbance—all are instead driven by bottom-up processes. The ability of fishers to work around harvest and gear restrictions to maximize catches, often eliciting even more intricate rules, is well known and an example of bottom-up dynamics that become difficult for "command and control" resource management structures to monitor and control (Mahon et al. 2008). Beyond fisheries, the periodic

crashing of financial markets and the suitability of the Earth's biosphere for life are also driven by such bottom-up dynamics (Levin 1998; May et al. 2008).

"That life is complicated may seem a banal expression of the obvious" (Gordon 1997: 3 cited in Thrift 1999), but the development of mathematics flexible enough to acknowledge constantly changing entities, be they people or ants, has helped to provide a radical quantitative alternative to traditional statistics for understanding ecosystems. Prominently illustrating this are debates around single species, bioeconomics models in fisheries, such as "maximum sustainable yield" (MSY) (e.g., Larkin 1977; Allen and McGlade 1987; Wilson 2006). Maximum sustainable yield is a calculation that uses species-specific growth rates and a logistic growth model to provide the maximum yield that can be taken from a population indefinitely, in theory. Controversial aspects are its base assumption that marine species fluctuate around some "normal" value and its inability to consider the effects of species interactions (e.g., Larkin 1977). In addition, population dynamics in the ocean are more "loosely" regulated or weakly converge around an equilibrium point than on land (Wilson 2006), and "by studying the equilibrium solution of deterministic equations [MSY and MEY], we immediately rule out the possibility that the long term situation may be *dynamic*—that a fish population may always change and never attain a stationary state" (Allen and McGlade 1987: 147, italics in original).

Recognizing a need to move beyond single species management, which we argue is a type of reductionist approach, a dominant response has been to improve governance perceptions of ecosystem change in hopes of enabling institutions to avoid ecological crises by reacting more quickly (e.g., Berkes 2006; Garcia and Charles 2008; Mahon et al. 2008). One way scholars have done so is by using CAS to ask how institutions and individuals can learn and adapt faster to ecosystem changes, conceptualized as feedback loops (e.g., Allen and McGlade 1987; Garcia and Charles 2008; Mahon et al. 2008).

Fisheries, Complexity, and Power

The fisheries complexity literature still shows no explicit delineation of feedback loops connected to human behavior *besides ecological signals* or of the inherently political nature of fisheries governance (but see Berkes 2006). Who decides how to react to ecosystem change? Who bears any socioeconomic consequences, and do particular outcomes benefit some more than others? Such questions can be raised while retaining analytic focus on ecosystem impacts. Mahon et al. (2008: 106) note, "the capacity to self-organize and adapt does not necessarily result in sustainable or fair resource use systems," which ". . .will depend on the balance of power among stakeholders and their appreciation for these issues." How power imbalances affect ecological outcomes is rarely outlined empirically however. To address these shortcomings, we draw from political ecology, defined as research on ". . .linkages

in the condition and change of social/environmental systems, with explicit consideration of relations of power" (Robbins 2004: 12).

We see room to incorporate power dynamics into fisheries complexity feedbacks more than has thus far been attempted, by distinguishing between the degree of control that different actors exert over various aspects of a fisheries system such as legal regulations and options over gear, rights structures, or access. Such control is often exposed through regulatory debates and individual business choices. In examining the history of Pesca Vivencial's rise, we thus note *who* benefits from ecological, political, legal, or economic modifications and which modifications have persisted. We interpret the visible outcomes of negotiations as indicators of actor influence and power. Such an interpretation treats power as the ability of individuals and groups to constrain each other's actions and opportunities (Dahl 1957), an admittedly limited but useful definition that will still enrich current applications of complexity to fisheries.

Such an analysis goes beyond an often proximal focus on social dynamics in fisheries social science. Bioeconomic models, (e.g., Bucaram and Hearn 2014), characterize fisher behavior (e.g., seasonal fishing participation) and drivers (e.g., fuel prices, yearly seafood price) in the short term. Taking a step further means seeing fishers as people living in a society and not only as people that harvest fish. It was once common to note that while Galápagos environments have been intensely studied, social science scholarship was rare. Such claims no longer hold (e.g., Ospina 2006; Constantino 2007; Grenier 2007), but there is still a need to engage this social science with ecological research at the fine scale of specific species and populations of concern (e.g., striped marlin) and to trace specific mechanisms of connection.

Methods

This work is part of a larger project on the shifting livelihoods of Galápagos fishers, based on field research and semi-structured interviews with fishers, managers, and scientists conducted in the spring and summer of 2012 (Engie unpublished data). Our focus is the island of San Cristobal, the birthplace of the commercial fishing fleet and the local recreational fishing industry. We draw heavily from interviews with 18 fishers in San Cristobal, 2 in Santa Cruz, and 2 in Isabela involved in Pesca Vivencial via license ownership, vessel ownership, or partnership in business operations. We ascertained information on occupational dynamics via questions from a larger individual survey of active, part-time, and former fishers on issues relating to their livelihoods and the general state of change in Galápagos fisheries. Due to the open-ended nature of research, not all fishers were asked all of the same questions. However the data gathered gives various understandings of PV as individually practiced. We ascertained attitudes and motives from open-ended interviews and participant observation around town with fishers as well as scientists, managers, conservation professionals, shopkeepers, tour operators and

workers, and seafood brokers, including staff at nongovernmental organizations and the Galápagos National Park (GNP). Participant observation helped us to experience local perspectives in a more passive manner than in an interviewer–-interviewee setting, in which unspoken power relationships can manifest in unobserved ways (Bernard 2002). Much of our conclusions are from our body of interviews, anonymous unless given express permission to identify people, as well as participant observation. Therefore few interviewed sources are directly named in this paper. Coauthors draw more broadly from interviews with 184 people in total, including 18 on Santa Cruz, and also from continuous conversations with fishing and cooperative leadership over the course of the last 6 years and document analysis of proposed rule sets and statements.

Pesca Vivencial: A Very Brief Social History

To understand the breadth of its implications, it is necessary to trace the evolution of PV in vision and practices. The following sections outline some of Pesca Vivencial's history, as a guide to better understand how PV developed as well as to think through complex feedbacks.

