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Comparative institutions and management resiliency in Latin American small-scale fisheries

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Abstract

Encroachment by commercial fleets on small-scale fishing territories throughout Latin America over the last half-century is increasing inter-sector conflict. Small-scale fishery production is crucial to communities that rely on fish as a key source of protein in daily consumption and for supplying increased demand. As the continued viability of local management is threatened, we need to properly understand under what conditions informal institutions are resilient. Seven published Latin American case studies test which model management principles correlate with resilience. Shoreline exchange is identified as an effective practice promoting reciprocity and rapid collective action in the face of external threats. Published by Elsevier Inc.

1. Introduction

Small-scale fishing contributes a large portion of fish production for both First and Third World peoples (McGoodwin, 1990). It is crucial to understand the dynamics of Third World fisheries, especially the often overlooked low-technology sectors. Half of global fish trade is currently produced out of lesser-developed countries (LDCs). Out of total global fishing fleets, 94% are small-scale[1] and 65% are artisanal (FAO, 2002). In contrast to the commercial sector, many third-world small-scale fleets are declining in income and efficiency (Brown, 1978; McGoodwin, 1990). Over-capture of fishery resources and competition from more technologically sophisticated fleets, such as purse seiners and coastal trawlers, influence these trends [(FAO, 2000; NOAA, 1999) e.g., (Akpalu, 2002; Stergiou, 1989)].

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Marine capture fishery production has reached historical record highs worldwide topping 95 million tons total catch weight within the last five years (FAO, 2004), which is a steady increase from 55 million tons in 1960s (FAO, 2000, 2002; McEvoy, 1986). Despite absolute production increases, more commercial fleets are operating in territories informally claimed by small-scale fishers now more than ever.

McEvoy (1986) and McGoodwin (1990) argued that increases in the number of fleets, expansions in capture technology (post-World War II development of the "factory-freezer trawler"), and exponential world population growth result in more on-water fleets that are more technologically capable of rapid harvesting. Recent growth in fish harvests does not mean the amount of fish available for catch is increasing since more commercial fleets are harvesting with steady rates of efficiency (catch per unit of fishing effort). Accounting for increased technology, efficiency should rise, but increases in the number of fleets racing to feed a growing demand for fish thwart that assumption. With a growing commercial sector maintaining efficiency and increased demand due partially to population growth, per capita fish production continues to steadily decrease since 1980s from about 15 kg to 13 kg in 2003 (Acheson, Wilson, & Steneck, 1998; Fairlie, 1995; FAO, 2000, 2004).

The commercial sector has sharply increased harvesting efforts in or near what have traditionally been small-scale fishing territories in the last half-century (McCully, 1991; Platteau, 1989b). This expansion is partially due to decreased trends in per capita production in an effort to expand each individual fleet's share of the catch. These territories are most often adjacent to and informally claimed and managed by small-scale fishers in rural communities. Low-tech fishers residing in a peripheral community with weak market access must then compete with much more technologically sophisticated craft for a declining number of fish (McCully, 1991).

In Latin America (the regional focus of this study), most of the fishing craft are small-scale. They contribute a majority of fish and fishmeal for local use and to national exports for global market demands. In Peru for example, 70% of fish food for human consumption is from artisanal fishers. The artisanal sector is 90% of the fleets in Brazil; producing most of the protein consumed by the rural (and a proportion of urban) impoverished (Prado & Drew, 1999).

Diverging from global trends, Latin America's commercial sector has decreased its total marine production since the late 1980s. Latin American small-scale fishers are under increased pressure to maintain or increase their output of high-cost/high-value species influenced by drops in commercial production and income and efficiency decreases among the small-scale sector. Maintaining a stable level of production to meet growing demand at home and abroad is increasingly difficult for Latin American artisanal fishers.

Many small-scale fishing communities exhibit various informal institutions that serve to manage rights to the fishery, a common-pool resource (CPR).[2] Much of the CPR literature over the past three decades documents various types of "rules for rights" (Schlager & Ostrom, 1993) created by local natural resource users to regulate access and use for preventing the "tragedy of the commons" (Hardin, 1968). Fishers in a small community vulnerable to fish stock depletion, for example, can institute property rights systems. Fishing communities experiencing problems with commercial encroachment can organize themselves to monitor and defend clearly defined fishing territories. Local fishers enforce informal institutions since they are not codified in state law. Folk management is vulnerable to outsiders that can encroach and rule-break (e.g., fishing across informally private territories, ignoring local user catch limits) while avoiding local

sanction since they do not reside in the community. Increases in commercial sector capture capabilities and in-shore harvesting often result in inter-sector conflict over rights to catch amount, catch territory, and on-shore placement of fishing technology [(McCully, 1991) cf. (Platteau, 1989a, 1989b)]. Identifying institutional arrangements that buffer local conflict and change brought on by external sources is important for effective coastal management design strategies.

