

Managing Fisheries by Assigning Rights to Harvester Cooperatives

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Abstract

Managing fisheries by delegating authority to an association of users is gaining increased attention as a strategy for implementing rights-based reform. Assigning rights to groups rather than individuals can facilitate coordination and collective action and enable efficiency gains similar to those achieved when a firm organizes its inputs centrally. Evidence from developed country fisheries managed by coops indicates that these coordination gains can be substantial and that they often take forms overlooked in the traditional fishery reform literature, including gains from enhanced product recovery and quality, improved spatial and temporal deployment of effort and reduced environmental damage. In developing countries, assigning management responsibility to user groups can facilitate user-based provision of public goods in situations where governments do not function well. Developing country fishery cooperatives commonly provide monitoring and enforcement of access limitations, limits on fishing effort and actions to conserve shared stocks. This paper reviews theoretical arguments for why collective action in exercising fishing rights can bring economic gains and summarizes empirical evidence on the performance of fishery coops in developed and developing country contexts.

1 Introduction

Innovations in fishery management over the last three decades have been broadly based on delineating and assigning property rights. When the assignment of rights aligns individual incentives with the goals of management, self-interest can induce participants to solve many of the management problems that might otherwise be addressed by regulatory command and control. Under one version

of rights-based management, rights are assigned to well-defined user groups and the groups decide the details of how to manage their members. This option has received less attention from economists than the other two prominent rights-based approaches, individual transferable quotas (ITQs) and spatially delineated fishing rights (territorial use rights fisheries, or TURFs). Assigning rights to groups rather than individuals can facilitate coordination and collective action and, as argued here, this can allow fishery coops to reap efficiency gains similar to those achieved when a firm organizes its inputs centrally. This paper contributes to the fishery management literature by exploring the economic consequences of this management option. It draws upon insights from the theory of the firm to elaborate on the costs and benefits of organizing fishing inputs collectively. A review of empirical evidence on the performance of fishery cooperatives indicates that the coop's centrally organized structure can facilitate coordination among harvesters of a shared fish stock; in a developing country context fishery coops often can fill gaps in governance.

Fishery cooperatives are not at all new. Communities in developing countries have formed cooperative-like organizations to manage fisheries historically, but their efforts were largely ignored by academic researchers and policy makers until recently. In the developed world, fishers have long organized themselves as cooperatives to gain market power when selling fish to buyers and to promote the industry's interests with government, but seldom to manage or protect the resources they exploit (Hannesson 1988, p. 5). Fortunately, both circumstances are changing and assigning management responsibility to fishery cooperatives is gaining acceptance as an option worth considering in both contexts.

Fishery cooperatives as a management option: Overview

Among rights-based fisheries management approaches, ITQs are regarded by many as the 'gold standard' and with good reason. Where applied, they have been shown to end wasteful races to fish, economize on effort, raise the unit value of the catch and promote better conservation. 'Where applied' is an important qualifier, however. At present they are used in only twenty-two fishing nations, mostly in developed countries, and account for at most one-fourth of the global catch (Arnason forthcoming). In developed countries implementation often is slowed by disagreements over distributing catch rights across fishers with diverse skills and catch histories. The list of impediments is generally longer in developing countries for reasons linked to governance. ITQs place heavy demands on the host country's government to set the total allowed catch (TAC); to distribute the TAC among individuals; to monitor individual catches and punish quota violators; and to keep records on quota trades and ownership. Placing government in charge of these tasks when the rule of law is not well established can invite corruption.

Assigning harvest rights to user groups to manage as they see fit can make such problems easier to solve. In developed countries the political entanglements that can plague distributing initial rights among individuals often can be reduced by letting a well-defined user group solve this problem internally, rather than dictating the allocation from the top down (Sullivan 2000; Criddle and Macinko 2000). In developing countries, experience has shown that harvester groups assigned exclusive access to a resource often can manage monitoring and enforcement effectively, tasks government may not perform well when it is not tightly bound by the rule of law (Deacon 2010). Assigning rights to groups may also make it easier to internalize externalities among harvesters. Even with ITQ management, competition for the best fishing sites can be inefficient and free rider effects can block the stewardship of stocks and provision of public good fishing inputs (Costello and Deacon 2007). Overcoming these collective action problems is arguably easier when rights are held by an exclusive group rather than by individuals (Grafton, *et al* 2006). Group assignments need not be made by government; if individual rights-holders can contract with one another, groups can form voluntarily.

The term ‘fishery cooperative’ is used broadly here to denote an association of harvesters that collectively holds rights to control some of all of its members’ fishing activities, regardless of whether the association’s structure satisfies the legal definition of a coop.¹ The terms fishery cooperative and harvester association are therefore used synonymously. Fishery cooperatives formed entirely for marketing purposes are excluded in order to focus on management functions. Deciding whether a group of fishers should be deemed a coop is not entirely straightforward, especially in developing countries where associations can be informal and contracts are uncommon. Our working criterion for a coop is that the group collectively controls some aspects of each member’s fishing effort. Coops and TURFs often blend together, as when a coastal community claims exclusive rights over a marine resource and forms an association to manage it in the community’s interest. The conceptual distinction, often blurred in practice, is that TURFs claim resource ownership on a spatial basis, whereas coops contractually control the actions of members.

Fishery ‘co-management’, an arrangement whereby users and government share management authority in some fashion, is sometimes seen as a distinct management strategy, but again differences between approaches often are matters of degree than absolutes. For example, a fishery cooperative may rely on governments to legitimize and possibly enforce the coop’s exclusive right to use a resource, or government may impose fishing restrictions beyond what the coop requires, e.g., on the total catch or permitted gear. While acknowledging government’s role, such arrangements will be

¹ A cooperative is legally defined as a business organization formed and operated for the benefit of the individuals it serves. Typically, the coop’s members control its actions via some sort of democratic process.

included under the fishery coop heading if the cooperative exercises substantive collective control over its members' actions.

To set the stage for what follows, Section 2 provides descriptive information on what functions fishery coops perform. Cooperatives amount to contractual agreements in which otherwise independent agents cede rights over certain actions to a manager, who coordinates them to achieve a collective objective. Because the 'firm' shares the same structure, theories of the firm are reviewed in Section 3 for insights on the emergence, scope and functions of cooperatives. Sections 4 and 5 describe the often different roles fisheries coops play in developed versus developing country contexts, facilitating the resolution of externality and free rider problems in the former and filling in institutional gaps in the latter. Sections 6 and 7 describe prominent fishery cooperatives in developing and developed country contexts and Section 8 concludes.

The number of fishery cooperatives operating worldwide is unknown, but it is surely vast.² Unfortunately, published studies exist for only a very small fraction of these and it is plausible that the coops chosen for study by researchers are among the more successful. This important caveat should be kept in mind when reviewing the case study evidence to avoid drawing the unsupported conclusion that assigning management to coops always adds value. A second caveat is that this review is US-centric to a degree, and developed country-centric to an even greater degree, despite the fact that fishery cooperatives apparently can and do play a greater role in the developing world than the developed world. This mismatch is due to the availability of information on the structure and function of fishery coops and empirical results on their performance.

An important conclusion is that different management instruments, ITQs, TURFs and coops, often can be used together simultaneously to achieve goals that no single management format could achieve. Searching for *the* best management instrument in a given situation can be misguided.