Setting the Stage

Two major dynamics in the 1990s and early 2000s strongly shaped the emergence of PV. First, PV was proposed in the midst of dramatic ecological and economic shifts in Galápagos fisheries that began in the 1980s (Zapata 2006; Hearn 2008; Schuhbauer and Koch 2013), with nearshore fisheries catch rates generally declining in both abundance and size in the primary fisheries of sea cucumber, lobster, and demersal fish (Hearn 2008; Toral-Granda 2008). In the 1990s and 2000s, clearly unsustainable fishing levels fueled intense conflicts between fishers and managers that were rooted in exponential growth of an export market for easily harvested sea cucumbers, previously thought worthless (Epler 2007; Hearn 2008). These years also coincide with the largest economic crisis of the century in Ecuador from 1995 to 2000, uncontrolled migration from the mainland, and the realization that highly valuable sea cucumber stocks were still in great abundance in Galápagos after their stocks had been depleted off of the Ecuadorian coast (Ospina 2006).

By 2005 the sea cucumber "gold rush" that had paralyzed the archipelago was well past its heydays (Bremner and Perez 2002; Hearn 2008). However people previously unassociated with fishing had swelled the first official roster of registered fishers, lured to the job by high sea cucumber profits or to simply lay claim on future options and potential industry buyouts (Bucaram and Hearn 2014, Engie unpublished data). While many fishers and opportunists have left, there is still an overcapacity in the sector.

A second major ongoing issue has been continuing attempts by fishers to break into tourism. With nearshore fisheries showing signs of decline for decades, the most obvious contender to replace or supplant local fisher livelihoods was the massive tourism-based economy, estimated to have a total value of $418.8 million USD in 2007 (Epler 2007), of which 62.9 million entered the local economy (Taylor et al. 2006). While increasing numbers of fishers are indeed leaving the sector for wage labor on tourism vessels, our interviews noted that this option has been viewed as suboptimal and not providing a living wage equal to a fishing livelihood until recently. Older fishers also noted that their possibility of being hired as a sailor declines given labor market competition. Even though land-based tourism has been growing at the expense of cruise-based tourism (Quiroga 2013) and has wider local participation, fisher perception of inaccessibility of the lion's share of the tourism market is unmistakable.[2] In part due to their failures, Pesca Vivencial's originators utilized their fishing skill sets, knowledge of the ocean, and ready possession of boats and aquatic permits (for fishing) to try and break into the tourism market in a novel way when they perceived other avenues closed.

A key point to note about fisher perspectives around Pesca Vivencial is that they represent the desire for *equity and fairness* on top of replacing lost fishing incomes in a 1:1 manner. Although tourism revenues make the Galápagos one of the wealthiest provinces in Ecuador, the rising tide of prosperity has not lifted all boats but rather engendered a "bitter social mobility" among fishers and other residents (Ospina 2006). Both Pesca Vivencial and sport fishing represent access to the rich tourism economy in a way that was unavailable before, and for this reason both have been championed as democratic activities to develop by various fishing factions.

The Stakeholders and Visions of Pesca Vivencial

An important point to remember in the GMR is that *fishers are not the only stakeholders affecting fishing*. Many other stakeholders share overlapping space, including the Galápagos National Park (GNP), the Ecuadorian Navy via the Directorate General of the Merchant Marines (DIGMER), the National Association of Tourist Businesses in Galápagos (ASOGAL in Spanish), smaller tourism vessels and operators, seafood merchants, scientists, and students. The first two have direct oversight in fisheries rule making with jurisdiction over managing fisheries resources and maritime security and traffic, respectively. The others influence local fisher options by indirectly affecting markets or from lobbying influence

[2] Carlos Ricaurte, largely credited as one of Pesca Vivencial's creators, viewed breaking into tourism as an inherently political process and one in which established routes such as converting his vessel to a tourism operation were closed to him, as proven by his unsuccessful application for a bay tour permit in 1997.

over zoning or other resource use rules. Illegal industrial fishing interests from outside the GMR likely affect fish abundance as well. However, all of these groups are not often considered when discussing fisheries change.

Galápagos fishers themselves are not homogeneous but have varying political interests and coalitions, sub-fishery participation and techniques, and vessel ownership status (e.g., Wilen et al. 2000; Zapata 2006; Murillo et al. 2007). We emphasize these intricacies because as soon as Pesca Vivencial was proposed, its systematically hybrid fishing and tourism character triggered the involvement of stakeholders in tourism, marine safety, and others, forcefully illustrating how each marine activity in the GMR must go through various jurisdictional layers. The figure below shows the organization scheme and the major stakeholders in Galápagos fisheries (see also Chap. 8) (Fig. 10.1).

Stakeholders held multiple visions of what the activity should and could be from the beginning, although all visions share some commonalities: to provide alternate income sources for Galápagos fishers, to engage in some kind of cultural exchange, and to achieve a more sustainable fishery (Table 10.1).

As originally conceived fishers would not alter their typical fishing practices or equipment but simply demonstrate them to interested tourists; the proposed name Pesca *Artesanal* Vivencial (PAV) stressed the continuity with typical artisanal practices. This version of PV was a *commercial fishing* activity that did not focus on giving tourists their own recreational fishing experience but offered a glimpse in the world of a fisher, although tourists might participate in fishing at times (Reck, interview, 2012). Molina (2005: 2) called it "demonstrational artisanal fishing." In addition, the activity was not necessarily thought of as a replacement to commercial fishing but could be a supplement that freed the fisher to catch less (Reck, interview, 2012). This idea was discussed during the creation of the GMR's first set of Fisheries Regulations written at the establishment of the GMR in 2000, although PV was not ultimately incorporated. It thus predates 2005, when UCOOPEPGAL, the provincial-level cooperative of Galápagos fishers, first presented PV largely unchanged to the JMP and AIM (Table 10.1). In their presentation they noted that a vacationing tourist would accompany a fishing vessel for a day while "conversing about the life of the fisherman, one's happiness and difficulties in a true spirit of intercultural exchange" (Table 10.1; UCOOPEPGAL 2005).[3]

Sport fishing on the other hand, long conducted in sporadic and unregulated fashion in the Galapagos since the 1950s (Molina 2005; Epler 2007), was immediately suggested instead of PAV inside and outside of the fishing community. However supporters of PAV were wary of any market labeled and practiced as sport fishing eventually being captured by outside and inside elites, as has happened in tourism to some extent (e.g., Epler 2007). Fishers were far from united; some may have been opposed to a recreational fishery outright from the beginning, while

[3] This idea also draws continuity from the 1970s and earlier, before the rise of large cruise ships, when tourists commonly paid fishermen to take them around the islands and to participate in fishing activities (Stacey and Fuks 2007, interviews).

