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Adding Environment to the Collective Action Problem: Individuals, Civil Society, and the Mangrove-Fishery Commons in Ecuador

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1. INTRODUCTION

Research in sustainability science has emphasized that collective action plays a critical role in resource governance, resilience and adaptation to various forms of environmental change (Adger, 2003; Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005; Dolsak & Ostrom, 2003; Endter-Wada & Keenan, 2005; Kurien, 1995; Nelson, Adger, & Brown, 2007). Broadly defined as cooperation among individuals, collective action is often based on communication, trust, reciprocity, and a shared vision (Mosimane, Breen, & Nkhata, 2012; Ostrom, 1998; Ostrom & Walker, 2003; Smith, 2010). Successful coordination among individuals may prevent the scenario Garrett Hardin (1968) famously described as the tragedy of the commons, in which shared resources are overharvested by rational actors maximizing their personal gains. Four decades of research on the commons have largely debunked Hardin's assumptions by highlighting the ability of individuals and communities to self-organize for the governance of natural resources (Acheson, 2011a; Agrawal, 2001; Araral, 2009; Ostrom, 1990; Dolsak & Ostrom, 2003; Ratner, Meinzen-Dick, & May, 2013; Ruttan, 2006; McCay & Acheson, 1987; Ostrom *et al.*, 2002).

Common property theory has largely emphasized the role of institutions in mediating individual resource use (Berkes, 1996; Ostrom, 1990) and experimental research has advanced understanding about other conditions under which such forms of collective action are possible (Henrich *et al.*, 2005; Ledyard, 1995; Ostrom & Walker, 2003). However a general theory about individual decision-making within the context of common pool resource dilemmas remains poorly developed (Janssen, 2010). Despite the wealth of experimental research on collective action and case studies of common property institutions, surprisingly little attention has been given to the ways in which resource characteristics and ecological dynamics influence individual behavior (Janssen 2010) or the creation of institutions (Agrawal, 2001; 2002). A more robust understanding of human-resource interactions is needed to strengthen theoretical propositions about collective action, group formation, and the sustainable governance of the commons.

The research presented here explores the influence of local civil society institutions on human-resource interactions in the commons at two levels in coastal Ecuador: 1) the fishery for mangrove cockles (*Anadara tuberculosa* and *A. similis*), bivalve mollusks harvested from the roots of mangrove trees at low tide by artisanal fishers; and 2) its broader mangrove wetland habitat. For decades, the conversion of mangrove forests for shrimp farming in Ecuador has exacerbated harvesting pressures on many small-scale fisheries. Since the 1990s, a thriving civil society sector has grown out of grassroots resistance to shrimp aquaculture. At the same time, Ecuador has taken great strides in the direction toward participatory sustainable coastal management (Beitl, 2011; Guest, 1999; Olsen, Ochoa, & Robadue, 2003; Robadue, 1995). Mangrove deforestation rates have begun to subside since the year 2000 and some areas are showing signs of recovery (CLIRSEN-PMRC, 2007). Presently, many local fishing associations continue to engage in activism concerning the defense of mangroves and some also work collaboratively with government agencies to address resource management and development issues in artisanal fisheries.

Despite the innovative policy interventions and the recovery of mangroves in some areas, the fishery for mangrove cockles continues to experience harvesting pressures (Mora & Moreno, 2009; Mora, Moreno, & Jurado, 2009; 2011). In 2001, the Subsecretaría de Recursos Pesqueros (SRP), a government regulatory agency, prohibited the harvest of shells smaller than 45mm in length. These regulations are in line with customary norms by which fishers have traditionally left behind smaller shells in the mangroves to allow biological processes of larval dispersal, settlement, and growth. Members of fishing associations (hereafter referred to as *socios*) adamantly insist they are more "responsible" fishers than non-affiliated cockle collectors because they obey shell size regulations and participate in workshops that increase awareness. Some government officials believe that mandating all cockle collectors to join associations would address problems of overexploitation. But many cockle collectors are wary of institutions and prefer not to participate (Beitl, 2012). Verifying popular claims about who engages in "responsible fishing" would not only settle the debate and inform fishery policies in Ecuador, but also contribute more broadly to theoretical understanding about the complex relationship between collective action and the environment.

This multi-sited comparative case study of two resource systems draws on ethnographic and fishery data to explore the general question: how do resource characteristics and the institutional context affect people's behavior toward common pool resources? Specifically, I ethnographically explore the emergence of local associations of cockle fishers and other "ancestral users" of mangrove resources within the context of widespread environmental degradation associated with shrimp farming. I further examine how those local institutions influence human-resource interactions by statistically testing whether membership explains differences in 1) fishing behavior (measured by the average length of shells in each fisher's catch); and 2) participation in activities that promote mangrove conservation (i.e. reforestation, activism). These two measures of human-resource interactions represent two different kinds of collective action problems, which may partially explain why local institutions successfully encourage participation in management regimes that uphold the mangrove commons but seem to have little effect on cooperation in the fishery commons. Understanding such mixed effects of collective action behaviors in different resource systems further contributes to knowledge about the interaction between other outcomes like ecological sustainability, livelihoods, and equity, which is of increasing interest in the literature on common pool resource governance (Agrawal & Benson, 2011; Persha, Fischer, Chhatre, Agrawal, & Benson, 2010).

2. COLLECTIVE ACTION, INSTITUTIONS, AND ENVIRONMENT

Global trends of population growth, urbanization, and rising market demand or seafood products have been transforming coastal zones and artisanal fisheries throughout the developing world for decades. Coastal mangrove forests have been among the most vulnerable forest types to such forms of global change for their widespread undervaluation that has often led to their conversion to other uses like shrimp farming (Alongi, 2002; Cormier-Salem, 2006; FAO, 2007; Martinez-Alier, 2001; Valiela, Bowen, & York, 2001). The social and ecological impacts of shrimp aquaculture such as landscape transformations, community displacement, livelihood loss, the erosion of resource rights, and conflict, have been well-documented in the literature (Cruz-Torres,

2000; Deb, 1998; Dewalt, Vergne, & Hardin, 1996; Gunawardena & Rowan, 2005; Martinez-Alier, 2001; Meltzoff & LiPuma, 1986; Primavera, 1997; Stonich, 1995; Stonich & Vandergeest, 2001; Veuthey & Gerber, 2011). Such chronic environmental degradation increases vulnerability in coastal areas and threatens resilience (Adger *et al.*, 2005), or the ability of a social-ecological system to learn, adapt, reorganize, and maintain its identity in the face of change (Berkes, Colding, & Folke, 2003). However, in some places around the world including Ecuador, coastal communities have empowered themselves, engaged in collective action, and formed coalitions of resistance to defend livelihoods and the environment where property rights have been poorly defined (Martinez-Alier, 2001; Stonich & Bailey, 2000; Veuthey & Gerber, 2011).

(a) Civil society as collective action institutions

Civil society plays a pivotal role in environmental issues of the new millennium (Little, 1999). It is often well-positioned to negotiate and advocate rights-based approaches to resource management and sustainable development, especially in places where commercial interests are privileged over local wellbeing (Johnson & Forsyth, 2002) or where government agencies are unable to adequately meet local needs. On the Ecuadorian coast, many civil society organizations were born out of a struggle between artisanal fishers and shrimp farmers over access to resources. In the early 1990s, extensive mangrove deforestation in Ecuador provoked outrage among activists and communities who began to mobilize in response. Muisne, one of the study areas for this research in the northern province of Esmeraldas, has been an important center for collective action and grassroots resistance to the shrimp industry when a group of youths formed a local non-government organization (NGO) in the early 1990s (Veuthey & Gerber, 2011). This NGO has played an instrumental role in helping communities organize into associations of ancestral users. Now internationally connected, the NGO continues to work with associations throughout the Muisne-Cojimíes Estuary to lead community development projects, network with other "ancestral user" associations in other provinces, and create national and international awareness campaigns for mangrove conservation, social justice, and the defense of livelihoods.