2 What are fishery cooperatives and what do they do?

The motive to form a cooperative is the prospect that collective action by a group that faces similar circumstances can improve on the outcome that would result from independent, non-cooperative behavior. In developed countries the primary motive historically has been enhanced market power in the group's sales or purchases. A 1980 survey of 70 active fishery cooperatives in the U.S. found that virtually all were involved in marketing the catch or securing inputs such as fuel,

² At least 400 operate in Bangladesh; Japan's coastal fisheries are managed by over 1,700 spatially defined user groups, mostly organized as cooperatives (Uchida and Wilen, 2005); an international association of fisheries cooperatives reports that over 18,000 such organizations operate in India (www.icfo.coop/publications.php).

dock space, gear and insurance for members; none were involved in managing the resource (Garland and Brown 1985). Since 1990 several prominent fishery coops (or harvester associations) have been formed in the U.S., New Zealand, Canada and other developed countries, principally to achieve resource management or conservation goals (Grafton, *et al* 2006). Plausible reasons for this shift in emphasis are declining fish stocks, the failure of government to provide effective responses and the move to extend national jurisdictions into the oceans. While marketing often remains a relevant concern, these organizations are increasingly focused on eliminating excess capacity, slowing the rate of fishing, enhancing product quality and coordinating fishing effort.

In developing countries, fishery cooperatives often fill gaps in governance by providing basic 'rule of law' and regulatory functions such as monitoring and enforcing access rules, imposing basic regulations such as limits on catch size or allowed gear, and mitigating conflicts among users. Instances of developing country fishers forming associations to solve congestion or gear conflict problems on the fishing grounds and agreeing on rules to coordinate access to favored fishing sites are common in the case study literature (Schlager 1994). Success often depends on support from a third party authority such as a local government, however, to facilitate or at least legitimize exclusion of outsiders (Berkes 1986, 1992).

Table 1 presents evidence from case studies of 67 fishery cooperatives around the world. The key criterion for inclusion is the existence of published research that gives sufficient information to characterize a coop's actions, so the sample of coops is not random. Nevertheless, the patterns are revealing. Fully eighty percent of the developed country organizations coordinate members' harvest activities. In developing countries, seventy-two percent of coops take on one or more regulatory functions normally carried out by government in developed countries, including controlling catch, limiting the size of fish caught, restricting gear, and limiting fishing areas. The most common activity among developing country coops is enforcement, another function generally assigned to government in developed countries. Another group of actions amounts to provision of public good inputs: restocking, habitat restoration and research support. Marketing is common among both income groups, but not predominant.

3 Cooperatives and the theory of the firm

The word *cooperative* has two meanings. It can be used as a noun to refer to an organization formed by independent parties to pursue common interests. Members of a cooperative cede some decision making rights to the coop's management, which allocates resources to promote the members' collective interest. *Cooperative* can also be used as an adjective to indicate a willingness to

act in conjunction with others toward a common purpose, e.g., as part of a team. Both meanings figure prominently in the theory of the firm. Workers who join a firm cede rights over how their labor will be used in return for payment, and the firm then directs the labor of all workers hierarchically to achieve the firm's goals. Firms also enable inputs to work noncompetitively as members of teams. The theory of the firm may therefore shed light on the scope and function of cooperatives. One feature of fishing as an economic activity magnifies the potential gains from coordinating inputs centrally: all fishers share the use of a key input, the stock of fish, and the stock's condition depends on the actions of all users.

The functions and structure of the firm

In descriptive terms, economists have long viewed the firm as a collection of contracts between inputs and management that is structured to enable a hierarchical allocation of resources (Holmstrom and Tirole 1989). Coase (1937) saw this structure as an adaptation that minimizes the transactions costs that would plague attempts to organize production entirely by separate contracts and bilateral transactions among independent inputs. Williamson (1979) added content by emphasizing that contracts are always incomplete because future contingencies cannot be fully anticipated. He pointed out that incomplete contracts create incentives to be opportunistic, i.e., to exploit unspecified contingencies to one's own advantage. Both Coase and Williamson saw the solution to these problems as 'integration', vesting control of the required inputs with a single agent.

This did not fully explain how integration eliminates the scope for opportunism, however. Grossman and Hart (1986) addressed this problem by drawing a sharp distinction between two forms of contractual rights: specific rights, assignments of control explicitly spelled out in contracts, and residual rights, which assign control over functions not delineated in specific contracts. When future contingencies cannot be exhaustively spelled out, opportunism can be suppressed by assigning all residual rights to one party, the firm's manager or owner, whose compensation depends on the net receipts of the enterprise. The organizational structure of the firm, an entity formed to hold residual rights, accomplishes this (Grossman and Hart 1986).³

Organizing production in firms can facilitate team production and this can expand production possibilities (Hamilton, Nickerson and Owan 2003). If the contributions of team members cannot be separately observed, however, rewards must be based on their joint output; each input then has an incentive to free ride on the effort of others. Starting with Alchian and Demsetz (1972) theoretical treatments of team production have focused on this free rider problem, while paying scant attention

³ Grossman and Hart (1986) also examine how the identity of the party assigned residual decision rights affects efficiency and how the limits of integration, i.e., a firm's size or scope, are determined.

to the gains from team production. Nevertheless, firms commonly organize production in teams even when separable task assignment is possible indicating that productivity gains from teamwork often exceed the costs of free riding. Hamilton, Nickerson and Owan (2003) argue that team production can expand production possibilities due to skill complementarities, knowledge transfers and task specialization, and from the use of abilities such as communication, leadership and flexibility that play no role when tasks are entirely separate.⁴

Firms, fishing and cooperatives

A fishing firm's profitability depends critically on the condition of an input it shares with all of its competitors, the stock. Aspects of the stock's condition that matter could include its total biomass, the average size of individual fish and their density at various locations. These aspects, in turn, depend on the combined actions of all harvesters: the amounts caught, gear used and spatial deployment of effort. Individualistic behavior will lead to rampant externalities among harvesting firms, as has been the case historically. If the stock's condition and the individual actions of fishers were observable and if links between actions and consequences were well known, bilateral contracts among harvesters could in principle restore efficiency. This solution can be dismissed as a practical possibility in most situations, however, due to transactions cost. Compounding matters, the links from actions to consequences may be poorly understood and the contracts involved would need to stipulate conditions that often are stochastic and unobservable. The logic that rationalizes the formation of firms suggests 'solving' this shared input problem by placing a single agent in control of (some aspects of) each harvester's fishing effort and then structuring payoffs to maximize the group's profit, e.g., forming a fishery coop.

The resource allocation problem in a fishery is simplified in an important special case: where profit depends on the stock's mass but not on other attributes. In this instance an ITQ policy that constrains the total catch and assigns transferrable shares of the total to individuals can achieve efficiency without hierarchical control. In many instances, however, the profit from harvesting a unit of the stock may vary over time and place even when stock is biologically homogeneous. This can arise from patchy stock distributions, spatial productivity differences, differences in proximity to ports or seasonal variations in price or cost (Cancino, Uchida and Wilen 2007). Such economic heterogeneity can compel wasteful competition for the most profitable fish, dissipating part of the

⁴ Empirical evidence from individual firms indicates that teamwork gains can be important. Hamilton, Nickerson and Owan (2003) found substantial productivity gains in a garment manufacturing firm that switched from individually assigned tasks and piece rate payments to team production with compensation based on the team's productivity. Hansen (1997) found that basing pay partly on a group's productivity significantly raised productivity by in a financial sector firm.

fishery's potential rent even with ITQ management (Costello and Deacon 2007). A fishery cooperative organized to coordinate the actions of all users can potentially eliminate such losses.