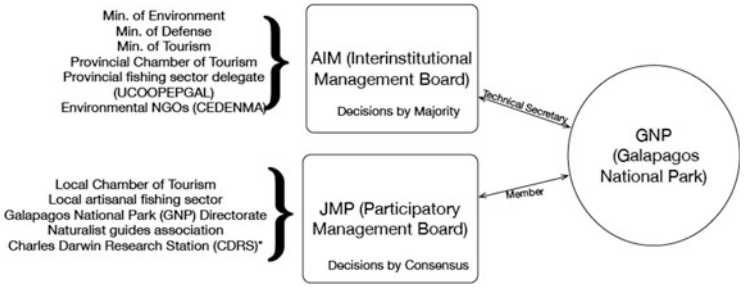

Fig. 10.1 The participatory management structure within the Galápagos Marine Reserve. Spanish acronyms are used for the AIM, JMP, CEDENMA, and UCOOPEPGAL. Modified from Heylings and Bravo (2007). *The CDRS serves an advisory role to the GNP and no longer has voting power

others championed either sport fishing or PV (Reck, pers. comm). Still others have consistently advocated sport fishing instead of PV because of its established global market appeal. Finally, *some* opportunity is simply the goal for many who support any development of Pesca Vivencial, sport fishing, or some combination.

Finally, visions of PV continue to evolve in step with the fishing practices that were ultimately allowed (details in section "Between Two Worlds: Tourism and Fisheries" below), so that many local license holders now associate PV with sport fishing, if we define that as being oriented toward giving a tourist their own recreational fishing experience. However our fisher interviewees still differentiated PV from sport fishing elsewhere, strongly at times, by the following characteristics: being in the hands of local ownership, having a broad base of target species that is always catch and release (after a 50 lb trip limit), and ability to be conducted on a wide variety of vessels beyond luxury sport fishing yachts. In mainland Ecuador in contrast, sport fishing has historically been an elite activity in which comfort was essential and luxury vessels valued (Molina 2005).

Regulatory Evolution

We argue that legal recognition is a significant marker of the establishment of an activity in the GMR, where "there is a long history of officials turning a blind eye toward certain unofficial or non sanctioned forms of tourism. If a major controversy does not arise, regulations are often then formulated and the activity permitted. Cases in point include the status of land-based diving operations, sport fishing that exists but is not legally sanctioned, and large cruise ships based elsewhere that sporadically run cruises through the islands" (Epler 2007: 52).

Historical contingency likely aided PV's uptake in 2005. The speed with which the idea was quickly taken up by was clearly at least partially due to its potential as a viable economic alternative for commercial fishing that could reduce harvests, although stakeholders harbored varied reservations (see below). The fishing sector

Table 10.1 Regulatory evolution of Pesca Vivencial, from the proposal as first presented by fishing sector representatives (top row), followed by major changes in subsequent legislation

Event	Goals and objectives	Legal classification and zoning	Vessel requirements	Manner of cultural transmission	Activities	Monitoring and implementation
Presentation by UCOOPEP-GAL to JMP, July 21–22, 2005	1. Establish income for Galápagos fishers 2. Improve knowledge of the reality of Galápagos fishing 3. Foster intercultural exchange	A fishing activity, called Pesca Artesanal Vivencial (PAV) No further framework yet proposed	1. Fibra with fishing license, 6.5–9.5 m length 2. Security equipment required by DIGMER	*The fisher*: presents attractions and dangers of the sea, demonstrates fishing techniques, reminds all of targeted species, fishing spots, security norms. Lunch onboard as a time for sharing histories, dinner in the house of the fisher with their family	1. Line techniques (capture of bait fish, shore fish, and tunas with hand lines and lures) 2. Submarine fishing (diving)	
			↓ ***Major changes*** ↓			
Provisional Regulations, July 28, 2005	The Galápagos fisher... *uses their own work infrastructure and vessels* ... to sell their fishing culture (emphasis added)	Relevant laws: LOREG,[a] Constitution, Special Fishing Regulations in the GMR Exclusively in fishing zones (2.3)	Additions: 1. Emergency oxygen equipment for diving 2. Vessel owners present cooperative membership	*Art. 21:* Fishers will participate in training courses to offer good service, to be offered by various organizations	Additions: Resting site for snorkeling or swimming While diving, tourists can only observe, not fish	*Implementation:* Shared among the GNP and fisher groups *Monitoring*: Fisher groups, with support of GNP Fisher groups also define regulations for species not currently in the Fishing Calendar

Feb 23, 2011	Same as Provisional Regulations, but language omitted about fishers' use of their own vessels		Additions/ changes: 1. All boats allowed except wooden, between 7.5 and 12.5 m length 2. Vessel cannot have a permit for other tourist activities		Additions: 1. Trolling (dragging a baited lure behind the boat) 2. Fishing rod, with reel or without 3. Nets	GNP controls monitoring, control and registration of vessels and fishers GNP defines regulations for species not currently in the Fishing Calendar based on technical studies
JMP meeting, Oct 4, 2012		A touristic activity, called PAV				
Nov 9, 2012	*Reform of Fishing Regulations that eliminates any mention of PAV*					
Res. 7, GNP, Jan 18, 2013		A touristic activity, called Pesca Vivencial (PV) Inclusion of RETANP with above statutes. Resting sites in zones 2.3 and 2.4[b]	Additions/ changes: 1. Vessels can be used for *either* artisanal fishing or PV, but not for both 2. Cabin now mandatory	Fisher and Naturalist Guide Guide will relate safety at sea, development, techniques and regulations of fishing, and conduct in the GMR	Additions: PV vessels will be able to travel among ports	*Monitoring:* GNP will establish participatory monitoring