Despite numerous external and internal challenges, case studies showing the resiliency of Latin American local management systems. "Resilience," when applied to folk CPR management, is the capacity of that management system to absorb disturbances while maintaining its behavioral processes and structure (Berkes, Colding, & Folke, 2003; Berkes & Folke, 1998). Changes unforeseen by local fishers, such as encroachment, can increase failures and decrease benefits causing the breakdown of folk CPR management systems that have existed informally in small-scale communities for generations (Gunderson & Holling, 2002; Holling, 1986).

What factors account for the resilience of Latin American small-scale fisheries? As the continued viability of informal management institutions are being threatened, we need to properly understand under what conditions these institutions are resilient. Ostrom (1990, 2005) and Baland and Platteau (1996) have constructed models of several institutional design principles from years of case studies associated with long-enduring user-managed CPRs. They argue that problems, such as encroachment, can be solved (or at least decreased) by appropriate institutional design and management practices. Baland and Platteau extend the institutional arguments and attribute successful local informal management to specific social characteristics of the user group.

We analyze seven previously published case studies from small-scale fishing communities in Latin America to discover which informal institutions are most strongly related to resilient management and to identify other institutions that potentially shape the model principles. Institutions are important to the environmental, economic, and social health of fisheries, while specific social characteristics are significant concerning the continued viability and operation of those institutions. More significantly, we highlight unique cultural and social patterns in artisanal fishery communities that correlate with resiliency in the face of external threats. Specific model institutions are resilient and "shoreline exchange networks" are an effective practice promoting reciprocity and rapid collective action in the face of external threats. Informal institutions are powerful "unwritten laws"[3] that can promote traditional economic livelihood and help maintain local control of natural resources.

Next, we review two major themes in the CPR management literature: resilient institutional principles and reciprocity. Then, we summarize Latin American small-scale fishery case studies drawn from various previously published literature that address the research question. We conclude with a synthesis of results and a discussion of study implications and limitations.

2. Resilient institutional principles

There are several models in the CPR literature that discuss the institutional characteristics and contexts associated with long-enduring folk management systems. These models examine informal institutions and social characteristics successfully transferred across generations of CPR users in a large number of local case studies over the last half-century. These management

systems are also credited with maintaining or enhancing local environmental, economic, and social health.

The principles offered below synthesize the two most often cited models, which encompass factors from a large number of case studies.[4] The first seven principles are from Ostrom and the last three from Baland and Platteau.

First, *clearly defined boundaries* around the resource and of who has which rights to use the fishery (Schlager & Ostrom, 1993) are crucial since they reduce transaction costs of identifying potential incursions by entities from outside the community (Dolsak & Ostrom, 2003; Ostrom, 2001) and alleviate potential "tragedies" of pure open-access (Hardin, 1968). Clear knowledge, by way of geographical or cultural marker (e.g., ethnic indicator), of who is an appropriate user group member is important since people seen as "outsiders" working in small-scale groups can disrupt trust and reciprocity (McElreath, Boyd, & Richerson, 2003; Ostrom, 2005; Sethi & Somanathan, 2006). Second, there must be *congruence* between provisions and inputs (i.e., benefits and costs). Returns from CPR use for each member and the group need to be roughly equal to time, energy, and/or material investments made by each. Also, rules must coincide with real and perceived equity, local ecosystem cycles, and social organizational patterns. Examples in small-scale fisheries include rules that restrict technologies and/or harvesting amounts when fish stock regeneration rates are low (Acheson et al., 1998). This can reduce the possibility of seasonal or long-term depletion by decreasing capture potential and shrinking intra-group inequality since only a few fishers often gain access to imported technology (McCully, 1991).

The third principle of *equitable rule modification* defines an oversight process whereby users can change rules if needed. If the voice and interests of group members are not heard, then they may "exit" (Hirschman, 1970) or will possibly begin cheating community norms (Ostrom, 2001), which increases enforcement costs. Lack of managerial input from resource users can decrease other forms of information exchange within the group and endanger management institutions with stagnation or slow responses to change. Recent CPR studies evidence that users are less likely to cooperate with each other when institutions are controlled by a local or government elite and are less subject to group decision-making (Ostrom, 2005).

