Chapter 23

Coping with Environmental Change

Systemic Responses and the Roles of Property and Community in Three Fisheries

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Abstract

We compare how fisheries in three marine systems – from Atlantic Canada, Pacific Mexico, and the eastern United States – respond to significant environmental changes, whether deviation-amplifying or deviation-mitigating. We ask what triggers changes that can avert fisheries collapse and how this is affected by intersections of governance and environment. We conclude by affirming the importance of both exclusive, secure property rights, and community-oriented decision-making power in tipping the balance towards more adaptive ways of responding to environmental change.

Keywords: Atlantic Canada, Pacific Mexico, eastern United States, environmental change, ITQs, property rights, community, Newfoundland northern cod fishery, moratorium, surfclam fisheries, stewardship, deviation mitigation, deviation amplification, enclosure

Introduction

In this chapter we compare how fishers and communities in three marine social-ecological systems – in Atlantic Canada, the Pacific coast of Mexico, and the eastern United States – have coped with significant environmental changes. In addition to providing material for analysing how and why people do and do not respond in time to protect a fishery or rescue it from imminent collapse, the comparison allows us to consider the roles played by distinct kinds of management of common resources: privatized rights in the form of Individual Transferable Quotas (ITQs), communal rights, and top-down centralized management. Incentives and desire on the part of resource users to sustain the fishery in the long term are present in all three cases; we turn to specific social, historical, and natural features of each case to explain their different outcomes to date. We conclude by affirming the importance of both exclusive, secure property rights and community-oriented decision-making power in tipping the balance towards more adaptive ways of responding to environmental change.

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The study of fisheries makes clear many of the patterns and outcomes of using and managing resources held in common ("common pool resources" or "the commons"). Indeed, although the challenge of managing the commons has been labelled "the fisherman's problem" (McEvoy, 1986), the scope and scale of environmental challenges now facing aquatic as well as terrestrial common pool resources suggests that it is everyone's problem. Property rights (more specifically access rights to common resources) strongly influence capacities for and outcomes of natural resource use and management. Property rights can be thought of along a continuum from lesser to greater exclusivity of access to places and resources and the benefits derived from them; they range from public and/or free rights at one end to individually exclusive, "sole owner" rights at the other. Economists have persuasively shown the losses of "rent" or productive potential that come about with totally free access rights in fisheries, the "tragedies of the unmanaged commons" (Hardin, 1968, 1994) that often ensue, and the economic benefits that attend more exclusive, privatized rights (Gordon, 1954; Scott, 1955). Limiting of access to fisheries and other commons can be referred to as "enclosure" – another way of talking about degrees of exclusivity of access, whether in terms of bounded spaces, time (seasonality of access or limited term concessions), or users (some people, institutions, or classes of organizations are granted access) or a combination.

Our three cases for comparison include one that has become a classic "tragedy of the commons," the Canadian northern cod fishery, and two others characterized by more exclusive property rights, which appear to have helped people manage their relationships to the commons and its climate-induced perturbations: surfclams in the US and lobster and abalone in Mexico. The two latter cases are especially interesting for comparison because they represent arrangements from two opposite ends of the spectrum of ways of enclosing a commons: individual (private) ownership of access to resources in the US case, and collective rights to access (though not "open" access) in the Mexican one. The surfclam fishery – the first US fishery to be managed with ITQs – comes close to the economists' ideal; we will consider whether and how ITQs affect human capacity to respond adaptively to the effects of climate change on surfclams. By contrast, small-scale benthic fisheries of Mexico's Baja California peninsula in an area known as the Pacifico Norte represent a clear-cut instance of "communal" property rights (McCay and Acheson, 1987), with exclusive property rights held by community-based cooperatives rather than individuals. We ask in turn how exclusive but collective rights have influenced their capacity to respond adaptively to environmental changes linked to ENSO or El Niño events.