[a]The Special Law for Galápagos, or Ley de Régimen Especial para la Conservación y Desarollo Sustentable de la Provincia de Galápagos (LOREG in Spanish)
[b]In the Provisional zonation rules of the GMR, zone 2.3 are the areas where artisanal fishing is allowed, and zone 2.4 is designated for special, temporal management

was placing mounting pressure on governance institutions to help find viable economic alternatives after the sea cucumber collapse. In December 2004 Pesca Vivencial was included within an official baseline list of acceptable alternatives for the fishing sector, of which local cooperatives subsequently decided PV was the highest priority (Zapata 2006). Approving Pesca Vivencial may also have been partially a political trade-off by decision makers, as our interviews with AIM members reveal. Managers saw PV as something that could be a concession to local fishers for accepting the elimination of long-lining, which many fishers advocate and had previously been allowed. Despite its extractive impact on fish populations, Pesca Vivencial was seen as an activity with a comparatively lower ecological impact than long-lining. A subset of international NGOs, government, and those in fishing communities thus became united in pushing forward PV as a legally sanctioned activity once the idea reached the JMP in 2005 (Table 10.1). "Consensus was achieved thanks to the existence of a common objective, where different stakeholders reached a win-win solution. The conservation sector (GNP and CDF) win as fishing effort is reduced, decreasing pressure on the marine ecosystem, the fishing sector (Fishing Cooperatives) win as they have found an alternative economic activity that will allow them to gradually abandon extractive activities, the tourism sector (CAPTURGAL and the naturalists guides) win as this mechanism has reduced the level of conflict and allows the members to obtain higher incomes" (Zapata 2006: 47; translated from Spanish).

In retrospect it is fair to say that collective efforts to approve Pesca Vivencial were achieved not through actors sharing a common vision but through sets of actors that happened to see different needs met through a common action. However, these diverse reasons may also help to explain the protracted negotiations that began as soon as PV was given a legal nod of approval in 2005, which eroded consensus (section "Between Two Worlds: Tourism and Fisheries").[4]

Between Two Worlds: Tourism and Fisheries

A dilemma of whether to categorize PV as a fisheries or tourist activity surfaced during the approval of provisional rules and has been by far the most significant regulatory debate.[5] To help resolve concerns over tourist passenger safety, environmental NGOs helped mediate a trial PV trip in Puerto Ayora in 2006 (Zapata 2006). While considered a success in demonstrating feasibility, it also marked a

[4] These disputes extended even into the fishing community, where debates over initial exclusion of two of the three types of fishing boats as potential PV vessels delayed approval of provisional rules by several months. Beyond this many fishers took a "wait-and-see" approach because of a lack of clarity on PV's market potential (Zapata 2006).

[5] Objections were raised by ASOGAL and DIGMER during the AIM meeting where PV was introduced in 2005 (Zapata 2006). ASOGAL's approval is needed on all marine activities in the GMR, giving added weight to its objection.

seminal moment—official agreement that Pesca Vivencial vessels had to be converted away from basic fishing boats to accommodate tourists safely.

Molina (2005) noted the following governance issues:

- According to Section 40, article 2 of the GMR management plan, fishing vessels cannot be used for tourism activities, and tourism vessels are prohibited from fishing.
- Fisheries monitoring, specifically regulating catch sizes, is the responsibility of the GNP, and "this should not be done by the Fishermen's Ecological Organization (EFO) from Isabela" (p. 15).

Regulations and Park-fisher partnerships in 2005 were thus not well set up to accommodate an activity hybridized across fishing and tourism, and neither perhaps to entrust the fishing sector with capacities to self-monitor. Molina (2005: 15) also noted that "tourists should not be required to sign a document freeing a boat owner from liability in the case of accidents (common in fishing)."

As one AIM participant decidedly put it, the dual concerns raised over safety and jurisdiction were "the knife in the back" of PV as it was originally conceived.[6] This is because (1) as outlined above from a governance standpoint, demonstrational fishing was difficult, and (2) economically, these debates fundamentally changed how local fishermen could participate in PV. First, the decision will trigger regulations under RETANP (Special Regulation for Tourism in National Protected Areas, or Reglamento Especial de Turismo en Areas Naturales Protegidas in Spanish), the national law that regulates tourism. It states that vessels must have certain characteristics of other tourism boats and therefore narrows the accessibility of PV to most Galápagos fishers, most of whom do not have the capital to set up their vessels to cater to tourists like established Galápagos tour agencies. Traditional boats used for daylong artisanal fishing trips are fiberglass or wood-hulled, often uncovered, and contain no restrooms, cabins, or many other features comfortable for tourists. While not technically necessary, some license holders have bought more luxurious sport fishing boats which comply with safety measures while catering to customer comfort at levels competitive with sport fishing ventures elsewhere.

Categorizing PV as a tourist activity has also influenced inter-actor relations. Because boats must be outfitted with expensive insurance, safety, and navigation equipment, significant start-up capital is needed. This need might contribute incentives to make certain types of engagement in the PV industry more likely, such as the "testaferro" phenomenon (see below), made fertile with a constant pressure from nonresidents seeking entry into a market seen as potentially extremely lucrative. People who are not licensed fishermen have entered the activity by partnering with local fishers where they can. This dynamic combines with a risk aversion of

[6] The total lack of knowledge about the economic viability and market potential of PV was also an issue (Zapata 2006), although the debate over whether to categorize PV as a tourist activity was immediate and overshadowing.

many local fishers to borrowing money, given negative experiences with falling behind on bank loans and losing or nearly losing homes or land in the past (Engie unpublished data).

Some license holders have partnered with outside investors or family members who finance and own the vessels in all but name and run PV operations in a variety of partnership arrangements. The majority of the time the local fisher is a minority partner in the business and profit sharing, which has spawned the terms "straw owner" (Schuhbauer and Koch 2013) and the Spanish "testaferro," negatively implying exploitation. However, it is unclear how negative these arrangements are for fishers, some of whom work on the vessels regularly or have aligned with several PV license holders in larger tour agencies. Arguably in all cases, fishers have increased their income and economic security for the present, while remaining connected to the sea. Interviews imply that a significant proportion of all PV license holders in San Cristobal are in such arrangements.

In sum, PV gradually became less associated with commercial fishing and is now dominantly perceived as a touristic activity that some fishers engage in (Table 10.1). As a result, however, the pool of people potentially most likely to succeed in PV, and possibly to apply for licenses in the first place, may *not* be the same pool of commercial fishers who now seek to leave the fishery. The implications of these developments remain to be decided—some may worry that PV will not help reduce commercial fishing harvests or provide alternate livelihoods to fishers. On the other hand, participation in local tourism may increase for Galápagos residents in general, touching upon an equally important concern for social equity. In accord with the worries (or hopes) of both sides, both things seem to be happening (Table 10.2).