Hierarchical organization can also facilitate provision of public good inputs by overcoming free rider problems. For example, when searching for fish concentrations part of an individual's search effort will generally be redundant because a particular patch may already have been searched by others. Efficiency requires that all harvesters share such information because it is a public good, but no individual has an incentive to do so. Informal agreements may suffice for small scale public input provision, as when a small number of independent shrimp and squid fishers agree to share in the cost having a single boat deploy lights that attract fish to the group. Informal arrangements do not suffice for more extensive fishery-relevant public good problems, however, such as investments in stock enhancement, effort to deter poachers and installation of fish aggregation devices. Forming a harvester association can potentially reduce the transactions costs associated with solving these coordination and public good problems.

The public good discussion suggests that using management tools in combination may achieve efficiencies no single instrument can obtain. For example, when ITQs exist but are not fully efficient due to collective action problems, forming a coop among ITQ holders could facilitate the necessary coordination. Similarly, a coop that collectively invests in stock enhancements might use an internal ITQ instrument to allocate harvests among members efficiently. Because fishery coops function by acquiring decision-making rights from individual fishers, it follows that the outcomes they can achieve depend on the regulatory regime. With open access, a coop formed to invest in stock enhancement would be pointless since non-joiners or new entrants would free ride on its efforts. In a limited entry fishery with an aggregate catch limit the scope for collective action is greater, but still incomplete. For example, a coop consisting of a subset of permit holders could coordinate actions to minimize congestion and gear conflicts, but would be unable to capture all gains from enhancing the stock. The scope for collective action is even greater in an ITQ fishery, but still incomplete unless all quota holders are members.

Sharing the catch to mitigate over-fishing

When individuals produce separate outputs but then are paid shares of the group's aggregate production, each has an incentive to free ride on the efforts of others, leading to under-production. This suggests that the over-exploitation characteristic of common pool fisheries might be solved or mitigated if users pool their catches and then allocate each member a share of the total. Several authors have examined this possibility or closely related options; see Uchida and Wilen (2005), Heintzelman, Salant and Schott (2009), and Kaffine and Costello (2011). Heintzelman, Salant and

Schott (2009) considered this management approach in the context of a two stage game in which players are identical and the number of harvester groups, which they call partnerships, is set exogenously. In the first stage individuals first decide which partnership to join; in the second stage each individual chooses a level of harvesting effort. They demonstrate that the rent maximizing allocation can be implemented as a subgame perfect Nash equilibrium. Stability of the first stage assignment of individuals to partnerships cannot be guaranteed unless there are productivity advantages from team production, which links to the empirical evidence described earlier. Uchida and Wilen (2005) extend the analysis to incorporate the added market power harvesters can achieve by forming groups, which then reduce harvests to get a monopoly price. Kaffine and Costello (2011) examine a related but distinct problem: using a *profit* sharing rule to internalize externalities between spatially separate patches of a common pool resource that are connected by migration. Because profits are shared rather than outputs, the result is partial unitization of the resource.

The output-pooling solution described by Uchida and Wilen (2005) and Heintzelman, Salant and Schott (2009) requires that individuals submit their entire catch to the group and that each is free to choose individual harvesting effort. If a harvester group can monitor the catches of individual members, however, it has the ability to control over-fishing by assigning catch quotas directly. It is reasonable to ask why a group would overlook this direct approach in favor of a strategy based on encouraging shirking.

Empirical evidence on the practice of catch sharing to offset common pool over harvesting is largely anecdotal. Platteau and Seki (2000) cite evidence from a Japanese glass-shrimp fishery that seems to function in this way, but other Japanese sharing arrangements are structured differently. Uchida (2004) reports on a fascinating case of coordination and catch pooling in Japan's *sakuraebi* fishery. Catches are pooled among fishery association members, but the intent in this case is to even out deliveries to various processors in order to regularize their production rates. Vessels are based at different ports and without pooling deliveries to individual processors would depend on which vessel had the best success on a given day. Some fishery cooperatives in Bangladesh collect a share of revenues from each member's catch, but these contributions represent a tax the members pay to support the coop's collective activities, e.g., stock enhancement and monitoring against poaching. The partial pooling of revenues in some of Chile's *loco* fishing cooperatives appears to serve a similar purpose (Uchida and Wilen 2005). In these three examples at least, catch sharing apparently is not intended to induce 'effort shirking' by coop members.

4 **Developed country cooperatives: Narrow and broad efficiency considerations**

Traditional command and control fishery management in developed countries encouraged entry and led to excess fishing capacity. Attempts to constrain effort by closing seasons caused races to fish, lowering catch quality due to rushed operations and making fishing unnecessarily dangerous. The most obvious reason to assign catch rights to a harvester group is to solve these narrow harvesting efficiency problems. Collective action can potentially address broader resource allocation problems as well, however, such as stock enhancement and habitat protection. To succeed in any of these endeavors a group must be able to reach informed, self-interested collective decisions and monitor and enforce compliance by its members. While these tasks are by no means trivial, they are similar to the management problems an ordinary firm solves in any line of business.

Narrow efficiency gains

The term narrow efficiency gain refers to actions that reduce harvest cost or increase catch value. Eliminating redundant capacity, ending races to fish and concentrating effort among the most efficient harvesters would qualify as cost reducing examples. So would provision of public good inputs, such as information on stock concentrations, investments in shared infrastructure and efficiency enhancing coordination of fishing effort. The first set of actions, often labeled ‘effort rationalization’, can be accomplished by instituting rights to the catch and assigning them either to individuals or to groups. The second set requires collective action and this may be facilitated by assigning rights to a group. Our focus here is on the second set.

Coordinating effort deployment over space can raise efficiency when variations in proximity to ports or patchiness of stocks cause unproductive races to hot spots (Cancino, Uchida and Wilen 2007). Coordinating effort over time can be beneficial when seasonal variations in price or cost cause individuals to harvest prematurely (Costello and Deacon, 2007). Using ITQs to regulate effort generally will not capture these benefits unless individual quota holders form agreements with one another, i.e., form an organization such as a coop. In principle, ITQs delineated by the time and place of catch could solve many of these problems, but this solution seems impractical except in special cases.

To illustrate how coordinated timing can raise the value of a given catch, imagine a stock that inhabits offshore patches at various distances from the port where fishing vessels and processors are based and suppose the exvessel price varies predictably over time during the season. To maximize profit from harvesting a fixed total quantity, each patch should be harvested on the date its value peaks, and patches should be fished in order of peak value from highest to lowest until the total

catch target is reached. Uncoordinated behavior by individuals will not generate this result, even under ITQ management. No fisherman will be content devoting a unit of quota to a low profit patch when the same ITQ could be used for a higher profit patch. High profit patches will therefore be over-subscribed. Under plausible conditions, individuals will race to harvest these patches before the time of peak profit in order to ensure they do not lose access. This dissipates some or all of the differential value high profit patches can generate (Costello and Deacon 2007). Species such as salmon that migrate can encounter a similar problem if their value changes predictably along the migration route. It can be individually rational to fish the stock before it reaches the location of maximum value in order to gain access before other harvesters have diminished it (Deacon, Parker and Costello 2008, 2010). While the necessary coordination might in principle be achieved by bilateral contracting, the transactions costs seem prohibitive. A harvester association represents an institutional platform that could potentially achieve these coordination gains with lower transactions costs.