Similarly, in the southern province of El Oro, several communities throughout the Archipiélago Jambelí also began organizing in the early 1990s to gain government recognition of their "right to work" as artisanal fishers in the face of the rapidly expanding shrimp industry. Particularly in the south, one important benefit of creating associations and cooperatives has been increased access to government and non-government agencies for technical and financial assistance, such as loans and subsidies for economic development in rural coastal communities. Several local associations are now members of an umbrella federation of artisanal fishing organizations of the south, which is nested within a larger, national federation that works closely with government agencies to organize meetings and events that facilitate participatory practices in fisheries and coastal management. Such cross-scale institutional linkages are often considered an appropriate approach to managing complex social-ecological systems like fisheries (Berkes, 2002).

In the last decade, local institutions have gained more government and international support, which has fostered local empowerment and allowed for new forms

of social-ecological change on the Ecuadorian coast. The new Presidential Decree 1391 calling for a regulation of the shrimp industry will most likely create more opportunities for cross-scale collective actions and collaboration between multiple sectors for the recuperation of lost mangrove habitat.[i] Under the new institutional arrangements that emerged from this policy, shrimp farmers have already begun to sponsor reforestation projects carried out by local associations and other civil society organizations, in which mangrove planters are often financially compensated for their participation. It is expected that such efforts will restore many of Ecuador's degraded coastal wetlands that were converted for shrimp farming during the 1980s and 1990s.

(b) Common property and local resource rights

Decentralization and devolution of ecosystem management to local communities for the promotion of environmental stewardship and social equity has been a central theme within the common property literature (Agrawal & Gibson, 1999; Antinori & Bray, 2005). One defining characteristic of Ecuador's innovative coastal management policies has been the recognition of the "ancestral" rights of artisanal fishers in 1999, paving the way for 10-year mangrove concessions granted by the government to local associations throughout the coast. These new common property rights called *custodias* have two general aims: 1) to conserve and restore degraded mangrove areas; 2) to promote sustainable resource use and community management. Currently, 37,818 hectares of mangroves are held in 41 concessions for community-based conservation (Rosero Moya & Santillan Salas, 2011).

The local management of a *custodia* requires collective action on the part of individuals bound by a community or institutional affiliation. To qualify, a community or group of "ancestral users" must first organize into an association or cooperative officially recognized by the state. As an organization, they must then submit an application package consisting of maps, the names of officers, a list of members, a copy of the association's agreement, and a management plan detailing the sustainable use of resources (Bravo, 2007). Similar to the system of co-management in Chile (Gelcich, Guzman, Rodriguez-Sickert, Castilla, and Cárdenas, 2013), the management plan of an Ecuadorian *custodia* is designed by the local fishing association in collaboration with an external NGO or university that provides technical assistance for a minimum of two years. In everyday use, these institutional arrangements function much like the common property regimes described by Ostrom (1990), in which members of the association work cooperatively to maintain a system of monitoring, sanctioning, and exclusion of outsiders over a particular resource domain collectively agreed upon by the association. Because of the benefits often cited, such as mangrove protection, sustainable resource management, local empowerment, and economic gains (Beitl, 2011; Bravo, 2007; Coello, Vinueza Burgos, & Alemán, 2008), several associations in El Oro Province have submitted applications for a *custodia* of their own. As an outcome of the multi-tiered institutional interactions between civil society and the Ecuadorian government, the *custodias* in Ecuador represent what some have called the "new commons," in which newly recognized resource rights have great potential to transform human-environment relationships (Ruiz-Ballesteros & Gual, 2012).

Some researchers argue that diverse outcomes of governance strategies are rarely analyzed together in the literature, and therefore there is no reason to assume that collective action institutions ensure sustainability, equity, and livelihood security to equal degrees (Agrawal & Benson, 2011). In a previous study of the cockle fishery, I found that one *custodia* in the province of El Oro was associated with larger catch and shell sizes, indicating ecological and economic benefits, but only for those members of the association who controlled access (Beitl, 2011). Nonmembers without access felt increasingly marginalized as mangroves were enclosed by shrimp farming on one hand and common property arrangements on the other (Beitl, 2012).

My previous study of the cockle fishery employed an institutional-level of analysis using the measure of success that Ruttan (2008) refers to as *collective goods provisioning.* This level of analysis does not capture whether individuals comply with the rules-in-use or if some other environmental factors are at play to promote larger shell and catch sizes. As Ruttan pointed out, it is important to be explicit as to how "success" is measured and distinguish between the *collective action problem* and the *provisioning of goods,* which are not necessarily related (Ruttan, 1998; 2008). In this paper, I turn to the *collective action problem,* which focuses on individuals as the unit of analysis, a more appropriate measure for capturing individual differentiation that helps explain the success or failure of collective action (Ruttan 2008).

(c) Two kinds of collective action: *contribution* vs. *subtractability*

The scholarly literature on collective action fundamentally points to two different kinds of collective action problems faced by individuals coordinating their efforts for collective benefit. The first kind of collective action problem refers to an individual's *contribution* of time, money, or resources (Beard, 2007; Hardin, 1982; Olson, 1965; Tilly & Tilly, 1981). Much of this research examines factors that facilitate or inhibit the ability of individuals to contribute to collective action, such as wealth heterogeneity, ethnic heterogeneity, social capital, and community size (Araral, 2009; Beard, 2007; Jones, 2004; Ruttan, 2006, 2008; Waring, 2011). Jones (2004) examines the effects of wealth heterogeneity on trust as a mediating factor affecting collective action, arguing that trust allows for more successful functioning among agricultural cooperatives in Ecuador. Beard (2007) also examines wealth in a multivariate regression of factors affecting contributions to collective action in Indonesia. She also found that social networks were a strong predictor of the ability of households to contribute to community development with implications for how benefits are distributed. In addition to multiple variables and societal constraints on collective action, institutions are often recognized for their mediating role (Araral, 2009; Folke & Berkes, 1995; Waring, 2011).

The second kind of collective action problem is described in the commons literature as a *subtractability* problem, a situation in which extraction by one resource user is costly for the group and the exclusion of users is difficult (Acheson, 2011a; Ostrom, Burger, Field, Norgaard, & Policansky, 1999; Ostrom, Gardner, & Walker, 1994). Rational choice theories about collective action in the commons stipulate that individuals have little incentive to cooperate or invest in resources when they are not rightful owners or when the costs of cooperating outweigh the benefits (Acheson & Gardner 2010; Ostrom, *et al.* 1994). Thus, a collective action dilemma refers to the ways

in which rational behavior by individuals results in a tragedy for the larger collectivity (Acheson & Gardner, 2010) or Hardin's (1968) tragedy of the commons. However, as noted by Folke and Berkes (1995: 123), individual decisions about resource use are usually mediated by social controls or sanctions. It has long been suggested that social interaction is embedded within the larger cultural ecological context (McCay, 2002; McCay & Acheson, 1987).

(d) Conditions for collective action

Much research on collective action has sought to understand the conditions under which decisions to cooperate are most likely. Institutions can serve as formal constraints (rules, laws, constitutions) or informal constraints (norms of behavior or conventions), which influence social interaction (Berkes, Folke, & Colding, 1998). For example, institutions often help define social interactions when actors do not share common goals or when power differentials are embedded within community relations (Agrawal & Gibson, 1999). Recent research has drawn attention to social networks (Beard, 2007; Crona & Bodin, 2006) and social learning (Biedenweg & Monroe, 2013) as structural conditions that influence social interaction.