The fourth and fifth principles are effective *monitoring* (watching for rulebreakers and outsiders) and the use of *graduated sanctions* to ensure caught rulebreakers are deterred from future offenses. Although initial violations are rarely reprimanded harshly, most robust CPR management regimes involve punishment appropriate and pervasive enough to promote rule compliance after several offenses and possibly increase self-monitoring (Ostrom, 2005). Sanctions have been theorized to be highly significant for maintaining reciprocity (e.g., Sethi & Somanathan, 2006), but monitoring that often enables punishment is less comparatively studied. Sixth, avenues for *conflict-resolution* between users need to be accessible to most, if not all, group members. Since some small-scale fishing communities are appropriated by a few families, inter-kin relations may show specific mechanisms that can inform wider community standards of conflict-resolution. Seventh, it is important that local, regional and state governments recognize informal management. The more *state tolerance* and legal recognition proclaimed and codified for folk management systems, the less likely disputes over state versus local users' "bundles of rights" (Schlager & Ostrom, 1993) will judicially favor the state.

Eighth, high *user demand* for the resource ensures increased local protection from exogenous threats. Many small-scale fishers are "natural resource use pluralists," utilizing multiple

subsistence strategies simultaneously or seasonally for food. If a CPR is perceived as vital by a group for their survival compared to other subsistence and market income generating natural resources, the more likely they will attempt to maintain rules regulating its use. The ninth principle is high *user knowledge of sustainable yields*, which is the amount of resource units that can be extracted from the CPR allowing for the same quantity to be extracted in the future (Gibbs & Bromley, 1989). Groups with high collective yield knowledge tend to maintain their resource base by preventing seasonal over-capture (Acheson et al., 1998). Finally, a strong *obligation to cooperate* promotes rapid collective action in the face of external threats. Mutual obligations for cooperation in small-scale communities often exist through "community exchange" institutions such as reciprocity and sharing (Gudeman, 1986, 1998). Shoreline exchange, the balanced "gifting" (Mauss, 1954) of materials, labor, and economic capital between fishers along their daily meeting place (the coastline) is a specific form of mutual obligation found in resilient Latin American small-scale fisheries.

These principles have been empirically tested, but not examined specifically concerning Latin American CPRs or Latin American fisheries. Schlager and Ostrom (1993) provide one of the most thorough previous analyses of Ostrom's model (first seven principles in Table 1). They compare 30 small-scale coastal fishery case studies from a variety of developed and

Table 1
Model of resilient CPR management principles

1.	*Clearly defined user group and resource boundaries*: CPR boundaries must be well marked and/or understood by all local users. Individuals with rights to withdraw resource units need to be well-delineated and accepted as part of the group.
2.	*Provisions are congruent with inputs*: Benefits of provisions accessible by each user and the entire group are considered fair given costs of labor, material and/or money inputs. Appropriation rules restricting time, place, technology, and/or quantity of resource units are congruent with local conditions.
3.	*Equitable rule modification*: Most individuals affected by operational rules can participate in changing the rules.
4.	*Monitoring*: Monitors, who actively audit CPR conditions and appropriator[5] behavior, are accountable to the appropriators or are the appropriators.
5.	*Graduated sanctions*: Users who violate rules are assessed increasingly stringent sanctions upon multiple offenses by other group members, officials accountable to members, or both.
6.	*Accessible avenues for conflict-resolution*: Individuals have rapid access to fellow users to resolve problems among users or between appropriators and users.
7.	*State tolerance of local management systems*: The rights of locals to devise their own management institutions are not challenged by external authorities.
8.	*High user demand for the resource*: Demands must be high (up to a limit) and the CPR needs to be seen as vital to users' livelihoods.
9.	*High user knowledge of sustainable yields*: User group members need to possess a shared knowledge concerning levels of sustainable extraction.
10.	*Users feel strong obligation to cooperate*: Mutual obligation and concern for social reputation within the group exist strongly among users.

Adapted from (Ostrom, 1990, 2005; Baland & Platteau, 1996).

lesser-developed nations. They are primarily concerned with variation between fishers that hold more or less "powerful" rights of access, withdrawal, exclusion, and transferability of territory. Fishers holding rights of exclusion and transferability over their territory or within the larger fishery are more successful at reducing conflict, assignment problems, and technological externalities. Different levels of rights held by users influence management effectiveness. In general, their results support Ostrom's model, as do more recent regionally focused studies (Ostrom, 2005).

"Resilient" management is another persistent theme in the CPR literature. Numerous studies since the late 1980s focus on management resilience to local ecosystem cycles [e.g., (Berkes et al., 2003; Berkes & Folke, 1998)], while a few highlight resilience to outsider encroachment (e.g., Platteau, 1989a, 1989b). Amazonian and Central American case studies show folk institutions are resilient during cross-scale market integration when exported goods have cultural and/or ritualistic significance to the community (Richards, 1997).