Information on the location of fish concentrations is a public good input. Making it available to all harvesters can reduce costs for all, yet traditional fishing regulations, including ITQs, make it individually rational to conceal such knowledge. Cost-reducing public good inputs are fairly common in fisheries and all suffer from the same under-provision problem. Examples are shared services for locating fish concentrations, shared devices for aggregating fish and shared port infrastructure. All suffer from free riding under most management regimes, including ITQs. On the value enhancing side, it may be collectively profitable to set a quality standard for the catch and achieve it by slower fishing and more careful handling. No single harvester has an incentive to take the necessary steps, however, if the entire catch will eventually be sold as an undifferentiated product. Adhering to a quality standard for a fishery requires participation by all harvesters. Again, the presence of a harvesters' organization arguably makes such cost reducing or value enhancing collective action problems easier to solve.

The introduction of ITQs in mixed species fisheries that use non-selective gear has created novel collective action opportunities. When gear is non-selective, individual fishers risk making catches that could be financially ruinous because quota must be held or acquired for each fish caught. (ITQ implementation increasingly prohibits discarding fish to avoid these penalties.) The accidental haul problem is most acute when quota is assigned to overfished species, fish that are not valued commercially but are included in the quota program to achieve conservation goals. Individual fishers can spread the risk of a 'disaster haul' by combining quota allocations for high risk species into a pool, which then acts as a mutual insurance company by providing coverage for any member who experiences a run of bad luck (Holland 2010; Holland and Wiersma 2010). To be viable, however, a risk pool must set standards for precautionary behavior by members, requiring fishing practices that

minimize such risks. The end result is an agreement in which ITQ quota holders cede some of their property rights, e.g., regarding fishing methods and use of quota allocations, to an association in return for an insurance benefit. This specific case, including the formation of risk pools, is presently playing out in the U.S. West Coast groundfish fishery as it transitions from limited entry trawl fishing to individual catch quotas.

Broader efficiency gains

Ceding control over some harvest actions to an association can incentivize stewardship, actions that protect or enhance the stock all harvesters jointly exploit. Stewardship can include direct investments in stock enhancement, adoption of rules that minimize incidental mortality of juvenile fish, habitat protection or modification, research on the status of stocks and collective enforcement to deter poaching. While harvester associations may facilitate stewardship, they do not represent a magic bullet. If membership is voluntary there may be holdouts, and in any case the tasks of reaching agreement and carrying out collective decisions remain. Nevertheless, harvester groups in New Zealand, Canada, the U.S. and elsewhere have formed in recent years and are carrying out each of these tasks (Grafton, *et al*, 2006). Several examples are described in Section 6.

Other considerations

Recent experience suggests that assigning quantitative catch rights to a well-defined group, which then divides its allocation internally among members, can be easier than fixing an allocation among individuals at the outset. Implementation of ITQs often generates opposition from those who are most adept at racing if the initial quota allocation is egalitarian, yet a non-egalitarian allocation may be politically unacceptable to a majority of participants. Indeed, conflict over initial quota allocations has been cited as a key obstacle that slowed adoption of individual catch shares in the U.S. (Matulich, Sever and Inaba, 2000). Sullivan (2000) observes that assigning rights to a group and making the group responsible for dividing the catch among its members can ease the negotiation problem. Internal quota allocations among those who formed the U.S. Pacific Whiting Conservation Cooperative were negotiated in less than one day and deliberations for the far more complex U.S. Bering Sea pollock cooperatives were completed in less than two months (Sullivan 2000).

Opposition may be further diminished by making association membership voluntary, so individuals can self-select into the association or opt to fish independently under pre-existing rules. The regulator still must divide the TAC between sectors, of course, but with careful attention it may be possible to divide it so that individuals who were highliners under traditional regulation can avoid

losses by continue to fish independently (Deacon, Parker and Costello 2010). Having the right to opt out may also defuse claims that instituting any kind of catch share policy usurps the traditional right to fish. Voluntary membership will cause individuals to self-select into the two sectors, however, which can limit efficiency gains (Deacon, Parker and Costello 2010).

Sidebar: Treatment of cooperatives under U.S. antitrust laws

In the U.S. the Sherman Act seeks to protect consumers from monopoly practices by prohibiting contracts, combinations and conspiracies that restrain trade. Unrestrained competition for a common pool resource can, of course, harm consumers by over-exploiting fish stocks and reducing supply or threatening sustainability. Conservation and antitrust policy can therefore work at cross purposes. U.S. courts recognize that collective arrangements among suppliers can benefit consumers in some circumstances and have granted numerous exemptions on that basis, e.g., to Major League Baseball (Yandle 1998, p. 13). When there are positive and negative effects the courts often balance the two under the ‘rule of reason’ standard. The resulting informational burden can be severe, however, prompting the courts to judge certain types of behavior as *per se* illegal—presumptively unlawful without need for further study. All horizontal agreements among commercial fishermen to restrain catches have been regarded in this way (Adler 2004, p. 22). Despite limited recent recognition that fishermen’s associations can enable conservation, U.S. courts have routinely found that these organizations violate antitrust laws (Carden 2011, p. 42; Adler 2004, p. 26).

The Fishermen’s Collective Marketing Act (FCMA) provides some relief from antitrust prosecution for fishermen seeking to harvest or market their catch collectively (Adler 2004, p. 39). The courts have interpreted FCMA as applying only to groups of small, non-integrated producers, however (Sullivan 2000, p. 3). Non-integration is an important limitation because it denies a potential strategy for controlling the catch—including processors in harvesting agreements and stipulating that they restrict amounts bought from members and refuse to buy catches from non-members. The courts have treated such exclusionary practices as boycotts and selective ‘refusals to deal’ and judged them to be *per se* antitrust violations (Adler 2004, p. 23).

Fishery cooperatives have been prosecuted for antitrust violations in several prominent court cases. While these associations often were formed for pecuniary gain rather than conservation, they generally did reduce pressure on stocks (Adler 2003, p. 34). The most famous of these is the Gulf Coast Shrimper’s and Oystermen’s Association (GCSOA), an organization of harvesters formed in the 1930s to control prices and limit catches along the Mississippi Coast of the Gulf of Mexico. GCSOA worked by negotiating contracts with processors that set minimum prices for shrimp of various size grades and prohibited processors from buying from non-member harvesters. GCSOA

also encouraged its members to refrain from selling to processors not in the agreement. The Association's pricing policy purposefully promoted conservation by postponing each year's effort until late in the season, which deterred harvests of under-sized shrimp (Johnson and Libecap 1986).⁵ Nevertheless, the courts ruled that these practices violated antitrust laws.