Corroborating numerous empirical studies on the crucial role of institutions, much experimental research has also shown that trust, reciprocity, reputation (Axelrod & Hamilton, 1981; Ledyard, 1995; Ostrom, 1998; Ostrom & Walker, 2003) and the ability to punish defectors (Boyd & Richerson, 1992) are among the multiple factors that influence people's willingness and ability to cooperate. Other researchers have argued that pro-social behaviors are rooted in our evolutionary past. From this perspective, human behavior is mediated through communication (Smith, 2010) or by an evolved psychological system based on repeated experiences that affect human emotion, guilt, friendship, dislike, moralistic aggression, gratitude, sympathy, trust, suspicion, and trustworthiness (Kurzban, 2003; Trivers, 1971). Such socio-cultural contexts constitute what many researchers refer to as "informal institutions" (Berkes *et al.*, 1998).

(e) Linking social and ecological systems

In addition to the socio-cultural context, some research on the commons has shown that certain characteristics of common pool resources make some more manageable than others, such as small size or definitive boundaries that facilitate the ability of groups to make collective choice agreements (Agrawal, 2001; McCay & Acheson, 1987; Ostrom, 1990). In some cases, a successful self-governing system may emerge from the ways in which resource users respond to environmental conditions (Basurto, 2005; 2008). Thus, the sustainability of any governance system is contingent upon the biophysical state of the resource system (Basurto, 2008).

Other research has shown that when resources are scarce, cooperative relationships may break down (Homer-Dixon & Blitt, 1998; Laughlin, 1974). For example, Wutich (2009) has shown that water scarcity in an urban setting in Bolivia places external pressure on cooperative relationships within the community even when operational rules and collective choice agreements are well-established. Araral (2009) has found that in addition to multiple factors, water scarcity has a curvilinear effect on

collective action in irrigation systems in the Philippines. However, in their systematic review of case studies, Agrawal and Benson (2011: 205) note that surprisingly less attention has been given to biophysical factors of resources in the fisheries literature.

In contrast to the multiple factors that break down collective action, other researchers have drawn attention to the importance of perceptions and common understandings, or what Russell Hardin (1982) may have classified as moral motivations for collective action. Some researchers argue that people must have a general sense of risk perception and awareness of the collective cost to avoid a tragedy (Burke, 2001), which also holds true for maintaining the strength of local institutions (Becker, 2003). Experience with resource decline also plays a role. For example, a conservation ethic emerged among lobstermen in Maine after a historical stock failure, allowing for the coevolution of new attitudes and cooperative behavior (Acheson & Gardner, 2010). Other researchers argue that cohesion under a collective identity is a necessary condition for collective action (Mosimane *et al.*, 2012).

On the other hand, motivations for collective action may not always be clear and not all forms of cooperation are in the interest of conservation. In her study of the management of mother-of-pearl shells in Indonesia, Ruttan (1998) found that villagers successfully cooperate and prevent free riding to defend access to fishing areas and ensure their own economic returns, but conservation is an epi-phenomenal outcome and not the result of intentional conservation. Such assertions challenge the assumptions about stewardship inherent in much of the common property literature. But as many researchers have pointed out, relatively few case studies have collected both biological and social data at the same time (Berkes, 2005; Pollnac & Johnson, 2005). More recently, researchers have made increasing efforts to link social institutions with environmental outcomes (Acheson, 1987; Bray, Ellis, Armijo-Canto, & Beck, 2004; Rustagi *et al.*, 2010; Persha, Agrawal, & Chhatre, 2011; Persha *et al.*, 2010). These studies of the forest commons have been able to quantitatively explore the relationship between identifiable user groups with enforceable property rights and forest outcomes. But theoretical understanding about human-resource interactions at the individual level remains poorly understood (Janssen, 2010).

Simulating dynamic ecological conditions of differential resource renewal rates under controlled laboratory conditions, Janssen (2010) has found that individuals subtract from a common pool in ways that respond to these ecological dynamics. In addition to communication, he proposes that group identity formation and an individual's commitment to cooperate also play a crucial role in the process of group formation and the development of strategies to avoid overharvesting. Gelcich *et al.* (2013) test for differences between already established user groups in the Chilean loco fishery. They show that members of fishing unions exhibit more pro-social tendencies and play the game differently than members of weak unions and nonmembers. Such findings from experimental research have profound implications for theories about collective action and the environment; however, most studies are based on hypothetical scenarios, even when conducted in the field (for example, see Cardenas & Ostrom, 2004 and Gelcich *et al.*, 2013). Based on their findings that experimental games do not robustly correlate with empirical observations, Gurven and Winking (2008) argue that the use of games as a methodological approach should complement, but not replace, ethnographic research.

Drawing on ethnographic and fishery data from the field, my approach complements experimental research that systematically studies the effects of ecological dynamics on behavior (Janssen, 2010). Following Ruttan's (2008) distinction between two ways of measuring the success of collective action, I hypothesized that collective action would have positive effects on common pool resources. As argued by Ruttan, the success of collective action may be measured by 1) *collective action problem*, or the degree to which individuals obey the rules-in-use or participate in the process or design of management regimes; or 2) *collective goods provisioning*, which measures the abundance, quality, or general condition of the resource base or institutions for sustainable governance. In this paper, I focus on the first distinction since I have addressed the effects of property arrangements on the cockle fishery elsewhere (Beitl, 2011).

3. RESEARCH DESIGN AND METHODS

(a) Research design, hypotheses, and procedure

The research design entails a mixed-methods approach using qualitative and quantitative data to study behavior toward two common pool resource systems, mangroves and the cockle fishery. Combining fishery data with ethnographic information about a population of cockle fishers across four study areas in coastal Ecuador, I explore how resource characteristics and the institutional context affect people's behavior toward common pool resources. Based on the literature and exploratory field research, I developed the following hypotheses:

H1: Contributions to collective action are explained by membership in local associations. I operationalize *contributions to collective action* as activities which may promote mangrove conservation and restoration. This hypothesis draws upon the data generated from informant responses on the questionnaire as to whether he/she had ever participated in mangrove reforestation projects, political demonstrations in defense of mangroves, workshops about mangroves or the cockle fishery, community development projects like those designed by government and non-government agencies for cockle mariculture, or a *minga*, which is a community work party organized in many rural areas throughout Latin America.

H2: Members of associations are more likely than independent cockle collectors to perceive problems of overexploitation in the fishery. Given that *socios* are organized into groups, bound together under institutional affiliations, and connected to government agencies, I expect they have more access to information about the status of the fishery and therefore heightened levels of concern, which in turn, may influence their fishing behavior.

H3: Membership in an association accounts for variation in average shell size in a fisher's catch, reflecting more awareness and heightened levels of concern (see H2). Controlling for age, the number of small shells harvested as "seed" for mariculture, and environmental variables such as community size (a proxy for fishing effort) and lunar cycle, I predict that members of associations engage in conservation-oriented behaviors like respecting the shell size regulations. My preliminary research on the fishery

suggested a need to test these assumptions often made by government officials and *socios* about who engages in more "responsible" fishing practices.

To test the hypotheses, I developed measures of sustainable fishing behavior and collective action that were appropriate to the ethnographic context of the mangrove cockle fishery in Ecuador. During the first phase of research involving observations in several communities and major ports for cockle landings, I designed and pre-tested a semi-structured questionnaire for cockle fishers. Many questions were based on theoretical constructs and my observations during the exploratory phases (Johnson, 1998). Some questions were adapted from surveys created by the Instituto Nacional de Pesca (INP), Ecuador's national fishery research institute. The final questionnaire was divided into the following sections: 1) information about cockles, including catch-per-unit-effort (CPUE), shell length (mm), and sites of extraction; 2) baseline demographic information; 3) questions about change in mangroves and the fishery; 4) household livelihood strategies and participation in collective action. Basic demographic information included whether the informant was a *socio* and the name of the association to which he/she belonged. I coded responses to open-ended and semi-structured questions from the interviews to create measures of collective action. To qualitatively explore collective action as an outcome of local resistance to shrimp aquaculture, I created a supplemental set of questions for representatives from associations about their motivations for organizing and challenges they faced as a group.