This chapter is written in the spirit and framework of systems thinking, as it evolved through the cybernetics era of the mid-20th century and was elaborated by Bateson (1963, 1972), Slobodkin (1968), Slobodkin and Rapoport (1974), and McCay (2002). System frameworks have come to inform a great deal of thinking and research in recent years, as evidenced by the focus on complex adaptive systems and resilience (Berkes *et al*., 2003; Davidson-Hunt and Berkes, 2003). From this perspective, responses to the effects of climate change can occur at many levels and scales. Some responses can make matters worse or merely fail to help restore system health or its ability to rally from insults. In systems language, ineffectual or backfiring responses that worsen the problem are called "deviation-amplifying" responses, and though it may sound counter-intuitive in ordinary speech, are called examples of "positive feedback" to the system. We discuss the Newfoundland cod

case in those terms. Other responses can mitigate the negative effects of change, helping to protect or even restore system health, and are referred to here as "deviation-mitigating" or "negative feedback" responses. The Baja California fishery we describe is an example. As significant effects of climate change are just beginning to be felt in the Mid-Atlantic surfclam fishery and the resource users and other observers do not yet have the luxury of hindsight, we engage in reasoned conjecture about future outcomes for this economically important American fishery.

All three cases form part of larger marine ecosystems, with complex dynamics and different environmental and fishing challenges for the people that work them. Fogo Island, Newfoundland, is within the Newfoundland-Labrador Shelf Large Marine Ecosystem (LME), with sharply seasonal productivity arising from the confluence of the cold waters of the Labrador Current and the warm ones of the Gulf Stream, since it is seasonally constricted by coastal ice. The fisheries of the Pacific coast of Baja California Sur are in the southern part of the California Current LME, and have always been strongly influenced by El Niño and La Niña changes in ocean conditions and weather. Surfclam fisheries of the Mid-Atlantic region are part of the Northeast Continental US LME, and are experiencing direct effects of sea temperature warming. The three cases offer a contrast between small-scale, local, and artisanal (the Mexican case) to large-scale, offshore, and industrial (the US surfclam case), with the Newfoundland case in between, but each is dependent on producing commodities for distant, globalized markets and is fully embedded in government-run and science-based fisheries management regimes. Other points of similarity and difference are made within our descriptions of the three cases, and in our conclusion we focus on the factor of property rights or "enclosure of the commons" as manifested in each of the cases.

Case Study 1: Fogo Island, Newfoundland, Canada

Fogo Island, on the northeast coast of Newfoundland, Canada, is the locale of nine small remote villages where fishing and fish processing are the primary sources of work. A local cooperative processes and markets the products, although fishers can and in later years often did market through off-island private firms. Weather and sea ice reduce the fishing season to four to six months of the year. Until recent decades, the fishery was primarily small-scale, involving locally built small (15–35′) and mostly open boats, using fish traps, gill-nets, and hook and line gear for cod and other species; in the 1970s and 1980s, larger vessels called longliners enabled more diversified and mobile fishing but cod remained important and the small-scale fishery continued side-by-side with the longliner fishery (McCay, 1976, 1978). Today the small-scale fishery has diminished greatly, a consequence of the "tragedy of the northern cod" that shows deviation-amplification at work.

Fogo Island is part of a much larger social-ecological marine system that can be defined by the very large spatial scale of fish migration and current structures and by the top-down federal institutional structure of Canada (the Department of Fisheries and Oceans, DFO, a federal ministry with regional offices for science and management). Despite the centralized management scheme, Fogo Island has some local autonomy through its community-based fish processing and marketing cooperative. Moreover, the fishers participate in fisheries management in various consultative capacities through their producers' cooperative and through committees of a province-wide union and advisory meetings with DFO

officials. As elsewhere in Newfoundland and Labrador, there is some small-scale locally-generated data for fisheries management through a program called "sentinel fisheries." However, that occurred after the fisheries collapse of 1992, and most data, stock assessments, and management rules come from the science and policy branches of DFO. Management decisions have been made on a large scale. These features of the case have important implications for the possibilities for responding and adapting appropriately to environmental changes, and help explain the responses seen during the critical period before and during the cod fishery collapse, described below.