U.S. antitrust authorities are becoming more receptive to fishermen's cooperatives formed to promote efficiency and conservation, particularly in fisheries already regulated by a TAC (Adler 2004, p. 41; Sullivan 2000). The Pacific Whiting Conservation Cooperative (PWCC), formed in 1997, sought to divide the existing TAC among fishery participants. The Department of Justice granted approval partly because PWCC agreed not to reduce catches below the TAC or to practice noncompetitive marketing (Adler 2004 p. 43; Sullivan 2000). PWCC actually raised product supplied to consumers by increasing product recovery from the fixed TAC. Shortly after PWCC formed a group of catcher-processor vessels in the Bering Sea and Aleutian Islands pollock fishery petitioned to form a coop with a dedicated share of the existing TAC. Sidestepping opposition from fishery regulators, the group received statutory permission from the 1998 American Fisheries Act. Eventually, two such cooperatives were formed. In both cases, the proponents solicited an antitrust review by the Department of Justice under its Business Review Procedure prior to coop formation (Sullivan 2000). This provides some short run assurance against anti-trust prosecution, but it does not guarantee permanent immunity (Adler 2004).

Applying the rule of reason to balance resource conservation, which clearly is in the public interest, against the threat of monopoly misbehavior from harvester associations would seem to provide an avenue for coops gain judicial approval. The scales presumably should tip in favor of conservation if the stock involved is depleted and if existing regulations already limit the total catch. Nevertheless, no antitrust judgments during the last 30 years have regarded conservation issues as salient (Adler 2004, p. 60). The obvious alternative is a statutory fix, e.g., broadening the FCMA exemption to allow agreements to control entry and restrict catches when the demonstrable effect is to conserve depleted fish stocks.

⁵ Libecap (1989) reports that GCSOA's minimum price for larger shrimp tended to be set below prevailing market prices, implying no adverse effects on consumers. According to Scott (1993) GCSOA succeeded for a while in regulating sizes and reducing the catch, but was unable in the long term to deter entry or fully control its members' harvests. Libecap (1989), Adler (2004, p. 4) and Carden (2011, p. 54 ff.) also describe the case of Monterey Sardine Industries, which the courts ruled against in 1941. The defendant was a cooperative association of fishing boat owners that had set prices and contractually required canners to purchase fish exclusively from the association. The court considered the question of conservation benefits, but ruled that any conservation ends that may have been served did not free it from provisions of the Sherman Act. Another famous case involved Local 36 of the International Fishermen and Allied Workers of America, which operated in Southern California during the 1940s. The courts found the union's practice of fixing prices and use of boycotts, threats and picketing to exclude nonmember fishermen to be *per se* violations of the Sherman Act. See Carden (2011, p. 55) and Adler (2004, pp. 30-31).

Anti-trust concerns are not a barrier to harvester associations in the European Union, where price fixing by fishermen's organizations is actively supported by government rather than prohibited (Hannesson 1988, p. 18). These Producers' Organizations are empowered to reduce quantities going to market if prices fall below designated levels, with compensation paid to fishermen whose catch is withdrawn or whose boats are idled.

5 Coop functions in developing countries

Coordinating effort and facilitating public good input provision, roles played by developed country coops, largely carry over to a developing country context. In addition, developing country coops often take on functions that government would perform elsewhere. Notwithstanding counter-examples, developing countries suffer more often than developed countries from lax rule of law and ineffective delivery of public goods (Acemoglu, Johnson and Robinson 2001, Bueno de Mesquita *et al.* 2003). Such gaps in government performance can lead to incomplete regulation of common pool externalities, weak enforcement of any regulations on the books and corruption in the application of government's management authority. Gaps in governance also affect the choice of management strategies. For example, ITQ management makes heavy demands on government for assigning individual catches, monitoring details of fishing activities, and keeping records to match catches with quota holdings; unsurprisingly, ITQs are rare in developing countries (Peru and Chile are exceptions), but have become prominent in New Zealand, Australia, Canada, the U.S., Iceland and elsewhere in Europe.

Key functions for any management system are monitoring and enforcing how and by whom the fishery is used. When legal and regulatory institutions function well it is advantageous to rely on government to perform these tasks. When the rule of law is not well established, however, placing government in charge of these activities may invite corruption. An attractive alternative in these circumstances is to place user groups in charge of enforcement. A user group interacts with the resource regularly and is well positioned to detect violations (Jentoft 1989). A user groups also stands to benefit if enforcement is effective and the resource is well managed, so interests and authority are aligned. This benefit accrues collectively to all members, however, so the user group must overcome the incentive each member has to free ride on the enforcement effort of others. Case study evidence from community managed irrigation systems and forests indicates that user groups can effectively carry out the mechanics of monitoring and enforcement (Tang 1994; Agrawal 1994). Government and the court system still play a pivotal role, however, in legitimizing a coop's right to exclusive control of the resource (Berkes 1986).

Developing country cooperatives frequently engage in coordinating fishing effort to minimize conflicts on the fishing grounds. Evidence from a meta-analysis of 30 developing country fishery coops found two prominent forms of coordination: allocating access to favored fishing spots among members in order to avoid conflicts or races, and setting rules on the types of gear that are permitted for fishing in different locales in order to reduce congestion and interference (Schlager 1994). A coordination rule adopted to manage an estuarine fishery in Valenca, Brazil has become somewhat famous. At one time competition for favored fishing sites led to interference during peak fishing times and physical violence, reprisals and property destruction were not uncommon. Over time a set of rules evolved that divided the fishing area into zones, with gear types assigned to each and a reservation system to assign access. Fishermen met at a local bar to announce intentions over fishing spots; if more than one chose the same site on a given day, access was decided by drawing lots. An informal rule of the system is that all participants are expected to punish violators.

6 Prominent developed country coops

Empirical research on the performance of fishery cooperatives is scarce and the few studies that exist focus on coops in the U.S., New Zealand and a few other countries. Prominent cooperatives for which such evidence is available are described in this section, taken up in rough chronological order of when they were formed. The highly coordinated shrimp fisheries in Japan described by Uchida (2004) are not covered as they are spatially based and regarded as TURFs.

Cooperative harvesting agreements in New Zealand

New Zealand's fisheries have been managed by ITQs since 1986 and user-based groups, known as management action committees (MACs), have become important in coordinating the behavior of quota owners. One group comprised of quota holders who dive for *paua* (abalone) near Christchurch has coordinated its members' actions since 2004. Members of this MAC share information on stock locations and diving conditions and spatially coordinate the group's fishing to avoid over-fished areas. The group also adheres to self-imposed size limits that are more restrictive than regulators require, trains divers to reduce incidental mortality and reseeds depleted fishing areas following harvests (Costello and Deacon 2008).

The Challenger Scallop Enhancement Company (CSEC), an enterprise formed from 38 individual quota holders under New Zealand's ITQ system, is a well-known example of user-based management (Arbuckle and Drummond 2000, Townsend 2005). While the Ministry of Fisheries

originally maintained a catch limit, Challenger typically constrained actual catches at lower levels to conform to what it considered to be sustainable yields. Challenger also invests in stock enhancement by reseeding habitat after harvests and funds research on stock abundance. Challenger coordinates harvests across areas based on information it collects on the spatial distribution of stocks. The company's operations are financed by fees the quota holders levy on themselves by majority vote. An indicator of Challenger's success is that it is now responsible for most management decisions in the fishery, subject to government approval.