To operationalize human-resource interactions in the fishery, I created proxies for fishing behavior by calculating the mean shell length per individual catch, the proportion of a catch with shells below the legal size, and CPUE. Shell length is often used in fisheries science as a biological indicator of performance to determine the status of the fishery (Flores & Mora, 2011). For the purposes of this study, shell length averages per catch is an appropriate measure of "responsible fishing" since smaller shells indicate noncompliance with customary norms and regulations concerning the harvest. Shell length is a more appropriate measure of "responsible fishing" than CPUE, which may more accurately indicate foraging efficiency, rather than intentional conservation.

These measures of collective action and human-resource interactions were designed to function in multiple contexts, across study areas, and under a variety of institutional arrangements to capture the complex interactions between institutions, individuals, and the environment. My attention to the ethnographic context under which civil society organizations began to flourish on the coast helps further explain the efficacy of collective action in environmental governance.

(b) Description of population and study areas

This paper draws on multi-sited ethnographic research from January 2009 to December 2010 in the provinces of Esmeraldas and El Oro on the Ecuadorian coast (Figure 1). After exploratory research in 13 communities and major ports, I selected four study areas to represent one urban area and one village in each of the two provinces: 1) Muisne (pop. ~7,000); 2) Las Manchas (pop. ~50); 3) Puerto Hualtaco (pop. ~40,000); and 4) Isla Costa Rica (pop. ~300). All study areas have been important centers for the marketing of mangrove cockles, but have lost more than 50% of their original mangrove cover since the 1980s.

(Figure 1 here)

There are an estimated 5,000 cockle fishers dispersed throughout the five coastal provinces in Ecuador (MacKenzie, 2001). Cockle collecting has traditionally been an important household livelihood strategy, particularly in the provinces of Esmeraldas and El Oro where the majority of cockle fishers are located (INP, 1971). Today, cockle collecting is largely commercialized. Many collectors sell most of their catch to supply local and regional markets, keeping only a handful of small shells for personal consumption. Shells are typically gathered from the roots of mangrove trees during low tide periods and each fishing trip lasts about three hours. Spring tides (associated with full moon periods) have a longer lag time between high tide and low tide permitting fishers to work longer hours if they wish. Some fishers take advantage of the longer hours, particularly in Muisne, but most stay within the three-hour harvesting period. Spring tides also allow fishers to travel further out or deeper into the mangroves to reach areas that are normally submerged during neap tide periods.

In Puerto Hualtaco, eight to nine motorboats carry up to 30 fishers (Monday through Saturday) to various sites along particular routes in the estuaries throughout the archipelago. With the exception of Hualtaco, most cockle collectors head out in small groups of friends or kin in motor-powered canoes, paddle canoes, or on foot to sites of their choice. Thus the average fishing effort, defined by INP as the total number of fishers on a given day, is higher in the urban areas of Hualtaco and Muisne (~200 and ~75, respectively) than in the villages of Isla Costa Rica and Las Manchas (~23 and ~10, respectively).

Membership in associations is considerably higher in the province of El Oro compared to Esmeraldas. In Esmeraldas, only 5% of those interviewed claimed affiliation (n=59) and in El Oro, 60% belonged to a local association or cooperative (n=93). In Esmeraldas, local associations of "ancestral users" focus their activities on mangrove conservation and defense. In El Oro, fishing associations collaborate with government agencies and focus on the development of the artisanal fishery sector. To date, there are no *custodias* in either of the two study areas in Esmeraldas. These new common property rights are the source of increasing tension among cockle collectors in El Oro (Beitl, 2012). Such differences between the two provinces provide important comparative insights about the socio-political context for human-resource interactions.

(c) Participant recruitment and data collection

I administered the general questionnaire to cockle collectors orally after obtaining informed consent and permission to count and measure the length of all shells in their catch using a digital Vernier caliper (n=153). In the village of Isla Costa Rica, I recruited participants (n=58) often with the help of the president of the association and his wife after conducting a community census. In Puerto Hualtaco, local intermediaries, field assistants, and occasionally INP biologists helped me randomly select individuals as they disembarked from the boats returning from fishing trips as the tide was rising (n=33).[ii] In Muisne, my field guide, Adrian and I randomly recruited informants from a boat situated in the middle of the estuary at the end of the low tide period, offering refreshments and to

tow people's canoes into port in exchange for their participation (n=47). On several occasions, we shuttled 10-15 cockle collectors to various sites, similar to the organization of labor in Puerto Hualtaco, but on a smaller scale. In the village of Las Manchas, Adrian and I recruited informants during five different visits (n=8), one of which we were invited to participate in cockle collecting with a local family.

In the interviews, I enquired about perceptions of change in catch and shell size over the last 10 years, the reasons why they believed the fishery was changing, whether they were concerned about overexploitation, and whether they trusted that others obey size regulations. I further enquired about their participation in reforestation and other forms of collective action. The semi-structured questions always invited elaboration depending on time, perceived patience, willingness, and age of the participants. Immediately before or after the interview, I measured the length of all the shells in each individual's catch, resulting in a sample of 12,433 cockles gathered from 71 cockle beds across the four study areas. I recorded the information with the help of one or more field assistants or a digital voice recorder. For each fisher's catch, I calculated the mean shell length and proportion of shells below three size classes (45mm, 40mm, and 36mm).

In each site, I conducted one or more focus groups to present preliminary results, verify the findings, and generate further discussion. Additionally, I gained much understanding about the ethnographic context through my extended home-stay in Isla Costa Rica, interviews and informal conversations with a variety of actors, and participant observation on fishing trips, events, and community meetings in all study areas.

(d) Variables and data analysis

Membership in an association (ASODUMMY) refers to present members, not including children of *socios* or former *socios*. My dependent variable, collective action, is represented by several proxy measures. I coded fixed responses from the interviews about collective action. The measures of collective action as a contribution are represented by five dichotomous dummy variables addressing the question of whether the informant had ever participated in reforestation, community mariculture projects, workshops, *mingas*, or political activism. I also coded free responses of informants when they offered to elaborate, resulting in a different *n* for certain questions since missing variables were dropped from the analysis (see Table 1).

Using SPSS 17.0 statistical software, I employed a 2-way cross-tabulation appropriate for analyzing the relationship between two categorical variables. I used chi-square likelihood ratio tests to explore whether there were statistically significant differences between *socios* and independents in their perceptions about mangroves, the state of the fishery, and their participation in different kinds of collective action. For continuous variables such as mean shell size, proportion of shells below legal size, number of shells gathered per hour, and age of the fisher, I used ANOVA.

To explore other factors that account for variation in the mean shell length of each catch, I conducted an OLS linear regression analysis using the average shell length within each fisher's catch (MEANTUB) as the dependent variable and proxy for fishing behavior.[iii] The regression model is an appropriate estimator since the dependent variable is normally distributed. Controlling for age of the collector, community size, lunar cycle,

and province, I used OLS linear regression to determine how institutional and environmental factors account for variation in fishing behavior. The two independent variables of theoretical interest include membership (ASODUMMY) and whether the informant trusts others comply with regulations (TRUST). Other independent and control variables are described below.