The story of Fogo Island's fishery is that of the entire east and northeast coast of Newfoundland. It experienced the process, now known throughout the world, of the collapse, or "tragedy" of the northern cod (Harris, 1998; Rose, 2007; May, 2009). In June 1992, the fishery for the stock of northern cod found off the east and northeast coasts of Newfoundland and southern Labrador was closed due to evidence of a nearly total collapse of the fish stock. Closures or severe cutbacks of other groundfish fisheries soon followed.

The build-up to the 1992 moratorium on cod fishing involved deviation-amplification. For one reason or another (see Case Study 3) the allowable catch levels during the 1980s were always greater than the actual catch, and the dominant response to declining catches was to intensify efforts (Finlayson, 1994; Finlayson and McCay, 1998), which, in the circumstances, led to worsening overfishing, or deviation-amplification. For example, in the inshore fisheries, which were the mainstay of the small fishery-dependent communities of Fogo Island and other coastal areas, fishers' response to catching smaller sizes of fish and smaller catches overall was to adopt smaller mesh nets and more efficient fish traps; the cooperative, like other cod processors, refined its filleting machines for small fish. Many participants in the coastal fishery knew that the stocks were declining, but they appeared unable to do much about it. In such a centralized system, management was a government responsibility anyway.

The situation was made worse by government decisions to rely more on the offshore trawler fishery in the effort to industrialize and modernize the fisheries, making them more year-round. As George Rose recently observed (Rose, 2007), in the early 1980s, the critical time for this tragedy to unfold, the federal and provincial governments reacted to evidence that the inshore fishery could not catch its 120,000 tonnes quota by giving more of the overall quota to the offshore fishery, thinking the fish stock was growing despite trouble in the inshore fishery. This was unfortunate because the less efficient inshore fishery tended to catch fewer fish when abundances were declining, making it inherently precautionary, whereas the offshore fishery was only too efficient and capable of keeping its catches high in the context of decline. The decision to give more to the offshore "lessened the inherent precaution of the inshore fishery and increased the potential for overfishing when quotas were set too high, as indeed they would be" (Rose, 2007).

The direness of the situation was masked by landings data coming from the offshore fishing strategies that compensated for declining catches by opening up new fishing grounds. It was also masked by a retrospective bias in stock assessments, whereby data on the later years of a fish cohort tended to show that the size of the cohort in earlier years had been overestimated (Finlayson, 1994; Finlayson and McCay, 1998). The signs and signals of trouble were hard to translate into terms usable in scientific population dynamics models, and the provincial court struck down an effort led by some inshore fishermen, academics,

and lawyers to force a review of the situation (Steele *et al*., 1992; Martin, 1992, 1995). The problem was belatedly recognized by a government unwilling to make hard choices when confronted by scientific evidence of stock decline, when those choices involved thousands of fishers and fish plant workers.

There seem to have been large and grave disconnects between experience-based observations, scientific knowledge, and policy, one effect of which was that the observations and efforts of many of the fishers, experiencing stock decline, as well as of some scientists, seeing problems in the data, were readily ignored. Even after the 1992 moratorium, science reports were allegedly edited and tailored to fit political efforts to continue providing jobs and revenue to fishery dependent communities at the cost of the natural resource that had sustained these communities (Hutchings *et al*., 1997a,b). The moratorium of 1992 was supposed to last only a couple of years, allowing the fish a chance to recover, but recovery has barely occurred almost 20 years later. Water temperature changes linked to the North Atlantic Oscillation, seal predation, a possible ecological regime shift, and continued fishing – offshore in international waters and inshore by-catches, both legal and illegal, and small-scale inshore commercial and subsistence fishing – have kept northern cod stocks at a very low level (Shelton *et al*., 2006). The fishery management measure of a virtually complete closure of the fishery was unable to arrest the decline in cod stocks that had been precipitated by the "deviation-amplification" processes of the 1980s.