3. Reciprocity

Some CPR literature from the past two decades focuses on users' social relations between themselves and within wider community contexts. Case studies of local irrigation canal management in Asia show "mutual obligation," strong social bonds, and frequent social interaction among users contribute to resilience [e.g., (Ireson, 1991; Wade, 1988)]. Sociologists argue such measures of social linkage should be used to understand the comparative operation and effectiveness of management institutions [see (Granovetter, 1985; Portes & Sensenbrenner, 1993)]. Anthropologists often theorize that reciprocity and sharing are adaptations by small-scale societies to risky environments (e.g., Geertz, 1963). Evolutionary anthropologists are increasingly emphasizing altruism as giving fitness advantages at the group level and aiding community survival (e.g., Bowles, 2006). Reciprocity as a specific form of obligated cooperation, however, does not exist just because of friendly or long-term social relations (cf. Plattner, 1984), but can also be present because it is instituted (i.e., sanctioned as a cultural norm) (see Marlowe, 2004). Norms of reciprocity become transmitted through repeated public and private sanctioning and are cognitively modeled as the ways one should act in a group (D'Andrade, 1989, 1992) subject to sanctions.

Reciprocal exchange also develops to ensure cooperation between individuals (Axelrod, 1984). In an occupation of high risks and uncertainty, small-scale natural resource users often practice "balanced reciprocity" between each other and their families (Sahlins, 1972). For fishers, this involves an act of self-sacrifice or kindness coupled with an expectation of equal return without which results in social consequences (McGoodwin, 1990). Balanced reciprocity ensures mutual obligation between users, which influences rapid collective action in numerous CPR case studies (Mearns, 1996).

We agree that institutions are embedded in inter-user social relations (Fisher, 1994) and it is crucial to understand the dynamics of institutional operation and resilience through this lens (e.g., Taylor & Singleton, 1993). Local fishers, who face encroachment, continue operating their informal institutions when social relations outside of management are robust. "Shoreline reciprocity" is often an adaptation to the spatial elements common to numerous third world

small-scale fishing communities and the extreme risks and hazards accompanying fishers' occupation (McGoodwin, 1990).

4. Shoreline exchange

It is crucial to distinguish between "on water" work activities (harvesting, gathering nets, etc.) and "off water" shoreline labor activities in small-scale fisheries (Acheson, 1981; McGoodwin, 1990; Pollnac, 1991). While stereotypical views focus on the "on water" work, many artisanals spend the bulk of their time and energy on shore by gathering, building, and maintaining or repairing their fishing technology (McGoodwin, 1990).

Artisanal fishing technology is often made by hand from locally gathered materials. Craft, hooks, nets, lines, and other supplies tend to degenerate quickly, especially for maritime fishers who sail in higher concentrations of rough and corrosive salt water (Acheson, 1981). Use of local materials reflects a lack of financial capital necessary to purchase or import synthetic materials. Artisanal fishers most often perform "on water" labor during one stretch of time, seldom lasting more than one-third to one-half of the day. That leaves the rest of the day or night to the gathering, building, and maintaining of fishing materials. Examples of shoreline labor performed during these times include: constructing a new craft every month or few months, more constant maintenance of re-tying and stitching fishnets, gathering used soda bottles to use as bobbers, gathering nearby wood or reeds and carrying them to shore for craft construction, and setting up finished craft on-shore.

These activities most often occur on the shoreline because less time and energy is required to carry gathered construction materials to the shore than hauling these unfinished materials back and forth between a fishers' residence, which can be more distant. Fishers engaging in farming and/or pastoralism often reside inland increasing the burden of storing and working on materials at home. Wood and reeds used for constructing craft in some artisanal fisheries, for example, can be quite heavy when bundled and carried, weighing hundreds of pounds. Since the fishing technology is used for "on water" labor, it is advantageous for fishers to keep cumbersome gear close to the water instead of carrying it back and forth from residence to shoreline.

Working on fishing technology along the shoreline sets the spatial conditions of labor within which reciprocal exchanges of goods, services, and labor occur. Artisanals with little to no excess capital, fluctuating income, and highly erosive technology (McGoodwin, 2001) often turn to fellow fishers "in the same boat" economically, socially, and technologically, to aid them in daily labor. This exchange tends to be more balanced than generalized (see Sahlins, 1972) since fishers often reside at a distance from each other, sometimes migrate to adjacent communities when fish stocks are more abundant elsewhere, and work "on water" in separate craft. These factors promote an expectation of immediate and equal return since fishers are out of sight of their fellow fishers when not on the shoreline. Geographical, social, and other "distances" promote balanced over generalized forms of reciprocity (Sahlins, 1965). Also, equal return expectations serve as fishers' informal evaluation mechanism helping decide whom to trust in such a risky work environment. Trust is often cited as a crucial quality determining other persons that fishers exchange with and to evaluate potential new fishers in a group (Acheson, 1981; McGoodwin, 2001).