Given the likelihood that the lunar cycle would influence characteristics of the catch, I recorded the date of capture and coded each observation as spring tide or neap tide (TIDEDUM) based on the tide table published by Instituto Oceanográfico de la Armada (INOCAR, n.d.). Spring tides are characterized by extreme high and low water levels, as well as longer lag times between high tide and low tide periods. In contrast, neap tides under the new moon are shorter. Since Ecuador experiences a semi-diurnal tide, the two low tide periods occasionally fall within daylight hours during the new moon and some fishers seize the opportunity to work during both low tide periods.

Community size (COMSIZE) can be considered a social or environmental variable. In the collective action literature, coordination is more difficult in large groups (Olson, 1965). However, some researchers have highlighted the mixed effects of group size on collective action (Yang *et al.*, 2013). In the research presented here, group size is a less useful construct since this population of fishers is not necessarily bound together by a group. Thus the variable COMSIZE is more appropriately a proxy for fishing effort. According to INP, the average daily fishing effort in Hualtaco is 192 and in Muisne, it is 55-80 individuals per day. Because of the relatively high fishing effort and classification as "urban" (see Figure 1), these two study areas were coded 1 for large community. In contrast, Isla Costa Rica with a daily fishing effort of 15-30, and Las Manchas with 10-20, were each coded with a 0 for small community. I also included province to control for unobserved geographic differences between study areas (PROVINCE).

In the two small communities, certain households practice mariculture, holding live cockles in net enclosures in the estuary near their houses until they reach a larger size or seasonal demand raises the market price. Collectors from those households often harvest a number of shells smaller than 45mm as seed for their holding pens. Given the likelihood that this practice affects the average shell size of each person's catch, I included the number of shells that were collected for mariculture (NUMCORRAL).

Finally, to further test the effects of ecological constraints on harvesting behavior, several cockle fishers allowed me to measure their shells gathered from two or more sites on different occasions (n=20). I used ANOVA to determine whether differences in shell sizes gathered by the same individual on separate fishing trips were significant.

4. RESULTS AND DISCUSSION

(a) Mangroves and contributions to collective action

Membership in local associations fosters a higher propensity of individuals to contribute to different kinds of collective action (Table 1). *Socios* participate more than independents in mangrove reforestation, community mariculture, workshops, *mingas*, and political activism related to the defense of mangroves. It is no surprise that the differences are statistically significant since many of these kinds of activities are organized by civil society institutions for their members, often in collaboration with other

sectors (government, NGOs, or private shrimp farmers). Civil society institutions serve as a social network that facilitates the flow of information, which may ultimately allow for successful community-based management (Crona & Bodin, 2006).

(Table 1 here)

There are some incentives for individuals to contribute to collective action. As mentioned earlier, many sponsors of reforestation projects offer a modest remuneration equivalent to expected earnings from a fishing trip. In this way, mangrove planting has evolved from a form of "symbolic resistance" during the early 1990s (Veuthey & Gerber, 2011) to new forms of multi-level institutional collaboration (Berkes, 2002). However, even when there are no incentives like payment for participation, sometimes participation is voluntary. Those who participate explain they are doing it for the greater good, for the benefit of mangrove conservation, or because of their obligation as a *socio*. Some are incentivized by the desire to maintain a good reputation as collaborative and dependable among their peers. In the interviews, many *socios* expressed great pride in their ability to collaborate with one another, government officials, or researchers like myself. Thus, there are often social pressures among *socios* to participate, particularly in the smaller communities where *mingas,* community organizations, and other collective activities are part of daily life and an obligation for everyone. These findings corroborate experimental research on collective action that emphasizes the importance of trust, reciprocity, and reputation (Ostrom and Walker, 2003).

With financial support from international donors, activist organizations in Muisne and Quito have been organizing public awareness events and demonstrations against policies that have favored the shrimp industry since the early 1990s. While not all cockle collectors recognize any benefits to participating in political demonstrations, many expressed their feeling of empowerment now that they are able to make their voices heard. Demonstrations are sometimes organized locally, but many often take place in the capital city. For many cockle collectors who subsist on $5-20 a day, it is difficult to travel and show support for these efforts. However, the NGOs organizing the events invite members of associations throughout the coast to participate by covering their travel costs and food expenses. Similarly, the local NGO in Muisne often supplies meals and pays for the travel costs for *socios* from distant villages to participate in workshops. In contrast, government agencies typically do not offer any compensation for participation. As such, many associations in the province of El Oro and just a few in Esmeraldas raise their own funds to send one or two representatives to events or workshops organized by government agencies.

Independent cockle collectors give multiple reasons for not participating. Many of the independents I interviewed said they did not know about events or were not "invited." In some interviews, I sensed some resentment in comments like, "they (the sponsors) already have their people picked out" in reference to who is invited to participate; and "only *sabidos* work in reforestation," implying that members of associations are conniving and corrupt. Some independent cockle collectors were interested in participation, but did not have the money to pay membership dues to the local association, reflecting the ways in which economic constraints can present barriers to collective action (Beard, 2007). As one informant expressed, "They do not tell us (about

reforestation projects) because we are the poorest of the poor, but yes, I would go…" Others were interested, but were highly distrustful of local institutions, asserting they hoard money for themselves and "always ask for collaboration but never give anything back." Overall, many independent cockle collectors in both provinces do not have the time, resources, information, trust, or interest in contributing to these kinds of collective action.

General suspicions among many independent cockle collectors about institutions were more prevalent in Esmeraldas where several informants expressed their overall disappointment in the ability of the local NGO to effect change. After confirming that I was not affiliated with the NGO in the interviews, several informants confided their belief that the NGO was "profiting from the poor." I often heard the argument that they "used" local people to advance their own interests, receiving large sums of international donations while many cockle collectors remained destitute in the face of a declining resource. Another critique was that they created certain levels of dependency among the local associations who would not voluntarily participate without incentives. These findings lend further support to the notion that trust is a crucial factor behind successful collective action (Cook & Cooper, 2003; Eckel & Wilson, 2003; Jones, 2004). They further represent the ways in which grassroots movements may sometimes become further disconnected from local needs as they are increasingly scaled up and integrated into global networks (Igoe, 2003).

(b) Environmental motivations mobilizing collective action

While civil society organizations serve as a context for collective action, they simultaneously represent an outcome of collective action from a historical perspective. Civil society began to flourish on the Ecuadorian coast throughout the 1990s and early 2000s when many people in coastal communities organized around social justice issues in response to environmental degradation associated with shrimp farming. Some informants in Muisne, Esmeraldas commented that they had participated in reforestation and activism in the past when shrimp farms first began to encroach and there was a stronger sense of trust in community organizers. They nostalgically recounted stories of subversion when artisanal fishers and activists joined forces in the late 1980s to resist the powerful shrimp industry, break pond walls and dykes, and threaten shrimp farmers with machetes. However, as people increasingly lost confidence in the NGO and its affiliated associations, the spirit of community activism also disintegrated. Among many independent cockle collectors in Muisne today is a sense of hopelessness and resentment against the very same activists who fervently advocated their cause many years ago. Today Muisne, divided between hope and indifference, is a difficult place for the local NGO to encourage participation. On the other hand, even one of its biggest critics in Muisne mused, "Without collective action, if we hadn't formed a group to resist shrimp farming, we would have no mangroves today," recognizing the NGO's vital role in the struggle over resource distribution conflicts.

In El Oro, many fishing associations similarly started out with the goal of defending their livelihoods. Today, these institutionalized forms of collective action play an important role in village life. As one community leader in Isla Costa Rica explained in his own words, "Collective action is the backbone of small communities with little

material wealth." Other associations in Puerto Hualtaco organized for similar reasons in the face of rapid mangrove deforestation that threatened so many livelihoods. Now artisanal fishers in El Oro enjoy the benefits of government support in the form of credits, subsidies, and for some associations, *custodias*. As such, the sense of hopelessness and rampant individualism I observed in Muisne, Esmeraldas is much less pronounced in the province of El Oro where fishers generally enjoy a higher standard of living, better prices for their catch, and the benefits of government support. This point further draws attention to the crucial role of the social-political context, which helps further explain the efficacy of collective action.