Given the sad outcome of the northern cod story, we feel compelled to look for more hopeful signs and positive responses to environmental change. What if any are the signs of significant restructuring and shifts toward more sustainable, "deviation-mitigating," system dynamics in this case, as might be predicted from such a dramatic collapse (Gunderson and Holling, 2002)? Finlayson and McCay (1998) found little evidence of institutional change within the parameters of fisheries management in Newfoundland, despite the creation of a broader and more representative consultative system (Charles, 2001). Instead, the dominant response to change has been industrial diversification, taking advantage of both strong markets and strong, even increasing, populations of crustaceans (Schrank, 2005); queen crab and northern shrimp, which may have increased in response to decline of top predators such as cod. The fisheries management system has seemed more precautionary in the management of crab and shrimp, but this may have as much to do with lack of the data and scientific understanding needed for sophisticated stock assessments as with any "lesson learned" from northern cod.

Diversification has been the key to survival of Newfoundland's fisheries economy and fishery-dependent coastal communities in the wake of the collapse of northern cod. However, there is nothing inherently more sustainable about diversification *per se*; outcomes are still unfolding and will depend in part upon the nature of marine resources and unpredictable global markets. Indeed, "diversification" includes a "fishing down the food web" response (Pauly *et al*., 1988), to the point that sea cucumber has been processed on Fogo Island and even jellyfish has undergone pilot studies. The fishery has also continued a focus on other groundfish, particularly "turbot" or Greenland halibut, which amounts to another kind of "fishing down," not down the food web but into far deeper (and more distant) waters, with very questionable management controls (Healey and Mahé, 2005).

From a broad systems perspective (and from economic ledgers) we might interpret the situation as not tragic at all, but rather involving a viable restructuring, a positive regime

shift. Crab and shrimp turned out to be more valuable than cod and generate many jobs as well. Diversification has enabled the islanders to survive the demise of the cod fisheries, but there are social costs. For the most part, crab and shrimp fishing takes place offshore and thus requires large and expensive boats, up to 65 feet in length, and long fishing expeditions. Striking economic differences are evident within the local fishing communities between the families heavily involved in the large-scale crab and shrimp fisheries and those which are not. Such stratification, with its effects on vulnerable sectors of the population (e.g., older and poorly educated men and women and fish plant workers) and on the viability of local communities, is among the social costs of diversification in response to change in the fisheries system.

The high investments required for crab and shrimp combined with intense competition among buyers for the product (especially crab) have threatened local institutions such as the Fogo Island cooperative and, indirectly, local communities. Many of Fogo Island's vessel owners stopped delivering their catches to the local cooperative because of agreements made with other buyers in order to secure financing for the costly vessels required for successful crab and shrimp fishing. This reduces jobs available in the cooperatives' fish plants, which are the principal source of income for island households, and it created the backdrop for a dramatic conflict over gender, equity, and human rights, which has torn the island's communities further apart (Penton, 2001; McCay, 2003).

A coda to the Fogo Island case, and the others we discuss, concerns critical moments or forms of intervention from the outside. Although the island's population declined from almost 5,000 in 1992 to less than 3,000 in 2009, Fogo Island's fishers and communities have shown considerable resilience. This is in part due to the constructive engagement of outsiders, working with local leaders, in helping provide resources for coping and adaptation. Such work on Fogo Island began in the 1960s, with a major rural development effort organized around community films and the creation of the cooperative (Healey and Mahé, 2005), and it has recurred from 2006 to the present with the efforts of a private foundation begun by a former resident of the island to revive aspects of traditional culture in ways that foster community survival (McCay, 2003).