5. Results

Seven published Latin American case studies provide data on management principles in an encroachment context for this study. We select these cases for two reasons. First, historically and at the time of documentation communities are mostly small-scale and artisanal with informal instead of state management. Also, the publications focus in whole or partially on describing local institutions and whether management systems are resilient or breaking down. Comparative case study approaches prove useful illuminating questions of success and failure in CPR management (Burger, Field, Norgaard, Ostrom, & Policansky, 2001). While space does not permit a full comparative inventory of ecosystem variables, all cases show accessibility by various types of encroachers. Examples like Lake Titicaca are perhaps less prone to commercial encroachment given their lagunal environment, but still experience artisanal and small-scale outsiders entering without group permission. Commercial encroachment is common across the case studies often occurring in locally claimed deep-water territories near continental shelf areas. A limitation of this study is that institutional influence maybe different in inland v. maritime fisheries and no multi-institutional model of CPR management should be considered a blanket resolution across all confounding variables (Ostrom, 2005).

Five of the seven case studies are "resilient." Resiliency is evidenced by the continued existence and functioning of traditional management institutions during and/or after periods of external threat. Additional factors influencing the long-term resiliency of livelihoods and institutions in encroached communities include the extent locals defend their culture against outsiders, which is often a function of collective action and organizational competence (Richards, 1997). Whether outsiders usurp resource management and establish their own local organizations and facilities, co-exist with residents, or leave (intentionally or get expelled) can depend on the degree of defense. Resiliency also depends on the intensity of encroachment; whether encroachers are performing one or a combination of fishing local territories, docking on community coastlines, and/or building and utilizing on-shore facilities.

In commercial encroachment cases, where outsider fleets enjoy a marked capacity advantage, resistance usually provides little deterrence. Of these case studies showing resiliency with commercial encroachment, small-scale fishers co-exist with other sectors in the same communities. Local CPR institutions and reciprocal relations can co-exist with commercial extractors operating in the same community as evidenced with forest dwellers in Latin America (e.g., Richards, 1997).

Next, we discuss each model principle outlining case examples that are representative of the other communities and/or uniquely effective for local arrangements. Table 2 summarizes context and results.

(1) All case studies exhibit unambiguous borders of the entire CPR subject to local use and communal or private territories (Edwards & Steins, 1998) within the larger fishery. Bahia, Coqueiral, and Lake Titicaca show the least sign of disagreement concerning recognition of the boundaries subject to local fishers' use.
(2) Six cases show appropriate rules for local conditions, especially concerning technology provisions. Drastic seasonal shifts in floodwater levels and catch at Baixo leads to gillnet restrictions during the year's most productive periods. Technology constraints

Table 2
Case studies summary

Location	Ecosystem	Model principles	Encroachment, resiliency
Resilient cases			
Bahia, Brazil (Cordell, 1984; Cordell & McKean, 1992)	Maritime (with mangroves and coral reefs)	9 present	- Commercial fleets in deep-water territories
		- #9 inconclusive	- Canoe fishers defend local space - Robust shoreline activities
"Baixo" region, Brazil (McGrath, Castro, Futemma, Amaral, & Calabria, 1993)	Riverine and enclosed lakes with seasonal flooding (Amazon floodplain)	8 present	- Commercially-linked outsiders dock and use canoes in river territories
		- lacks #6	- Community canoe fishers defend local space and shift to nearby lakes during rainy seasons
		- #9 inconclusive	- High reciprocity
Coqueiral, Brazil (Forman, 1970)	Maritime with scattered reefs	9 present	- Commercial fleets in deep-water territories
		- #9 inconclusive	- Raft fishers defend local space - High reciprocity - Robust shoreline activities
Lake Titicaca, Peru (Levieil & Orlove, 1990; Orlove, 2002)	Enclosed lake with shoreline totora reed beds	9 present	- Artisanal outsiders and national Coast Guard in territories
		- #9 inconclusive	- Defense and expulsion of outsiders by reed raft and wood canoe fishers - High reciprocal inter and intra community exchange - Robust shoreline activities (totora reed collection)
Rio De Janeiro and Sao Paulo states, Brazil (Begossi, 1998, 2001)	Maritime and rivermouths near ocean	10 present	- Commercial fleets in territories
			- Canoe fishers defend local space - High reciprocal information exchange - Robust shoreline activities