Fishing Practices and Participants

Because PV has never actually been practiced as a demonstrational, commercial fishing activity, some believe "there is no PV in Galapagos" (interviews, 2012), meaning that all license holders are involved in various types of sport fishing. Putting aside debates over the definition of PV for the moment (Engie unpublished data), fishing practices under the name of PV have bifurcated into two main styles, the nearshore fishery or "pesca chica" and the high seas fishery or "pesca grande" or "pesca de altura." Importantly, on San Cristóbal the majority of operators offer and engage in both of these styles to capitalize on any opportunity in a market many perceive as sluggish and to expand activity beyond the few months of the year when billfish can be found in greatest numbers. The pesca chica is closest in vision to the original proposal for tourists to participate in traditional Galápagos fisheries. Multiple species are targeted, with bottom fish such as groupers caught around coastal areas using fishing rods as well as traditional *empates*, consisting of a fishing line held in one's hand with a baited hook at the end. Empates may also be demonstrated around deeper water seamounts in the high seas fishery. However, no one makes a living solely based on such trips, and our observations imply that

this trip type is the minority of all PV outings. The "pesca de altura" immediately differed from the version first presented by UCOOPEPGAL delegates (Table 10.1). More closely resembling sport fishing in other areas, it mainly targets larger striped marlin and tunas that swim midwater, using the method of trolling fishing poles from the boat through deeper waters. Commonly targeted environments are underwater seamounts or "bajos" that are scattered around the Galápagos platform where marlins can be most reliably found (see Schuhbauer and Koch 2013). Beyond a profit motive, the high seas trips seem to be promoted also because they are popular and familiar to tourists.[7] Even when clients are interested in learning about the *empate*, they also want to use familiar rods and reels during a costly day trip.

The demographics of license holders are highly diverse and reflect how PV is being taken up by people who see various opportunities to better their lives. Different people engage for different reasons. Three out of 16 interviewed fishers in San Cristobal were full-time commercial fishers when they began PV activities. Two fishers have become passive recently in the past 5 years, one by choice and one reluctantly for family needs. An additional two have transitioned during the last 5–10 years to fishing only occasionally or on weekends. When the opportunity arose, both wanted to enter PV and retain fishing ties. Some license holders have roots in fishing families but went on to full-time careers elsewhere, still fishing on weekends and participating in long trips when possible over the years (Table 10.2). Pesca Vivencial represents the possibility to stay connected to their fishing culture. For all, in an economy where job security is never assured, PV has provided an additional activity where they may leverage their property (in vessels and commercial licenses) and fishing skills for a safer and more diversified livelihood. Strengthening the local tourism economic base, those involved are now well poised for market growth, and their privileged access over mainlanders for the limited number of licenses has given some an edge they may not have been able to begin competing without.

Feedbacks: Bringing Together the Ecological and the Social

With the limited data available, some inferences can be made about the ecological impact of Pesca Vivencial fishing practices. For the immediate future, ecosystem capacities do not appear to be limiting to PV and sport fishing growth *broadly*, although yearly fluctuations in marlin catchability have impacted business. Generally speaking, while nearshore fisheries are strained, it is likely that PV does not add greatly to this strain overall with its 50-lb trip limit, with the critical caveat of monitoring and enforcement into the future. For tunas and striped marlin although abundance is unknown, circumstantially there is less concern, although far from

[7] The high seas trips being offered in 2011 were around $1,200/day, and nearshore trips were only slightly less.

Table 10.2 Summary of select involvement among surveyed fishers involved in Pesca Vivencial in San Cristobal

Personal role in PAV[a]	# of people	Years since fishing full-time[b]	# of people
Owner	1	0	3
Owner, operator	1	1–2	1
Owner, fisher (as mate or captain)	3	3–5	1
All	11	6–10	2
		>10	5
		N/A	2

Days at sea in the PV in 2011	# of people	Occupational diversity	# of people
1	1	PAV, commercial fishing	4
4[c]	2	PAV, other jobs	3
5	2	PAV, commercial fishing, other jobs	7
6–7[c]	1	PAV, other business owned	4
8	1		
≥20	7		

Numbers in each column indicate the frequency of responses. In 2012, these questions were posed about Pesca *Artesanal* Vivencial, in accordance with the name at the time
[a]Including two not currently operating
[b]Unclear for four respondents
[c]Trips, instead of days at sea

none. As one scientist put it, "...it's more acceptable, probably, to do a kind of sport fishing for billfish than (to) do grouper fishing (recreationally)," because of the concern for strain on nearshore stocks (Hearn 2008; Toral-Granda 2008). In addition the banishment of the industrial tuna fleet from the GMR's waters in 2000 drastically cut harvest levels that the PV fleet could never replace.[8] Similarly the seamounts of the Galápagos oceanographic platform that are within the GMR have been largely untouched by the local commercial sector because of their distance from ports and a lack of any developed market for consuming their species. However there is little information regarding the biodiversity and vulnerability of these seamounts.

In the immediate sense, fluctuating abundances clearly affect yearly business cycles, particularly of migratory marlin. All interviewees noted that a particularly low abundance of marlin in 2011 affected their sales. Although eventually other species might pose constraints on PV and sport fishing, there is likely an envelope of industry growth. Notably, interviewees were united in their view that legislative ambiguity and lack of support overshadowed ecological constraints.

There are important interisland differences as far as the possibilities and limitations of Pesca Vivencial. Because Santa Cruz is the hub of tourist activity with over two times the hotel capacity and restaurants and bars (Epler 2007), PV fishers there

[8] Ospina (2006) noted that in 1998 one midsized Ecuadorian industrial tuna vessel had a capacity of 600 net tons, while the large boats of the Galapagos artisanal fishing fleet combined comprised only 50 tons.

have more opportunity to sell tours to passing tourists and are concentrating on small and medium size pelagic and demersal fish. In both Isabela and Santa Cruz, PV is mostly nearshore because of the greater distance and difficulties to get to the seamounts. In San Cristobal where fishers have closer proximity to seamounts, people have invested more in luxury boats, and more clients are of the type that come looking for big game fishing. Conversely there is little walk-in interest. The place-based contexts of proximity to seamounts and local tourism flows are thus both becoming geographic influences for the type of fishery conducted and therefore ecosystem impacts.