Case Study 2: Pacifico Norte, Baja California Sur, Mexico

In sharp contrast to Fogo Island and its experience of the "tragedy" of the northern cod, the fishery of Mexico's Pacifico Norte region, on the west coast of the peninsula of Baja California, has been internationally recognized as a fisherman-led, community-based effort to prevent major stock decline (in the spiny or red rock lobster fishery) and help restore diminished stocks with government partners (in the abalone fishery). The unusual social and institutional organization of resource users in this case appears to shape the more corrective responses and adaptations to environmental change we observe.

The fisheries of the Pacific coast of Baja California Sur are in the southern part of the California Current Large Marine Ecosystem, which is marked by strong upwelling and complex rocky shore habitats, and these fisheries are strongly influenced by ENSO (El Niño-Southern Oscillation), or El Niño and La Niña changes in ocean conditions and weather. This has notable effects on the two main fisheries of lobster and abalone. The fishers are engaged mainly in lobster pot fishing and diving for abalone and whelk from small

open boats 15–30 feet in length; they also engage in finfishing with gill-nets. They, like many of the fishers of Fogo Island, Newfoundland, belong to cooperatives. The ten fishing cooperatives of this region manage the harvesting and processing operations and are engaged in some marketing through their federation. They are more extensively involved in the fisheries than is Fogo Island's cooperative. The cooperatives, not the fishers, own the vessels and most other factors of production and marketing. Even more striking and important to the outcome is the fact that the cooperatives hold exclusive concessions to vast areas of inshore fishing grounds for abalone, lobster, and turban snail, the major export fisheries.

The basic feature of institutional structure, through which response and adaptation at various scales are implemented, is a co-management relationship between government fisheries agencies and this group of ten local cooperatives (Ponce-Diáz *et al*., 2009), which allows for both local-level and coordinated responses to signs of trouble in the fisheries and environment. The cooperatives of the Pacifico Norte region are organized into a federation which coordinates many marketing and other services, such as resource monitoring and analysis of scientific information and providing advice to government agencies and the cooperatives. The cooperatives' prosecution of the fisheries is regulated in significant ways, from internal regulations made through general assemblies of all members, to co-management ("co-responsibilidad" or co-responsibility) with government agencies, within the framework of a law governing cooperatives that originates from the same socialist principles that created the ejido system of collective land tenure in Mexico.

In 1992, the Pacific Norte cooperatives were granted 20-year, renewable fishery concessions for abalone and lobster. The concessions, which gave the cooperatives and their members exclusive rights of access to those stocks within well-defined territorial boundaries, provide a major incentive for localized resource management, especially for lobster, whose life history better fits the 20-year time span than does that of the longer-lived abalone (Costello and Kaffine, 2008). Concessions come with rules created by the government fisheries agency, but in practice many of them are negotiated with the cooperatives and federation experts; the cooperatives hold significant leverage for political reasons and because the enforcement of these rules depends greatly on the cooperatives. Certain rules governing the concessions derive from top-down mandates, such as closed seasons and quota limits for abalone, which are based on a biomass model used by the fisheries research agency (Muciño-Diaz and Sierra-Rodriguez, 2002). Other rules come about through negotiation with the government, such as when cooperatives argue to shift the date of the open season to be more in line with observed reproductive patterns of lobster. And still others are locally derived, such as choosing to make the size limit for abalone even more stringent than the one recommended by government in order to rebuild abalone populations faster.

They have averted the complete fishery failures we see in cases like northern cod, Although decline in abalone populations since the 1960s has been dramatic, the fishery continues, under strict but collaborative management, and appears to be holding its own (Ponce-Diáz *et al*., 1998), unlike the case for other abalone fisheries in North America, which are commercially and in some cases biologically extinct. The lobster fishery has seen increases in both effort and catches and was awarded certification as a sustainable fishery by the Marine Stewardship Council. In other words, the fisheries of the Pacifico Norte cooperatives appear to be cases of "deviation-mitigation," or corrective and/or precautionary responses to environmental change.