Unresilient cases			
Caye Caulker, Belize (King, 2000; Sutherland, 1986)	Maritime with reefs	6 present - lacks: #2, #4, #10 - #9 inconclusive	- Commercial fleets and small-scale outsiders in territories - Management breakdown - Less reciprocity and shoreline activities - High influxes of capital and technology
Rio Grande, Brazil (Castro & Begossi, 1995; Castro & Begossi, 1996)	Riverine	4 present - lacks: #3, #4, #5, #6, #10 - #9 inconclusive	- Tourists in territories - Management breakdown (artisanals emigrating) - Lack shoreline activities

All seven communities and regions have experienced moderate to severe outsider fishing encroachment. Experiences range from commercial sector fleets moving in and fishing on local fishers' territories to state-owned fleets and recreational fishers exploiting traditional territories and adjacent waters.

allows more stock to "rollover" and be available during less abundant times when waters recede and artisanals compete with commercial fishers on the rivers. At Coqueiral and Rio de Janeiro/Sao Paulo, technology adoption from outsiders is collectively restricted only occurring when it is deemed congruent with local ecology. Coqueiral raft fishermen discard opportunities to import more advanced boats since their "jangadas" constructed of wood and vegetable fiber are lightweight and maneuver well in the swampy coastlines of northern Brazil. Institutional congruence with local ecology is a comparatively strong element, but an additional part of this principle concerning equitable provisions among users is inconclusive.

(3) In six case studies, fishers report few or no problems concerning decision-making integration with little to no evidence of unjust exclusion from local fishers' organizations. Those complaining of discrimination are recognized by active fishers as deserving sanction because they previously broke local rules or are community outsiders. Collective management decisions are less inclusive at Rio Grande. Intra-group fractioning is worsening with high artisanal emigration to neighboring communities offering wage labor and a few fishers acting against technology restrictions by leasing motorized craft from new tourist boat rental shops. Out-migration is a key "shock" to resiliency since it removes local actors, thus thwarting collective action opportunities (Ostrom, 2005). Most fishers adhere to input rules, but the "scaling-up" of some increases their capacity to capture multiple territories and disjoint appropriators'[5] allocative efforts.

(4) Five cases exhibit local fishers acting as monitors and mechanisms to hold users accountable to others. Bahia, Baixo, Coqueiral, and Rio de Janeiro/Sao Paulo have locally well-known and respected fishers who watch for rulebreakers and monitor weather patterns during their work. For example, "mestres" at Bahia are experienced and respected artisanals and leaders in folk management. They observe lunar-tide cycles to help determine where territories should be for seasonal fish migration and identify community outsiders and rulebreakers while working. Artisanals' construct their crafts from totora reeds growing in "sunken gardens" (or "reed beds") adjacent to the shoreline of fishing communities at Lake Titicaca. Collecting totora promotes monitoring for outsiders by most artisanals since the location of reed beds provide clear view of a community's territorial waters. At Caye Caulker, a few long-time community members and outsiders regularly steal a small portion of lobster fishers' daily catch. Fishers inadvertently spot these robbers who have become "known thieves." Out of 40 traps set by most fishers, it is common to find at least one or two empty when retrieved. Since Caye Caulker lobster is a high demand species and provides relatively large economic returns to locals, monitoring and sanctioning are not worth the time and energy spent for a small percentage of catch. The same amount stolen can be caught in the extra time allocated to identify and decide on punishment for rulebreakers.

(5) Six cases show social ostracization and other informal methods of punishing rulebreakers. Artisanals at Bahia and Lake Titicaca bring particularly harsh sanctions against those who fish in others' territories. Punishment at Bahia includes sabotaging equipment and crossing or entangling nets. Despite lacking monitors at Caye Caulker, strong collective mechanisms exist to exclude "known thieves" from gaining membership in

the fishers' cooperative. Baixo, Coqueiral, and Rio de Janeiro/Sao Paulo exhibit similar sanctioning.

(6) In five cases, strong methods for resolving group conflicts exist. Across Rio de Janeiro/Sao Paulo, elders or recognized leaders who have participatory histories in local management have final say in disputes. This is similar to the "aconselheiro" (mediator) system at Bahia where artisanals seek out retired and well-respected fishers to resolve conflicts. Intra-group conflict increased among local fishers since the arrival of commercial encroachers on the rivers at Baixo. Canoe fishers at Baixo either exhibited few conflict-resolving mechanisms before encroachment or their methods were less adaptive. Reasons why others are able to develop and/or maintain conflict-resolutions and Baixo locals do not are unclear. Increasing conflict between artisanals and investors in motorized rentals at Rio Grande shows a linkage between principles #2 and #6.