As is evident through the above sections, feedbacks between fishers and marine ecosystems run in both directions and on immediate and long-term timeframes. Many other ecosystem impacts will depend on how trends in the PV industry continue to develop, as discussed below.

Pesca Vivencial: A Complex and Adaptive History?

One way to trace how ecological and social change connect to each other around Pesca Vivencial's rise is to conceptualize humans and fishes as "entities" in one connected complex adaptive system with open, porous boundaries and subsystems. Is the PV industry truly a complex adaptive system? We take Levin's (1998) three essential properties of a CAS and apply each one to a different aspect of Pesca Vivencial's development. Stripped to its essential components, a CAS has "(i) *sustained diversity and individuality* of components, (ii) *localized interactions* among those components, and (iii) an autonomous process that *selects* from among those components, based on the results of local interactions, a subset for *replication or enhancement*" (Levin 1998: 432). While these descriptions are highly abstract, they simply mean that, using ecosystems as an example, there are selective forces that each individual feels, which influences their actions and the outcomes of those actions.

Levin's first two dynamics are clearly visible in the history of Pesca Vivencial, made up as it is of fiercely independent fishers, institutions, and interest groups that have chosen various visions, business models, fishing practices, and vessel types, and show shifting political alliances. Let us discuss the third dynamic from the perspective of ecological change translating to social change. Overall, lower densities of sea cucumbers (Toral-Granda 2008) and a need to dive to ever-deeper depths for them (Engie unpublished data) have ended the era of easy, high profit margins in fishing. This ecological limit, combined with growing monitoring and restrictions compared to previous decades (Ospina 2006), means that a less open-access, easy profit fishery could thus be a reality that Galápagos society has and must continue to adapt to. We interpret human response as influenced by the power

differentials between stakeholders, which, along with ecosystem change, act as "autonomous selection processes."

In actuality like other heavily managed systems (i.e., agricultural), a fishery is not a true complex adaptive system since fisher choices are not completely autonomous (Levin 1998). However since small-scale fishers operate as largely independent units, they approximate CAS dynamics in many ways even within management policies such as spatial zonation that broadly structure actions.

In many ways the CAS metaphor is quite amenable to tracing the political negotiations that resulted in present-day regulations, which make sense of the version of Pesca Vivencial that ultimately was "selected" out of different visions from 2005 to the present. It helps us understand the uptake of the practices that emerged as arising from actions of diverse individuals on their "local" level that, over time, were unpredictable, individualistic, and uncoordinated. Historical contingencies (e.g., political expediency and declining abundance of commercial fishing stocks) eventually became amplified at local (in terms of individual businesses) and institutional (in terms of regulations) levels in different ways. PV is the social "emergence," so to speak, of an opportunity that fishers created for themselves (with much support) in a growing tourism economy, as other opportunities became closed, given the degradation and limited space left in the sea cucumber and lobster fisheries in the early 2000s, but also (a) their perceived limited political and occupational avenues and (b) growing monitoring and restrictions on fisheries use, all factors noted as influential by the concept's creators themselves. The activity shows no signs of being orchestrated by some "grand plan", on the contrary one could say that as an emergent process, PV continued from the bottom-up despite the efforts of government regulators to control and even stop it at various times.

We note that the CAS framework is not without limits. On the one hand, complexity has no normative stances on societal concerns, unlike terms such as resilience and sustainability. On the one hand complexity escapes the ambiguities of having to define terms like "benefits" and "sustainable" and is impressively flexible enough to be productively hybridized with many other styles of explanation, as we do here with political ecology. However such neutrality around social change also makes complexity of little utility *alone*, in understanding the base drivers of environmental politics or diversity or understanding why things are diverse at the "beginning" of study. We simply establish the existence of diversity as one element that subsequently generates complex and adaptive dynamics. In addition the very unpredictability of its emergence would likely have left PV as something that could not have been foreseen by managers or researchers.

A constantly changing system means that tracing every feedback loop is impossible. However, particular social-ecological feedbacks, and their political dimensions, are discussed in more detail in the sections below.

The Multiplicity of Complex Adaptive Feedbacks

Perhaps what most strongly marks the appeal of a complex adaptive systems framework is its emphasis not only (or even mainly) to understand these social dynamics but to link them to ecosystem change in traceable ways and via specific mechanisms.

Much of Pesca Vivencial's implications hinge on its future development. It would be tempting to place the bulk of analytic attention on conditions that might make potential "alternate states" more or less likely. Potential states, or sets of implications, that sport fishing opens in the GMR include (a) too rapid expansion in pursuing billfish that might result in a depletion of apex predators in GMR food webs.[9] On the social side, a potential ability of sport fishing interests from abroad to enter the market (i.e., via testaferros) taps into an institutional fear of (b) a loss of control and sudden, irreversible changes toward less sustainable development, including downgrading of the high-end Galápagos tourism market to promoting the area as a generic island playground, which is an unwanted "perverse model" of growth (González et al. 2008).

However, taking complexity's implications seriously means that an equal or greater focus on individual approaches to practicing PV is needed. Complexity prompts us to consider the multiple trajectories that are simultaneously unfolding in a place. One of the major messages of complexity theories is the importance of attending to variance as much as averages, "anomalies" as much as trends, and the whole as much as points.

Let us review one of the most pondered and unproven causal chains concerning Pesca Vivencial: whether commercial fishing effort on coastal fish stocks will decline in part because it is transferred to the PV, through either helping commercial fishers diversify incomes or to leave commercial fishing entirely. This hope has been a prominent reason for institutional support. While it is unknown how commercial harvests have changed because of PV, it appears to have become a complementary rather than an alternate activity for the three interviewed PV license holders that were previously full-time fishers. However, one such interviewee was pursuing strategic partnerships with new tour agencies locally and abroad in 2012. Over time this license holder aims to quit commercial fishing for the PV full-time as their business expands to support them. Other license holders interviewed still hope that PV will one day replace their commercial fishing activities, though they did not have active leads on new partners. Out of the 17 asked of their future job preferences in an open-ended question, 8 declared a preference to work exclusively in the PV if their business supported them. Nine more stated a preference for doing more work in PV. Therefore although speculative, we hypothesize that the present pattern of complementarity to commercial fishing activities is not environmentally

[9] There is also concern among biologists about the true survival rate of catch and release fish, although many released in good condition survive the immediate future (Domeier et al. 2003).

negative, broadly speaking. The nascent industry is only starting up, and its potential to economically replace fishing has not enjoyed much time and legislative clarity.