The stewardship involved took a long time to develop, however, and was itself the outcome of response to environmental change. In 1982/83 (before the concessions were implemented and before the current orientation towards stewardship within the cooperatives), a major El Niño brought warmer waters through the disruption of local upwelling. This resulted in decline of the kelp that sustains abalone. Combined with already declining catches in prior years, a drastic decline of abalone began. The government fishery agency threatened the cooperatives with complete closure of the lucrative abalone fishery if they did not agree to severe austerity measures. Added to the fact that the government had long sought to gain more control over these lucrative, locally-run export fisheries, the rise of global awareness of El Niño helps explain the response by government. In 1982/83, fears circulated about the actual and predicted catastrophic effects of the most severe El Niño in memory; it made global headlines and was experienced in some developing countries as a sort of Armageddon (Broad *et al*., 2002). The negotiated outcome of the government ultimatum was that cooperatives took on greater responsibility for sustainable and cooperative management of the fishery in exchange for being allowed to continue fishing but at a lower and more tightly regulated level. In effect, this formed the beginnings of co-management that continues to evolve in these fisheries (Weisman, 2007).

El Niños occurred again in the 1990s, and cooperatives had to adjust once again to lean and uncertain times. In each case, when quotas for lucrative, abalone fisheries were severely reduced by government, cooperatives, family members, and anyone living in the communities felt the impact. To help tide families over, the cooperatives took on additional debt and gave credit to members to help them get through the worst times. Community cohesiveness and the degree to which the survival of the cooperatives is connected with the survival of its members made such critical institutional responses possible (Weisman *et al*., 2007), as did the lucrativeness of the fisheries.

Another response by some cooperatives during and after the El Niño events described was diversification to other fisheries, such as finfish, whelk, and more recently sea cucumber and sea urchin, which are sold to Asian markets (Weisman *et al*., 2007). Diversification to other fisheries was initially thought of as a short-term solution to the problem of economic crisis when abalone became scarce. But, in fact, the cooperatives have come to depend on them, and the finfish fisheries now fill a social niche in many cooperatives, functioning to keep more people gainfully employed than would be otherwise possible, and provide such work at times of year when more lucrative lobster or abalone is out of season and economically leaner times set in. Longer-term effects of those diversifications, as in the case of Fogo Island, are still playing out, but thus far they have not required new sources of capital and new business arrangements. Nor have they yet created differences in social position and income within the communities that may threaten the system itself. However, greater effort in fishing for finfish may have implications for the ecological system, depending on the ecological impacts of the gill net fisheries that appear to have more substantial effects on coral and other structures than the traps used for lobster (Shester, 2008).

Regarding the question of identifying what triggers change that can avert fishery crash, in this case the threat of fishery closure in 1982/83 was one of several critical moments in which cooperatives had to reassess what they were doing and consider alternatives. Government intervention was the clear initial impetus for the shifts towards more careful fishing practices and other rules and scientific monitoring, which cooperatives put into

effect themselves over the following years, with various ups and downs in the process of trying to implement them as well as ongoing debate with government about how much conservation was enough.

The willingness of the cooperatives to undertake the costs of carrying out these and other responsibilities aimed at sustainable fisheries can be traced to the incentives provided by the concessions (Costello and Kaffine, 2008), but their ability to do so is very impressive and unusual given the limited intervention of government in many aspects of the cooperatives' internal operations. The cooperatives have shown strong capacity for both reducing the threat of illegal fishing in the cooperatives' zones and enforcing the internal rules and standards for work within the cooperatives.