The Pollock Conservation Cooperative

The Bering Sea pollock fishery is North America's largest by volume and targets spawning aggregations of high valued roe-bearing pollock during the late winter and early spring and more dispersed stocks in the late summer and early fall. Traditionally, separate fisheries operated for offshore and near shore stocks. In the late 1990s during a moratorium on U.S. ITQ systems, a group of participants operating large, offshore catcher-processor vessels petitioned the North Pacific Fisheries Management Council to form a cooperative with a dedicated catch allocation. The Council declined to apportion the TAC between competing groups, prompting the catcher-processor group to pursue a legislative solution. The result was the American Fisheries Act, which among other provisions gave Congressional permission for formation of the Pollock Conservation Cooperative (PCC) with a dedicated catch allocation; see Wilen and Richardson (2008), Sullivan (2000) and Criddle and Macinko (2000). Four of the PCC vessel owners were encouraged in their efforts by the success they had experienced in forming the Pacific Whiting Conservation Cooperative in 1997.

Prior pollock regulation assigned separate aggregate catch limits to offshore and onshore sectors and enforced both with season closures. Predictably, this caused races to fish. The PCC shifted to a system of individual quotas for members, based largely on historic catch shares, and this led to changes in fishing practice (Wilen and Richardson 2008). First, fishing capacity was reduced to roughly one-half of the vessels originally fishing; some vessels left the industry due to a buyout program and others through transfer of catch quota to other operators. The remaining boats slowed the rate of fishing, causing the season length to roughly double. Catch per haul and hauls per day both dropped, allowing more careful harvesting. Coop formation also enhanced coordination between catching and processing activities. Under the former system, success on the harvesting side of an integrated catcher processor depended on the rule of capture, encouraging a harvesting race, while processing success depended on careful handling of a given catch to maximize its value. Typically these activities were not well coordinated even within a single integrated enterprise. This situation changed for the better when PCC was formed, causing product recovery rates to rise. PCC

participants also fine-tuned the location, timing and method of fishing to target valuable roe-bearing females. Econometric examination of the resulting efficiency effects found that the PCC's policies raised revenues due mainly to shifts in the use of variable inputs (Morrison-Paul, Torres and Felthoven 2009).

The Chignik Sockeye Salmon Cooperative

In 2001 the Alaska Board of Fisheries agreed to allocate a portion of the 2002 catch from the Chignik sockeye salmon run to a voluntary fishermen's cooperative. (Deacon, Parker and Costello 2008, 2010 and Knapp 2008 examine this case in detail.) The fishery, located on the Alaska Peninsula, formerly operated under limited entry with season closures, which resulted in excess capacity and a race to fish. The goals stated in forming the coop were to enhance harvest efficiency and improve product quality through more careful handling. The State allocated the coop a portion of the run commensurate with the number of permit holders who joined, while allowing non-joiners to fish independently subject to a season closure. Because salmon migrate steadily during the season, the regulator could divide the overall stock into separate portions for the two groups by allowing them to fish at different times.

The cooperative operated during the 2002-2004 fishing seasons and achieved efficiencies in several ways. It concentrated effort among its most efficient harvesters, roughly one-third of the membership, which slowed the rate of fishing. The average price paid to harvesters in this fishery was abnormally high during years the co-op operated, which is consistent with more careful handling and higher quality catch (but also may reflect enhanced market power). The coop achieved coordination gains by sharing information among members on stock locations, providing shared inputs and directing its members' effort over space and time (Deacon, Parker and Costello 2008, 2010). Quantitative evidence on efficiency gains comes from license values, which were one-third higher in Chignik while the coop operated than in comparison fisheries or in the Chignik fishery during non-coop periods. The Alaska Supreme Court declared the coop illegal after 2004, ruling that the practice of allowing non-fishing members to reap fishery profits violated existing law. The lawsuit precipitating this judgment was filed by two high-skill independents who felt disadvantaged by the State's rule for dividing the allowed catch, vividly illustrating the importance of engineering policy changes to avoid making some stakeholders worse off.

The New England Sector Allocations

Overfishing in the New England groundfish fishery became acute in the 1980s. In 1991 environmental groups filed suit against the National Marine Fisheries Service (NMFS) and eventually prevailed in court. The regulators attempted to remedy the problem by controlling effort through a vessel buy-back program, a moratorium on permits, days at sea restrictions, trip limits and area closures. Landings and fishing mortality rates continued to trend upward, however, due partly to the presence of idle licensed capacity that was reactivated when the new controls were imposed (Holland 2007). This dismal performance prompted a second lawsuit, also successful.

The NMFS response again focused on effort controls, but added an innovation by allowing groups of permit holders to form sectors and petition for dedicated catch allocations for individual species. This amounted to a set of group-based quotas linked to each groups' catch history. A sector could largely manage its members' effort as it saw fit, so long as the group's allocation was not exceeded; in principle, a sector could avoid effort controls entirely by holding allocations for all controlled species. Paralleling Chignik, sector membership was voluntary and non-joiners fished competitively under the prior regulations which included effort controls, a group-wide TAC and a season closure. The first two sectors to form were the Georges Bank Cod Hook (GBHS) and Georges Bank Cod Fixed Gear Sectors (GBFS) and both adopted practices that limited their initial success. Both acquired allocations for some species but not all, and were therefore bound by effort limits that applied to unallocated species. They initially used internal catch allocation rules that resulted in a muted form of competitive, derby-style fishing. These flaws were scheduled for subsequent reform, however (Holland 2007, Crawford 2009, Holland and Wiersma 2010).

Early evidence indicates that these sectors have achieved significant economic gains (Crawford 2009). Revenues in the GBHS increased by seventy-five percent after the sector began operating and roughly doubled in the GBFS. Harvests by both sectors have remained well below their allocations and both have funded monitoring programs that are stricter than non-sector vessels face. Ecological performance has improved as well, due in part to the selective gear these sectors use. Discard rates for cod reported in the second year of GBHS operations were roughly one-fourth of the fishery wide average and discard rates for other species were modest (Crawford 2009). Data from GBFS indicate that its members' cod discards have been less than one-fourth the rates observed in the rest of the fishery. As of 2011, 17 sectors had formed and were allocated ninety-eight percent of the groundfish catch limit; these sectors were largely free from effort controls (Kitts, *et al* 2011). A large number of boats remained in the open access sector and competed for the remaining two percent of the allowed catch.

Other developed country fishery cooperatives

A fishery cooperative has managed Norway's Lofoten Islands arctic cod fishery for over 100 years (Jentoft 1989). For centuries the fishery's natural productivity had led to crowding and gear conflicts. In the 1890s the government sought to resolve these problems by delegating legal responsibility for management to committees of fishermen formed to represent different gear types. The committees were authorized to set fishing times, decide which gears are allowed on specific areas, and fix the sizes of gear-specific fishing zones. The committees enforce their own rules, supported by explicit government authority, and rule violations are reported to be rare. Descriptive accounts indicate that the system has worked well (Jentoft, 1989).

Several Canadian fisheries have been placed under management by harvester associations. Permit holders in British Columbia's geoduck fishery successfully petitioned the government for a system of individual catch quotas (Townsend, 2005). The quota holders formed an association which monitored and enforced quota compliance, engaged in spatial management of effort and funded research on stock enhancement. A second Canadian experiment in coop management was tried in the 1970s in the Bay of Fundy herring fishery, but eventually failed (Jentoft, 1989). Declining fish stocks led to general dissatisfaction and conflicts among members. Critically, dissatisfied members were able to leave the coop and form separate associations with separate allocations. Eventually, government abandoned certain enabling features and the coop foundered. A third Canadian example comes from its enterprise allocations in which government has assigned shares of the overall quota for offshore scallop harvests to nine firms. After this system was established the quota holders proceeded to consolidate fishing effort. They also coordinated actions in ways that benefit the group collectively, such as limiting harvests of under-sized scallops and supporting fishery research.