As implied above, not just particular properties (i.e., PV as complimentary to commercial fishing) but the trajectories they are on (i.e., whether people are acting to replace commercial activities with PV or not) are key to determining ecological change moving forward and the degree of social equity in generated wealth, in connected ways. In addition, whether particular ecological impacts will end up dominating others into the future will depend on the social structures that end up accompanying them.

Political Dimensions of Complex Adaptive Feedbacks

How were power and environmental politics incorporated into PV's social-ecological feedbacks? We highlight several major avenues where political dimensions are apparent.

First, we suggest that the very uptake of PV and then its sport fishing orientations were by no means inevitable. Many fishers and conservation interests were long wary of both PV and sport fishing, the former because of uncertainty of a market (Zapata 2006) and the latter as clashing with the philosophy of a marine reserve (interviews, 2012). Beyond this, the fishing community has always held strong enthusiasm for other tourism alternates as ways to reduce extractive activities, such as owning and operating vessels or guiding (Stacey and Fuks 2007). Despite all the indications of a collective will to channel resource use otherwise then, we have argued that over time the perceived lack of space in such routes, along with growing restrictions around fishing and a tourism industry that now dominates the Galápagos economy, helped push the PV industry into existence as a path of lesser resistance.

The social consequences of uneven tourism development in the Galápagos go beyond an absence of jobs to the innovation of new ideas, which are negotiated by people according to their political and social positions. These ideas then feedback to redirect resource use and, therefore, environmental change.

After its legal establishment, the influences of power differentials in its evolution are apparent on several levels. On a sector level, the regulatory debates around PV illustrate the ultimate power of tourism and the continued tight alignment between tourism and conservation interests in the Galápagos (Grenier 2007). Despite the wellspring of good will toward fishers, staying true to the original vision of Pesca *Artesanal* Vivencial would have required crossing and hybridizing highly entrenched and power-laden governance boundaries between fishing, tourism, and monitoring activities. Operationalizing the current vision of PV, situated as it is under the governance of tourism institutions, does not complicate these boundaries. Tourist safety issues are still handled by the Ministry of Tourism and DIGMER, fisheries monitoring via catch sizes is still the purview of the GNP, and educating tourists about the flora, fauna, and proper behavioral protocols within the GMR is

still channeled through certified naturalist guides, just as on all other tourism vessels in the GMR (AIM Res 007-2013, Table 10.1).

However, this PV version also prioritizes tourist safety and industry reputation in a world-class destination, while greatly weakening the access of the new activity to many fishers. Among these equally legitimate goals, the outcome shows that tourism interests won out, and other avenues were left unpursued—for instance, the possibility of building capacity among fishers to be empowered to explain their own Galápagos fishing culture, which will now be the domain of the accompanying naturalist guide as fishers look on, many of whom have not shared in this fishing culture (AIM Res 007-2013, Table 10.1). While events were more complex than a simple privileging of tourism interests, in fact the outcome does so and shows the tourism industry's greater power even while many in the fishing community welcome these changes for giving a (hopefully) clearer pathway for industry growth.

Pesca Vivencial's history also illustrates the differential power of the fishing sector in different arenas. Galápagos fishers have significant political capital, which enabled their idea to broadcast and which generated much support, not least exclusive rights to Pesca Vivencial permits and funding for pilot projects that have truly helped some fishers in starting up operations by paying for safety equipment (Zapata 2006). However as a group, fishers overall have relatively shallow financial capital. For instance while some fishers earn incomes on par with many other professions in the Galápagos, many lack savings and collateral (e.g., Castrejon 2011) to invest further in their PV businesses, let alone enter in the first place. Even *beyond* financial capital, the number of trips our interviewed operators and license holders were involved in ranged widely, between being at sea just 1 day to more than 60 days in 2011(Table 10.2).[10] The subsequent divergence of business growth trajectories may imply that after obtaining licenses and eventually outfitting boats, some fishers lack capacity in strategic business and social networks, which are vital to staying competitive in the tight Galápagos tourism market and which distinguish those with the most PV business from the rest. Within the industry therefore, it is clear that differences in individual capital, skill sets, and motives all affect how PV has grown, and for whom.

Conclusion

We began this article by asking how ecological and social changes connect in the rise of PV and how power-laden human interactions could be fit within the complex adaptive systems framework.

[10] Since data is self-reported the accuracy is not guaranteed, but regardless of exact numbers unevenness in the days worked in the Pesca Vivencial is undoubtedly a feature of the social landscape.

While PV and sport fishing both expand the number of exploited species in the GMR as currently practiced (notably striped marlin), they are also partial reflections of a local desire to participate more substantially in the multimillion-dollar Galápagos tourism industry. Because they were not inevitable, PV and sport fishing within it should thus be understood as by-products of social struggles *as well as* of much-commented environmental declines in commercial fishing. Therefore continuing to attend to the contested politics and livelihood struggles of the local fishermen involved is critical, along with strengthening knowledge on ecosystem impacts.

We present this case study as an example of using complex adaptive systems to reflect upon changing politics and proliferating resource use practices, a still uncommon application of complexity theories. While issues of power, poverty, or social injustice have been treated lightly in complex systems work, we should also ask: can they be better addressed? Constructive critiques are vital since there is strong interest in a research agenda delineating social-ecological feedbacks in the Galápagos (Watkins 2008) and conceptualizing change via alternate stable states (González et al. 2008).

Ultimately Galápagos marine ecosystems and fishers change together in linked ecological and social ways, whether characterized in a CAS or other framework. Complexity has undoubtedly helped consider Pesca Vivencial's "failures and opportunities" (Schuhbauer and Koch 2013) in a broader and more connected way and proved useful in understanding its varied implications. It also helps to make sense of Pesca Vivencial's unexpectedly dynamic regulations and plurality of fishing styles.