Mangroves throughout the Ecuadorian coast are now on a path to recovery through reforestation projects, *custodias,* awareness campaigns, and other institutionalized forms of collective action. However, such motivations for mobilizing raise important questions about whether the intentions of collective action are for economic gain or restraint in the interests of conservation (Lu, 2001; Ruttan, 1998). This may have less to do with the nature of the group and whether they are unified under a collective identity (Mosimane *et al.*, 2012), share a common understanding of risk perception (Burke, 2001; Becker, 2003) or conservation ethic (Acheson & Gardner, 2010) and more to do with the characteristics of the resource system (Agrawal, 2001) and the type of collective action problem at hand (Schlager, 1994).

(c) Fishing and the subtractability problem

The subtractability problem that characterizes the fishery is more difficult to overcome. Many *socios* are critical of independent cockle collectors, contending they lack awareness and understanding about the urgency of coastal resource decline. They believe independent fishers are free riding off the hard work and collective efforts of *socios* who sacrifice their time and energy for the greater good of resource conservation. Since they are the ones that attend workshops and take time to become informed about resource issues, many *socios* believe that independent cockle collectors lack awareness and do not respect the size regulations or customary rules in fishing. However, several proxies for "responsible fishing," such as the mean shell length of each fisher's catch and the proportion of shells below the legal size of 45mm, show indistinguishable behavior between *socios* and independents (Table 1). While on average, *socios* gather more shells per hour of harvest, this does not necessarily reflect a conservation ethic. On the contrary, it could be a function of access to better gathering grounds like *custodias* that restrict public access or areas with a lower fishing effort like smaller communities.

Table 1 also shows that both *socios* and independents have a shared awareness of risk perception (Burke, 2001) and perhaps some degree of a conservation ethic (Acheson & Gardner, 2010). Both *socios* and independents acknowledge that the fishery has been under pressure over the last 10 years (Table 1). However, *socios* are slightly more concerned about the future and differ more strongly in their opinions about potential solutions. This finding may reflect the ways in which information is disseminated and shared among members of a social network (Crona & Bodin, 2006), or in this case, the ways in which collective understanding is formed in a group bound together by institutional membership.

(Table 2 here)

(Table 3 here)

Despite slight differences in opinion about the urgency of fishery decline, the regression results show there are no significant differences in fishing behavior between *socios* and independents even after controlling for unobserved geographical differences between provinces, lunar cycle periods, community size, and the number of cockles taken as seed for mariculture (Table 3). Trust that others respect the rules also makes no difference in harvesting behavior, although this could be due to the fact that most cockle collectors are distrustful of other collectors in general. For both *socios* and independents, fewer than 30% of cockle collectors trust that people cooperate in the commons. However, for many *socios,* trust is conditional—that only other *socios* can be trusted.

Despite perceptions about how others interact with common pool resources, more than half of the cockle collectors I interviewed claim they personally abide by the rules-in-use by leaving smaller shells (>45mm) in the mangrove for the benefit of resource regeneration. However, there is also an indirect economic incentive for leaving small shells. Even though merchants pay by the number rather than by the size of shells or weight of the catch, the price is often negotiated based on subjective perceptions of "quality," or an eyeballed estimate of shell sizes and the proportion of a catch made up of *A. tuberculosa,* the species considered more palatable by many consumers.

On the other hand, several informants, both *socios* and independents alike, justified the collection of a handful of small shells for personal consumption to *completar,* or reach a certain goal. Traditionally before fishery regulations were implemented in 2001, keeping a handful of *rechazos* (non-marketable cockles) has long been considered acceptable under customary norms. However today, both *socios* and independents are worried that competition among fishers has resulted in the problem that smaller shells are beginning to appear on the market. As one collector in Hualtaco commented, "nobody gives the gathering grounds a rest anymore because if they do, someone will come along tomorrow." Another man from Muisne expressed similar frustration, "the problem is that if I don't take the small shells, someone else will come along and do it, so it's better that I take everything for myself." In the two small communities Isla Costa Rica and Las Manchas, cockle fishers justified the collection of smaller shells as "seed" for mariculture. Thus, there is little incentive to follow the rules-in-use based on the anticipated behavior of others in the commons, despite one's perception of risk (Burke, 2001; Becker, 2003), conservation ethic (Acheson & Gardner, 2010), or communication through a social network (Crona & Bodin, 2006). Contrary to other research on collective action (Araral, 2009; Folke & Berkes, 1995; Waring, 2011), these results suggest that institutions have very little mediating effect on this kind of collective action problem. As Schlager (1994) interestingly noted, the "appropriation externalities" or the subtractability problem that characterizes many fisheries, is quite different than other kinds of collective action problems.

(d) Subtractability and environmental constraints

The results of the regression analysis further suggest that environmental variables are more important than characteristics of the fishers or the institutions that hypothetically mediate their behavior. Shells harvested in the two large communities with a higher fishing effort tend to be 1.78mm smaller. This finding is not surprising since a higher fishing effort is often associated with harvesting pressures (Flores & Mora, 2011). The lunar cycle also has a significant effect on shell size. Cockles harvested during spring tides are 1.35mm larger, which is not surprising since spring tides allow people to work longer hours, travel further out, or reach areas normally submerged during neap tides. However most cockle collectors work three hours regardless of the lunar period, at least in Puerto Hualtaco where the nine boats operate on regular three-hour schedules.

(Figure 2 here)

Figure 2 corroborates the results from the regression analysis, suggesting that people harvest whatever the environment provides despite their conservation ethic or membership in an association. The ANOVA tests show significant differences in the average shell length and large-to-small shell proportions per catch, depending on the site of extraction for 15 out of 20 individuals who allowed me to measure their shells on more than one occasion. Within these environmental constraints, each collector gathers what the environment provides, regardless of whether he/she is a *socio* or not. Thus, behavior is situational, highly dependent on the environmental context, and most likely responding to ecological dynamics (Janssen, 2010), which are not fully captured here.

Furthermore, both *socios* and independents express interest in respecting the shell size regulations of 45mm, but many feel they have no choice but to *completar* in order to make ends meet and support their families. Such decisions to break the rules reflect rational choice perspectives that conservation is too costly (Acheson, 2011b). Contrary to findings by Boyd and Richerson (1992), the threat of confiscation by authorities is not enough to deter noncompliance. On the contrary, intermediaries awaiting the cockle collectors in the port frequently use their cell phones to warn fishers returning from the mangroves when the authorities are present. These increased levels of communication in the presence of authorities illustrate the ways in which communication and cooperation may sometimes operate against the interests of conservation (see Ruttan 1998). On the other hand, noncompliance with the rules concerning size regulations in the fishery commons often goes unnoticed. Few are able to observe such forms of non-cooperation in the commons. Those who witness rule-breaking understand the challenges of harvesting cockles under ecological constraints and would not likely turn their friends or kin over to the authorities.

Finally, membership in an association may increase one's access to community-managed gathering grounds with larger catch and shell sizes (Beitl, 2011), which lends further justification for the creation of more *custodias* as common property regimes that locally regulate access. Significantly more *socios* than independents believe that *custodias* are a viable solution to overexploitation (37% compared to 5% respectively), but there is still a lot of disagreement about the fairness concerning the enclosure of a public good (Beitl, 2012).