A *de facto* sector allocation system was established in the UK in connection with that country's entry into the European Economic Community (EEC) (Jentoft, 1989). Harvester associations initially established to organize fish sales and to administer EEC price supports were granted separate catch allocations in 1984. The associations distributed catch limits among members and took over responsibility for forming and administering rules for deploying effort and enforcing catch limits. Descriptive accounts indicate that this system has worked well, notwithstanding conflicts between associations (Jentoft 1989).

A user-implemented management regime was successfully introduced in the Yaquina Bay, Oregon herring roe fishery (Leal 2008). The pre-existing regulatory regime was limited entry with an aggregate catch limit enforced by season closures. The nine permit holders in this fishery obtained regulatory approval to divide the allowed catch equally, essentially forming a privately negotiated ITQ

system. This ended a pre-existing race to fish. The group jointly held a tenth catch allocation which was used to support collective actions benefitting the group, such as research on stock assessment.

The fishery cooperatives that manage Japan's coastal fisheries are among the most extensive worldwide, numbering over 5,000 according to Jentoft (1989). Their role was legally formalized in 1901 and over time they have assumed responsibilities for formulating and executing fishery management policy and for actions related to marketing. The Japanese case is discussed elsewhere in this issue.

7 Developing country examples

While fishery coops are widespread in developing countries, empirical evidence on management success is scarce. Fishery cooperatives in Mexico, Bangladesh and Turkey are reviewed as examples, selected mainly because they have been examined empirically and published research is available. In each case the fishing rights granted to cooperatives has a spatial dimension, so they have elements of TURFs.

Mexico's lobster fishing cooperatives in Baja California

Nine fishing cooperatives harvest a single stock of red lobster (*Panulirus interruptus*) along the west coast of Baja California, Mexico under government concessions established in the 1930s (Scientific Certification Systems, Inc. 2004; Costello and Kaffine 2008). Critically, each was granted exclusive access to lobster, abalone and other species within a delimited area. Each coop submits an annual pre-season plan for approval specifying the number of fishermen, boats and traps to be deployed. Each coop also takes responsibility for settling disputes among members and for ensuring that members comply with the plan's conditions. The coops contribute funds to partially cover the government's enforcement costs. While government nominally specifies closed seasons and size limits, the coops' management policies effectively constrain effort and catch. Government's role largely consists of limiting entry.

The coops appear to be economically successful, particularly in the case of lobster. The annual lobster catch, which is sold abroad in Asia and elsewhere, plausibly generates several million dollars in annual revenue for the 1,300 members. Success in managing abalone has been somewhat less impressive. Costello and Kaffine (2008) attribute the difference in performance to the fact that lobsters grow more rapidly than abalone and to the 20 year duration of coop concessions. They argue

that the coops rationally behave as if harvest rights are permanent for lobster, but not necessarily for abalone.

The lobster fishery's biological performance has been impressive. In 2004 it became one of the few fisheries in the developing world to be certified as 'sustainable' by the Marine Stewardship Council (MSC) (Scientific Certification Systems, Inc. 2004). Since 1988 catches have been stable and trends in catch per unit effort indicate that biomass has not fallen below maximum sustainable yield levels. The traps used in fishing are configured to allow escapement of sublegal fish and tangle nets are not permitted to avoid bycatch. Incidental mortality caused by lost or abandoned gear is considered minimal.

Freshwater fisheries in Bangladesh

Bangladesh has over 12,000 inland freshwater fisheries, occupying some 4.5 million ha. (Ahmed, Capistrano and Hossain, 1997). Some occupy open water bodies such as rivers and *beels*, natural depressions that collect water during the monsoon and expand and contract seasonally. Others exist in closed water bodies such as oxbow lakes, or *baors*, the remnants of meandering rivers; the latter are small, typically covering only 10-500 ha. (Ahmed, Capistrano and Hossain 1992, 1997). In water bodies that are naturally closed or can be closed by installing screens to prevent fish from escaping, it is common to release cultured fingerlings and raise them for harvest when mature (Thompson and Hossain, 1997). These fisheries are highly productive, yielding an estimated 40 kg./ha. per year and supplying a major source of protein for the population (Ahmed, Capistrano and Hossain 1997).

During 1950-1986 the government managed these fisheries by auctioning one- to three-year leases to the highest bidders (Murshed-e-Jahan, *et al* undated; Mustafa and Brooks 2008). The winning bidders tended to be landowners, money lenders, and local political elites. Typically, the lease holders allowed local harvesters to fish for a share of the catch, but did not restrict the catch or otherwise manage the resource. This reportedly encouraged short-term decision-making and denied stewardship incentives to those who actually exploited the resource (Murshed-e-Jahan, *et al* undated; Mustafa and Brooks 2008). An early policy shift toward community based management caused some fisheries to come under partial management by harvester associations known as Lake Management Groups (Murshed-e-Jahan, *et al* undated). According to Murshed-e-Jahan, *et al*, supply increased after local councils gained control, largely due to increased investment in fingerlings.

A community based fishery management (CBFM) project was implemented during 1994-1999 with participation from several NGOs, with the goal of shifting decision-making to local communities. A 5-year follow-on project was initiated in 2001 for an expanded set of fisheries with government support and additional NGO assistance. Under CBFM, community based organizations

largely were granted rights to manage the fisheries they exploited for an extended period. They were explicitly delegated responsibility for creating fish sanctuaries, restoring habitats and reintroducing depleted species. A statistical comparison of eighty randomly assigned CBFM sites and twenty control sites found that fish abundance (based on catch per unit effort) rose at CBFM sites relative to controls and that CBFM experienced the best gains in closed *beel* and river habitats (Halls and Mustafa, 2006). Simple before-after comparisons in three *beel* fisheries found that catch per person day of fishing effort increased dramatically at two of the three *beels* following the first CBFM project (Mustafa and Brooks, 2008). The conservation and coordination actions taken by CBFM councils included adoption of seasonal closures, closed sanctuary areas, gear limits to protect breeding stock and habitat restoration.

Fishery cooperatives in Turkey

Turkish fishers who organize themselves into cooperatives can apply to the government for exclusive harvest rights in local areas (Berkes 1986, 1992). A study of five of these groups in the Alanya region found that all attempted to achieve effort rationalization by setting, monitoring and enforcing harvest limits. They did not all achieve these ends, however. Success hinged on the presence of a third party authority such as a local government to facilitate or at least legitimize exclusion of outsiders.

In a comparative study of factors that contribute to management success, Unal (2006) and Unal, Guclusoy and Franquesa (2009) surveyed cooperative managers and individual members of six fishery cooperatives in Turkey. Success was generally regarded as low, and exclusivity was again a key factor. In some cases a coop competed with large numbers of non-coop fishers in the same fishery. In other cases the coop was only partially successful in constraining the harvests and effort of its own members. All six coops engaged in collective marketing and enforcement, with varying effectiveness.