When both ecological and social research is fitted to the CAS framework, power, at least broadly, will be rendered traceable and linkable to the ecological, with the hard linkage being Pesca Vivencial's fishing practices, empirically grounded in geographic particularities. Even while data on ecological impacts remains sparse, tracing out the social dynamics has helped us to hypothesize how social processes connect to ecological change beyond the short-term profit motive often emphasized in fishing research, to the rule sets, interest groups, and ability to attract clients that affects the growth of different fishing practices within the Pesca Vivencial/sport fishing umbrella. We hope that this article represents only the beginning of potential research agendas that study ecological change in marine systems directly linked to sociopolitical aspects of fishing.

References

Allen PM, McGlade JM (1987) Modelling complex human systems: a fisheries example. Eur J Oper Res 30(2):147–167

Berkes F (2006) From community-based resource management to complex systems: the scale issue and marine commons. Ecol Soc 11(1):45

Bernard HR (2002) Participant observation. In: Research methods in anthropology: quantitative and qualitative methods, 3rd ed. Altamira, Walnut Creek, pp 323–364

Bremner J, Perez J (2002) A case study of human migration and the sea cucumber crisis in the Galápagos islands. Ambio 31(4):306–310
Bucaram SJ, Hearn A (2014) Factors that influence the entry-exit decision and intensity of participation of fishing fleet for the Galápagos lobster fishery. Mar Policy 43:80–88
Castrejon M (2011) Comanejo de pesquero en la Reserva Marina de Galápagos: tendencias, retos, y perspectivas de cambio. Fundacion Charles Darwin
Constantino JCC (2007) Fishermen, turtles, and Darwin: Galápagos lives in evolution's laboratory. Doctoral dissertation. Available from University of Michigan, ProQuest, UMI Dissertations Publishing (3276122)
Dahl RA (1957) The concept of power. Behav Sci 2:201–205
Domeier ML, Dewar H, Nasby-Lucas N (2003) Mortality rate of striped marlin (Tetrapturus audax) caught with recreational tackle. Mar Freshw Res 54:435–445
Epler B (2007) Tourism, the economy, population growth, and conservation in galápagos. Charles Darwin Foundation, Santa Cruz Island, Galápagos, p 68
Garcia SM, Charles AT (2008) Fishery systems and linkages: implications for science and government. Ocean Coast Manage 51:505–527
González JA, Montes C, Rodríguez J, Tapia W (2008) Rethinking the Galápagos Islands as a complex social-ecological system: implications for conservation and management. Ecol Soc 13(2):13
Grenier C (2007) Conservation contra natura: las islas Galápagos. Abya Yala, Quito
Hearn A (2008) The rocky path to sustainable fisheries management and conservation in the Galápagos Marine Reserve. Ocean Coast Manage 51(8):567–574
Heylings P, Bravo M (2007) Evaluating governance: a process for understanding how co-management is functioning, and why, in the Galápagos Marine Reserve. Ocean Coast Manage 50(3):174–208
Keller EF (2005) Ecosystems, organisms, and machines. BioScience 55(12):1069–1074
Larkin PA (1977) An epitaph for the concept of maximum sustained yield. Trans Am Fish Soc 106 (1):1–11
Levin SA (1998) Ecosystems and the biosphere as complex adaptive systems. Ecosystems 1 (5):431–436
Mahon R, McConney P, Roy RN (2008) Governing fisheries as complex adaptive systems. Mar Policy 32(1):104–112
Manson SM (2001) Simplifying complexity: a review of complexity theory. Geoforum 32 (3):405–414
Massey D (2005) A reliance on science? In: For space. Sage, Thousand Oaks, pp 126–129
May RM, Levin SA, Sugihara G (2008) Complex systems: ecology for bankers. Nature 451 (7181):893–895
Michener WK, Baerwald TJ, Firth P, Palmer MA, Rosenberger JL, Sandlin EA, Zimmerman H (2001) Defining and unraveling biocomplexity. BioScience 51(12):1018–1023
Molina LM (2005) Sport fishing in the Galápagos. Charles Darwin Foundation, Santa Cruz Island, Galápagos, p 42
Murillo JC, Reyes H, Hearn A (2007) Social aspects of fisheries in Galápagos. Galápagos National Park Service; Charles Darwin Foundation; National Institute of Galápagos, Galápagos
Ospina P (2006) Galápagos, naturaleza y sociedad: actores sociales y conflictos ambientales en las Islas Galápagos, vol 55. Corporación Editora Nacional
Quiroga D (2013) Changing views of the Galápagos. In: Science and conservation in the Galápagos Islands. Springer, New York, pp 23–48
Robbins P (2004) Political ecology: a critical introduction. Blackwell, Oxford
Schuhbauer A, Koch V (2013) Assessment of recreational fishery in the Galápagos Marine Reserve: failures and opportunities. Fish Res 144:103–110
Stacey L, Fuks V (2007) Struggling for the golden egg: conservation politics in the Galapagos. Masters Thesis. Available from Roskilde University Digital Archive

Taylor JE, Hardner J, Stewart M (2006) Ecotourism and economic growth in the Galápagos: an island economy-wide analysis. Department of Agricultural and Report nr 06-001

Thrift N (1999) The place of complexity. Theor Cult Soc 16(3):31–69

Toral-Granda V (2008) Galápagos Islands: a hotspot of sea cucumber fisheries in Central and South America. In: Toral-Granda V, Lovatelli A, Vasconcellos M (eds) Sea cucumbers. A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper No. 516. FAO, Rome, pp 231–253

UCOOPEPGAL (2005) Pesca artesanal vivencial: una diversificación para el pescador, una apertura hacia la población para el visitante. Propuesta del Sector Pesquero Artesanal del Galápagos. Presented at the meeting of the Participatory Management Board (JMP), Santa Cruz, Galápagos, 21–22 July. Annex 7 in Zapata F (ed) La pesca artesanal vivencial en Galápagos. Sistematizacion del proceso. Fundacion Futura Latinoamericano, p 52

Watkins G (2008) A paradigm shift in Galápagos Research. Galápagos Res 65:30–36

Wilen JE, Stewart M, Layton DF (2000) Economic analysis of the Galápagos Marine Reserve resources management plan. Final Report. University of California, Davis, CA

Wilson JA (2006) Matching social and ecological systems in complex ocean fisheries. Ecol Soc 11 (1):9, http://www.ecologyandsociety.org/vol11/iss1/art9/

Zapata F (2006) La pesca artesanal vivencial en Galápagos. Sistematizacion del proceso. Fundacion Futura Latinoamericano, p 52