5. CONCLUSION

The purpose of this paper is to address gaps in the literature concerning the ways in which resource characteristics and institutional context influence people's behavior toward common pool resources. The main contribution of this paper is the use of both ethnographic and fishery data to explore human-resource interactions within two different resource systems, highlighting the differential nature of collective action problems. My findings suggest that both kinds of collective action problems (contribution and subtractability) are similar for the common theme of sociality and such social relations are reinforced by a group identity, such as institutional membership. Trust is a unifying factor behind both kinds of collective action problems (Ostrom & Walker, 2003). Just as a lack of trust discourages compliance with rules in the commons, a lack of trust in institutions discourages participation. This research has also shown other aspects of sociality that promote collective action (i.e. communication, social obligation, collective perceptions of risk, commitment to collective goals, and the enforcement of sanctions) operate differently depending on the resource system or level of analysis. This finding suggests that attention to resource characteristics merits further study to advance theories about collective action and governance of the commons (Janssen, 2010; Agrawal & Benson, 2011; Basurto, 2008; Wutich, 2009).

The ambiguous effects of collective action concerning mangroves and their associated artisanal fisheries are best explained in light of the different characteristics of the resource systems, their distinct social histories and local explanations for decline, and the differential nature of collective action problems. Both mangroves and their fisheries in Ecuador represent two kinds of common pool resources, but the historical reasons for their depletion are distinct. Fisheries are a classic commons problem characterized by *subtractability* and *excludability*, in which rational extraction by one user is costly for the group and the exclusion of users is difficult (Feeny, Hanna, McEnvoy, 1996; Ostrom *et al.*, 1999). As a different kind of common pool resource system, the sustainability of mangrove forests in Ecuador has been undermined for different reasons. Largely undervalued for the prospect of export-led growth promised by shrimp aquaculture, about one-fourth of Ecuador's mangroves have been converted into shrimp farms since the 1980s (Bailey, 1988; CLIRSEN-PMRC, 2007; Martinez-Alier, 2001). As a consequence, fishers are generally united in their belief that shrimp farmers have been responsible for the destruction of mangroves, but more divided in their perceptions about who is responsible for the decline of fisheries. A sense of social solidarity and collective responsibility has had less time to develop in the case of the cockle fishery, which has only begun to experience pressure in the last 10 years. Given these different social histories of each resource system, the coordination of individual actions is faced with a different set of challenges concerning agreement over the underlying causes of resource degradation.

The second explanation for mixed effects of collective action is related to the nature of the collective action problem (Hardin, 1982; Schlager, 1994). Membership in institutions encourages participation in activities that uphold the goals of mangrove conservation, as well as the management of common property regimes like *custodias*. Members of associations contribute to collective action for multiple reasons: 1) for their obligations as *socios;* 2) to uphold their reputations as collaborative, dependable, and

trustworthy; 3) for their fear of sanction for not following rules or group agreements; 4) for their access to information about events and encouragement by their peers to "collaborate" or participate; and 5) for their pride as members of associations and ancestral users of mangroves. However, the subtractability problem that characterizes the fishery is more difficult to overcome. Collective concern that the fishery is under pressure is not necessarily unique to *socios*, but such perceptions have not yet translated into practice in the broader population at the individual level. This research suggests that harvesting behavior is highly situational and dependent on ecological constraints. Both *socios* and independents alike are concerned about declining shell sizes, but feel they have no choice but to harvest whatever the environment provides, regardless of their membership in any institution or conservation ethic. This economic reality is not readily captured in experimental research (Janssen, 2010; Ostrom & Walker, 2003; Gelcich *et al*., 2013; Ledyard, 1995) where common pool resource dilemmas are hypothetical and material economic returns are not at stake. While experimental research yields powerful conclusions about decision making in the commons, it should not replace ethnographic field studies of human-resource interactions; rather the two methodological approaches have great potential to build theories about collective action in a complementary fashion (Gurven & Winking, 2008).

One way to address the subtractability problem or "appropriation externality" (Schlager, 1994) would be to increase the devolution of property rights to local associations through the creation of more *custodias* that restrict access and operate around periods of closure. However, improved resource conditions associated with *custodias* may be more a function of ecological conditions produced by management practices, rather than a reflection of "responsible fishing" by individuals, as this paper has argued. Moreover, enclosing the commons for the benefit of particular groups raises concerns about fairness, especially since there are often tradeoffs among outcomes of ecological sustainability, livelihoods, and equity (Beitl, 2011; 2012; Agrawal and Benson, 2011). Furthermore, while institutions encourage participation in mangrove restoration, it remains unclear how these human dimensions contribute to social-ecological change and how the benefits of mangrove restoration are distributed. Better understanding of ecological processes is needed to determine the relationship between mangrove recovery and fishery productivity. If institutions are promoting more participation among artisanal fishers in the process of mangrove recovery, then how are the benefits distributed back to fishers? What other socio-economic dynamics affect fishing effort and individual adaptations to changing environmental conditions? A systematic study of the fishing effort is needed to explore livelihoods and other conditions under which individuals leave the fishery and alleviate pressure on resources over time. Such further investigation comparing individual and collective adaptations to environmental change would contribute to better understanding of human-resource interactions at multiple levels and scales for building adaptive capacity and resilience (Adger, 2003; Anderies, Janssen, & Ostrom, 2004; Berkes, *et al.,* 2003; Endter-Wada & Keenan, 2005; Nelson, *et al*. 2007).

A common policy prescription in the commons literature has emphasized a need to create institutions for collective action for the sustainable governance of resources (Gibson & Becker, 2000; Gibson, McKean, & Ostrom, 2000; Ostrom, 1990; Ruiz-Ballesteros & Gual, 2012; Smith & Berkes, 1991). My findings suggest another reason to

move beyond panaceas and prescriptions for common pool resource management (Basurto & Ostrom, 2009). While civil society plays an increasing role in environmental conservation and local empowerment (Johnson & Forsyth, 2002; Little, 1999), not all citizens have the interest, resources, or trust motivating them to participate. Implications for resources under such conditions of heterogeneity and larger scales cannot be understated. The commons are not always easily bound by institutions or communities. Fostering trust and solidarity among the larger population cockle fishers in Ecuador who all universally share a stake in the fate of the dynamic mangrove commons will continue to challenge the strength and effectiveness of civil society as a context for collective action.

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NOTES

[i] Executive Decree No. 1391 of the 15 of Octubre 2008, published in *Registro Oficial* 454 de 27 de octubre de 2008. Under this executive decree, shrimp farmers had until March 31, 2010 to submit their application to legalize their lease occupying historical mangrove areas under the condition that they relinquish a certain percentage of their shrimp farm depending on the year of its construction and the total area occupying former mangrove habitat. For example, if the shrimp pond illegally occupies 10 ha of mangroves or less, the farmer would be responsible for reforesting 10%. For 11-50 ha of illegal occupation, he must reforest 20%. For 51-250 ha, he must reforest 30% within a year from submission of the application. Shrimp farms occupying areas declared as protected areas by the Ministry of Environment must be vacated immediately at the cost of the shrimp farmer, unless its construction took place before the area was formally declared protected.

[ii] Of the 36 recruited in Puerto Hualtaco, only three declined to participate.

[iii] All statistical analyses were conducted only for *A. tuberculosa* since it is ecologically more abundant and more culturally important.