8 Conclusions and unanswered questions

Replacing the rule of capture by secure, individual rights to an administratively determined total catch has led to efficiencies in harvest practices and to significant wealth creation. Individual rights to catch specific quantities are not equivalent to rights in the underlying resource, however (Scott 2000). Benefits from enhancing the stock, from protecting it against theft by non-owners and from ascertaining its condition and spatial distribution are collective in nature, simultaneously enjoyed by all who hold quantitative rights to catch. A single owner who held all catch rights would internalize

these benefits. Numerous owners acting independently have incentives to free ride on the efforts of others, however. With numerous owners, there is a collective action problem to solve. It was argued here that assigning exclusive catch rights to a well-defined group, rather than individuals, can make collective action easier to achieve. Alternatively, rights could first be assigned to individuals and individual rights-owners could contract with one another or form associations to carry out the necessary collective actions.

The design and performance of harvester associations in fishery management has received relatively little attention from economists. Consequently, it is too soon to reach broad conclusions about the advantages and disadvantages of cooperatives relative to other management options or about optimal coop design. Instead, the remainder of this review focuses on two key questions that are as yet unanswered and discusses research approaches for shedding light on each: How well do cooperatives succeed in capturing fishery rents? What factors contribute to success?

Identifying causal factors in coop success

The existing case study evidence cannot answer the first question: How well do cooperatives work? The selection of coops for case studies is surely biased toward successes over failures. Successes attract more attention and last longer than failures, so information is more likely to be available. Failed cooperatives, though surely common, are scarce to nonexistent in the published literature. Coop case studies also seem biased toward developed country fisheries over developing country fisheries. The compilation in Table 1 found more studies for developed country coops than developing country coops, yet the number of developing country cooperatives is known to be in the thousands. This bias could stem from differential availability of necessary data or from the fact that fishery policy research is most often done at developing country institutions.

A natural strategy for assessing the success of cooperative management in developing country fisheries would be to randomly assign cooperative management as a treatment in a set of the world's fisheries and follow how they perform relative to a control group. While assigning coop management directly as a treatment generally is not possible, policies that promote coop formation sometimes can be assigned in this way. In Bangladesh, individual inland fresh water fisheries were randomly assigned to a community based fishery management rights regime (the treatment) or to continuation of the existing system and various outcome variables were tracked for several years (Hall and Mustafa 2006). Assessing policy effectiveness in this fashion deserves greater emphasis. Simply comparing outcomes in fisheries managed by cooperatives versus other systems, as is typically done, requires that one account for the fact that coop formation is an endogenous process.

The role of individual trust and cooperation

Research methods from experimental and behavioral economics are providing avenues for examining the second question: What factors contribute to success? Historically, an individual's fishing success depended on the ability to capture for one's self a resource shared by the rest of the community. Individual selection processes presumably honed these skills. There can be attractive payoffs from cooperating and from coordinating actions across users, however. At the level of societies rather than individuals, success in capturing fishery wealth may be greatest in societies that encourage cooperation over competition (Grafton, *et al* 2006).

Evidence on links between cooperative attitudes and management success has come from field experiments with forest management in Ethiopia (Rustagi, Engel and Kosfeld 2010). Community members from 49 communally managed forests were engaged in laboratory experiments to gauge each individual's inclination toward 'conditional cooperation', a willingness to cooperate if others do. Communities with high proportions of conditional cooperators, as opposed to free riders, were more successful at managing their forests than less cooperative communities.

Indirect evidence of a similar link in fishery management agrees with these findings. Indigenous fishers from northeastern Brazil who are relatively trusting and cooperative in nature (as judged in laboratory experiments with voluntary public good provision, trust games and a stag hunt game) tend to practice moderation in exploiting a fish stock shared by the entire community (Fehr and Leibbrandt 2011). Moderation in common pool exploitation was calibrated by observing how individuals construct the traps used in fishing. Traps with small holes are individually profitable but collectively wasteful, because small, pre-fertile shrimp are unable to escape and contribute to future harvests for the community.

A second study from the same region indicates that causation may work in both directions, i.e., cooperative fishing may contribute to a community's overall level of trust. One of the communities studied exploits a fishery that requires only small vessels and gear, so the typical fishing unit is one person. The other is an ocean fishery requiring larger vessels and gear with a typical crew consisting of 2-8 individuals; the actions of crew members must be coordinated to achieve success. The populations exploiting the two fisheries are otherwise culturally and economically indistinguishable and cross migration between communities appears negligible. In both communities laboratory experiments were used to measure 'trust', willingness to coordinate actions for mutual benefit, and willingness to contribute to public good provision. Those forced by environmental conditions to cooperate in fishing were found to exhibit far greater levels of general trust and willingness to contribute to the public good.

Additional field experiments from the same region examined claims common in the case study literature—that having fishers participate in developing a communal management policy enhances prospects for success (Cavalcanti, Schläpfer and Schmid 2010). Among six fishing communities, fishers from three were engaged in a discussion process designed to develop a concrete resource management proposal. The other three communities did not receive this discussion ‘treatment’. Additional information was collected from all subjects on the trust each placed in others in the community and willingness to abide by the policy selected. An individual’s belief about the trustworthiness of others had the strongest effect on willingness to abide by the chosen policy. Participation in the planning process was relatively unimportant. Separate experimental evidence from the same area indicates that having a strong social network in a community enhances the individual’s willingness to cooperate in conservation efforts (Cavalcanti, Engel and Leibbrandt 2010).

How should fishery coops be formed?

Fishery cooperatives in developed countries often are formed voluntarily; in some cases they exploit part of an allowed total catch with the other portion exploited by non-joiners under limited entry or open access. Examples are described in Deacon, Parker and Costello (2010) and Kitts, *et al* (2011). If coop membership is voluntary the group that joins will be self-selected, with selection determined by the potential efficiency gain from cooperative fishing, the rule for dividing the catch between the coop and the non-joining sector and the coop’s internal policy for dividing its overall payoff among the members. If coop profits are divided equally, only the less skilled fishers tend to join (Deacon, Parker and Costello 2010). Under stylized conditions, however, it is possible to design a division of the allowed catch and a coop profit sharing rule that will entice all fishers to join. Alternatively, high skill harvesters might be induced to fish cooperatively by allowing formation of a second coop open only to fishers whose skill is sufficiently high. Since the benefits of cooperative fishing increase with the proportion of harvesters who join, identifying design principles that can increase membership deserves further research.

It was asserted earlier that assigning initial rights to a group, with the group then responsible for allocating among its members, can facilitate collective action more easily than trying to assign rights to individuals initially. The argument was intuitive and lacked rigor, however. Grafton *et al* (2006, p. 702) point to several prominent examples of group management that have followed the alternative route; individual catch rights were assigned first and rights-holders subsequently organized themselves collectively. In some cases the key ‘action’ was to petition a government authority to impose policies that benefit the group. Which route is most likely to succeed depends on the

transactions costs of forming associations, which are largely unknown at present. It is plausible that experiments could be designed to shed light on this important question.

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Table 1. Percentages of fishery cooperatives adopting specific regulations or coordinating actions

Coop activity or regulation	Developed countries (OECD)	Developing countries (non-OECD)
Coordinate fishing effort	80%	48%
Catch limit	21%	9%
Gear restrictions	28%	61%
Size limit	16%	7%
Gear sharing	27%	36%
Season limit	30%	40%
Spatial restriction	26%	36%
Enforcement	42%	70%
Restocking	10%	13%
Habitat restoration	0%	8%
Research support	62%	34%
Marketing	44%	33%
Profit or catch sharing	37%	59%
Sample size	38	29