(7) "Separated tolerance" best describes local–state relations in all the cases with government neither legitimizing local management nor attempting to enforce institutions that supercede folk managers. Insufficient economic resources often hinder attempts of state enforcement, formalization, or integration, as in the Brazilian cases (Bahia, Coqueiral, Rio de Janeiro/Sao Paulo). The Peruvian Coast Guard occasionally patrols community waters at Lake Titicaca attempting to persuade artisanals to adhere to state laws prohibiting informal monitoring and sanctioning, which is legally considered "vigilantism." With low state funding and small staffs, these attempts are few and feeble.

(8) Local users show high demand for their fishery in each case. Fishing either provides the majority income for natural resource use pluralists (Baixo, Lake Titicaca, Rio de Janeiro/Sao Paulo, Rio Grande) or is nearly the exclusive income strategy (Bahia, Caye Caulker, Coqueiral). Resource contribution to users' subsistence and/or market income also promotes the creation of folk CPR management (Ostrom, 2001, 2005).

(9) Data on capture knowledge is inconclusive. The Caicaras Indians of Rio de Janeiro/Sao Paulo is the only case where yield comprehension is described. Bahia and Coqueiral artisanals exhibit other types of "traditional ecological knowledge" (TEK) concerning seasonal weather, tide shifts, and how ocean-floor geology influences species migration.

(10) Besides monitoring, which enables shoreline exchange in cases like Lake Titicaca, obligation to cooperate is the only principle mutually exclusive to cases of resilient management v. institutional breakdown. The five resilient cases show most fishers engaged in intra-group balanced reciprocity. Caye Caulker and Rio Grande do not exhibit these reciprocities between most users. Bahia and Lake Titicaca, cases with almost all of the other principles, have the most evidence of reciprocity through shoreline exchange.

This principle helps account for the resiliency of other institutions. Collective action is the basis for creating, maintaining, enforcing, and changing management rules. Intra-group trust and reciprocity are two key elements for folk management creation in CPR contexts (Ostrom, 2001). Shoreline exchange positively correlates with resiliency providing the geographical

and social context for daily reciprocity and obligations to be met. Regular reciprocal shoreline meetings between fishers enable management decisions and information to exchange in a cordial setting. "Stable" (enduring) and "direct" (unmediated) user relations lower transaction costs of collective management (Taylor & Singleton, 1993). This provides a window to how institutions are socially embedded with fishers able to maintain management when group relations are robust.

6. Conclusions

Results support the models as the five resilient cases exhibit at least eight principles, while the two cases showing management breakdown have six and four respectively. Having multiple comparative cases, we can now better order the significance of model institutions (see Fig. 1). Monitoring and cooperation are the characteristics most highly correlated with resilient management since both occur exclusively in resilient cases compared to the other principles. Next strongest are equitable provisioning, rule modification, and graduated sanctions with these three present in all resilient cases, but also occasionally evidenced in non-resilient contexts. Conflict-resolution exists in both resilient and non-resilient groups while the remaining three principles are present across contexts. Applying weighted institutional importance in the field should be handled cautiously. Implementation of principles like obligated cooperation at the local level is difficult considering the diversity of local environmental contexts in the case studies and how altruism has evolved as an intra-ethnic sanctioned process (McElreath et al., 2003).

Shoreline exchange is another mutually exclusive characteristic linked with monitoring and especially cooperation. Fishers most often practice monitoring along shorelines where they can more easily scan territories, which provides the basis for cooperative labor since the coast is a low cost spot to place materials for technology construction and repair. The importance of