Table 1. *Differences between members and independents in their contributions to collective action and other characteristics*

Variables	Independent Collectors		Association Members	
Participation/ contribution to collective action		*n*		*n*
Participation in reforestation (%) *	58	83	83	54
Participation in community mariculture projects (%) *	28	71	53	51
Participation in workshops (%) *	18	68	73	40
Participation in a *minga* (%) *	68	65	98	42
Participation in a political march in defense of mangroves and livelihoods or fisheries (%) *	43	76	88	49
Perception and opinion regarding state of mangroves and fisheries				
Perceive difference catch sizes over the last 10 years (%)	87	76	96	55
Believe a difference in catch is explained by lack of awareness (%) *	15	62	37	52
Concerned about the future of the fishery (%) *	78	74	96	52
Claim to always leave small shells in the mangrove (%)	68	73	62	52
Trust that others leave small shells in the mangrove (%)	20	65	27	44
Not everyone has the right to work in mangroves: it is ok to exclude some fishers (%)	12	68	25	44
Believe *custodias* are beneficial for the resource (%) *	62	53	85	47
Suggest *custodias* are a potential solution to overexploitation (%) *	5	61	37	46
Believe that people respect the boundaries of *custodias* (%)	29	24	28	43
Other descriptive statistics				
Age *	32.48	69	38.74	54
Shells gathered per hour *	24.05	74	32.71	43
Shell length per catch (mm)	45.34	75	45.64	43
Proportion of shells in catch <45mm (%)	52	75	50	43
Proportion of shells in catch <40mm (%)	20	75	20	43
Proportion of shells in catch <36mm (%)	3	75	4	43

* Differences are significant at $p < 0.05$ level.

[a] Chi-square likelihood ratios were performed on categorical variables and analysis of variance (ANOVA) tests were performed on continuous variables to test for statistically significant differences between *socios* and independents.

Table 2. *Descriptive statistics*

Variable	Description	N	Mean	Std. Dev.	Min.	Max.
Dependent Variable						
MEANTUB	Mean shell length in each fisher's catch (mm)	118	45.45	2.591	38.14	52.11
Independent variables						
ASODUMMY	Member of association	118	0.36	0.483	0	1
AGE	Age of fisher	118	31.85	14.075	8	70
COMSIZE	Size of community	118	0.59	0.493	0	1
TIDEDUM	Lunar cycle (spring tide)	118	0.27	0.446	0	1
PROVINCE	Fixed effects to control for unobserved geographical heterogeneity	118	0.58	0.495	0	1
NUMCORRAL	Number of cockles used for mariculture	115	2.08	8.280	0	72
TRUST	Trust that other users comply with rules-in-use	98	0.13	0.341	0	1
Valid	n=95					

Note: Please refer to Section 3d for a more detailed description of the variables.

Table 3. *OLS regression results for fishing behavior (MEANTUB)*

Predictor	Coef.	SE Coef.	*T*	*P*
(Constant)	47.099	0.840	56.102	0.000
Member of association	0.367	0.659	0.556	0.579
Age of fisher	-0.008	0.020	-0.415	0.679
Size of community	-1.821	0.578	-3.152	0.002*
Lunar cycle (spring tide)	1.455	0.549	2.652	0.010*
Fixed effects to control for unobserved geographical heterogeneity	-1.261	0.631	-1.999	0.049*
Number of cockles used for mariculture	-0.081	0.030	-2.684	0.009*
Trust that other users comply with rules-in-use	0.475	0.777	0.611	0.543

$N = 94$, $R^2 = 19.9\%$, R^2 (adj) $= 13.4\%$, $p = 0.006$.
* Significant at $p < 0.05$ level.

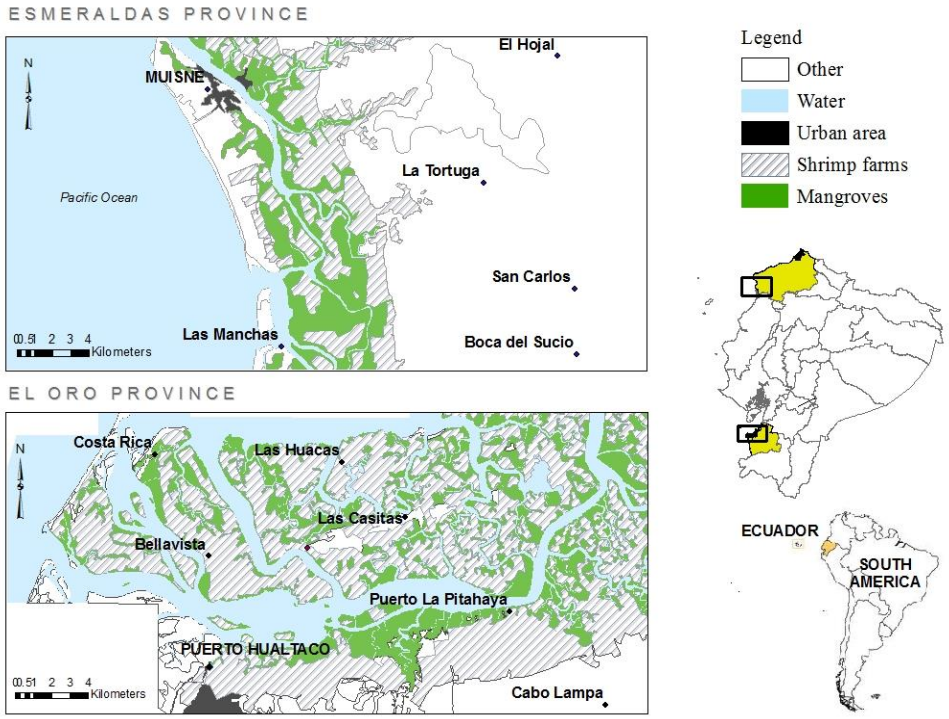

Figure 1. Maps of the study areas compiled by the author. Data source: CLIRSEN-PMRC 2006

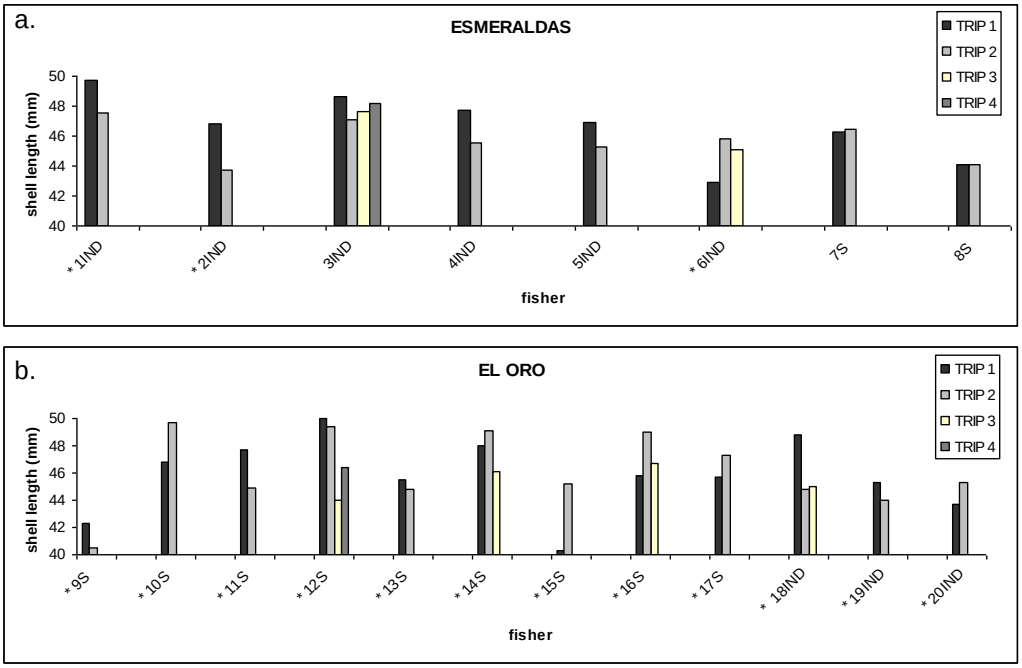

Figure 2. Differences in mean shell length of an individual's catch by fishing trip (n=20) in the provinces of (a) Esmeraldas and (b) El Oro. S=*socio*, IND=independent.
* One or more indicators significant at $p < 0.05$ level.