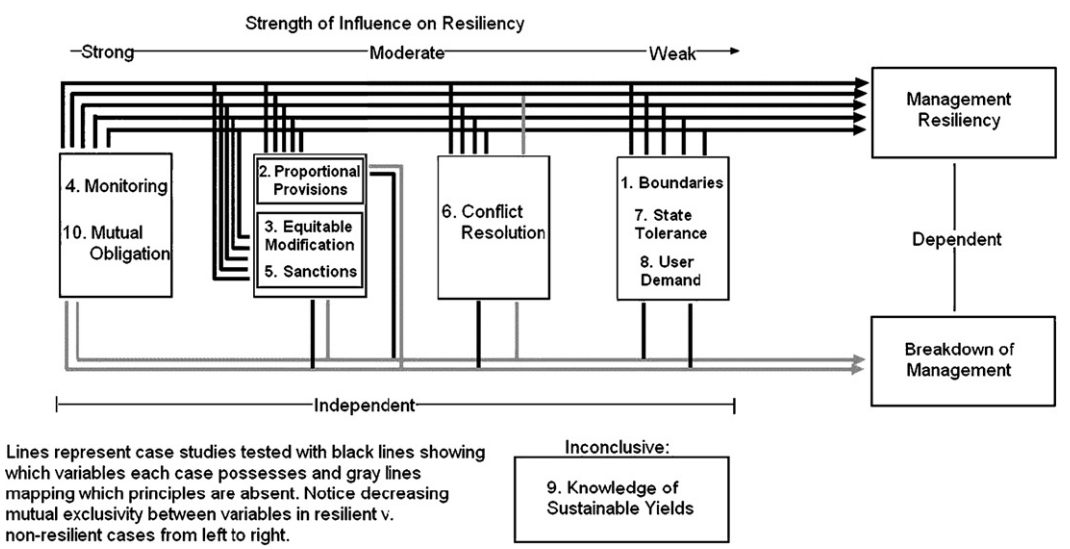

Fig. 1. Institutional strength on resilience.

monitoring and cooperative exchange support that institutional creation, enforcement, maintenance, and adaptation are embedded in user relations that form the basis of collective action. Groups with robust social relations are better equipped to maintain folk management processes and structures when encroachment occurs. Whether obligated cooperation is based on concern for reputation, however, as Baland and Platteau contend, is questionable [see (Bowles, 2006; Dalton, 1969) cf. (Burling, 1962; Schneider, 1974)]. Reciprocity may not exist to promote individuals' local reputation, but rather through strong lineage networks (e.g., Alvard & Nolin, 2002).

A key question for future research is: what are the long-term prospects for these and other communities facing encroachment? Is resiliency continuing? With the inevitability of commercial encroachment in an era of increased global export linkages and cross-scale market penetration (Richards, 1997), are these firms taking over, co-existing with, or expelled by local CPR users? Cases in this study show co-existence, which may be disrupted depending on each sector's influence on government and the state's interests in natural resource development. Often, the commercial sector enjoys control with advanced technology and national government legitimacy through licensing. The degree to which commercial firms construct on-shore freezing and processing facilities, which can be accessed by locals (Platteau, 1989b), and gain codified rights to local fisheries help determine the amount of local disruption. Trends in "scaling-up" investment, integration into commercial firms, and emigration by artisanal fishers could be measured in communities with management breakdowns.

Future research on folk CPR management needs to focus not only on institutional arrangements, but also on users' social spheres. Recent works show how effective resource management is embedded in wider community relationships concerning personal and labor interactions [e.g., (Mearns, 1996; Petrzelka & Bell, 2000)]. Understanding these social and cultural elements can help maintain folk institutions, which are increasingly being integrated into induced co-management design strategies. As co-management becomes a favored coastal development strategy with the integration of multiple diverse stakeholders, field agents need to understand which institutions are most crucial in order to work with locals to ensure those cultural elements are maintained. While Latin American fishers may not be able to gain formal title to their resource like neighboring farmers do (Lopez & Valdes, 2000), fishers can experience increased incentive to continue management of their fishery through ownership of their local culture.

Notes

1. The small-scale sector consists of beachlanding craft and owners are operators (Platteau, 1989a). "Artisanal" is a sub-category of small-scale. Artisanal fishers are non-motorized and mostly use locally gathered materials to fabricate their fishing technology. Commercial fleets are harbor-landing and motorized. They also tend to be owned by non-operator investors, which can be public or private.
2. We use North (1994) definition of "institutions": rules or constraints implemented in a society to ensure compliance with a groups' decisions. Informal CPR management institutions are the unwritten laws, conventions, and norms of behavior that establish peoples' relationships to natural resources (Gibbs & Bromley, 1989). "Folk management

systems" are a set of specific institutional arrangements that local resource users have developed to maintain rules for rights over a particular CPR (Berkes & Farvar, 1989). Institutions are the rules; a management system is the set of rules.

3. Term adapted from Cordell (1984) conceptualization of Bahia fishers' "law of the sea," which encompasses local norms of fishery use.
4. Several principles from the two models are not included because they are not applicable to the case studies. For example, Ostrom's eighth principle, "nested enterprises" is only applicable to CPRs that have managers across multiple levels of jurisdiction (often at the regional, provincial, or state levels). A majority of Baland and Platteau's principles are adopted directly from Ostrom and overlap the first seven included in the combined model.
5. "Appropriators" are equivalent to "proprietors" and "claimants" that hold local decision-making power over the provision of access and withdrawal rights (Schlager & Ostrom, 1993).

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