The Pacifico Norte cooperatives' distinction as the only small-scale fishery worldwide to receive certification for a sustainable fishery (for lobster) is another example of their success in responding and adapting to change – not only changes in the environment but also in markets, political climates, and global trends being set by environmental conservation NGOs (Weisman, 2006). In 1999, the World Wildlife Fund (WWF) together with a local NGO, Community and Biodiversity (CoBi), initiated a program to use certification as a method of helping small-scale, community-based fisheries receive recognition for and improve their management of local fisheries. The objective was to use certification, or "green marketing," to help them get financial benefits in exchange for their commitments to practices believed to ensure greater sustainability of fisheries (WWF, 2008). In April 2004, certification for sustainable lobster fishing was granted to nine of the Pacifico Norte cooperatives by the Marine Stewardship Council (MSC), a non-profit certifying body, and although wholesale prices did not go up markedly, other benefits of eco-certification, including enhanced political capital affecting interactions with government, led the cooperatives to seek and gain renewal (McCay and Weisman, 2007).

In sum, many factors contribute to the capacity of the Pacific Norte fishing cooperatives to carry out "deviation-mitigating" actions, which translate into what we would call positive actions for the system, including protection against over-fishing in the case of lobster, and efforts at both protection and restoration in the case of abalone. This comes from and informs the local history of experience with environmental changes, due to both El Niño and overharvesting as well as larger changes in laws and fisheries governance. It is also affected by an immensely productive natural environment that has helped buffer those changes and offered alternative fishery resources that required no major changes in investment or organization (in contrast with the Newfoundland case). The cooperatives also had capacity to respond to such challenges because of their strong structure and the degree to which they are embedded in the local communities, which had been poorly served by state and federal governments and depended on the cooperatives for survival. They had the incentives to respond because of the very high value of the fisheries, as well as a high level of dependence on the resources (which Fogo Island also displays) combined with some measure of autonomy to make and act on important fishery decisions (which Fogo Islanders did not have).

Paradoxically, isolation, which accounts in part for the lack of full government service, has also helped the cooperatives avoid overharvesting and fisheries decline. The self-sufficiency of the Pacifico Norte fishing settlements, supported by the cooperatives, has created an ethic of proud autonomy. That in turn has contributed to extraordinary efforts by the

cooperatives to enforce concession boundaries against outsiders and to maintain discipline within their organizations. Furthermore, the timing of the earlier El Niño events as well as the 1992 concessions was critical, in that fisheries in this region were still in relatively good shape, enabling the cooperatives to make significant investments in monitoring and enforcement when other cooperatives in the region appeared unable to do so, their abalone and lobster fisheries apparently in worse shape by this time.

The Pacifico Norte case represents a fishing economy built upon a place-based sense of community – through the cooperatives – that has incorporated what Princen calls "the logic of sufficiency" (Princen, 2005), whereby people embrace, or at least accept, the need to limit what they take, produce, or consume for a more sustainable – and sufficient – way of using nature's endowments. The system of locally managed fisheries operating within the framework of an otherwise highly centralized federal government regulatory structure also helps explain the timing and quality of responses by the cooperatives to environmental changes. Another factor may be that the high value of the major species involved and the fact that they remained at some level of profitability even at the time of crisis, gives the cooperatives the financial buffer they needed to be able to respond to signs of trouble and change, a condition that may be atypical for small-scale fisheries and for remote coastal communities.

However, this system has its vulnerabilities. The concession system marginalizes some people in the communities who are not members of the cooperatives. Membership is limited, especially where the cooperatives have developed policies to stabilize membership; family members are given preference for membership; and women in particular have few work opportunities. The system seems to depend quite heavily on the tight-knit nature of the communities and their isolation, both of which can end very quickly, as is beginning to happen with relaxation of Mexico's rules against foreign ownership of coastal properties and wakening interest in developing these coasts for tourism as well as salt production. Moreover, a decisive moment looms: the concessions are up for renewal in 2012. Prior to 1992, fishing cooperatives had exclusive rights in another sense, similar to those of land-based ejidos, but as of 1992, neo-liberal policies have opened access to the fisheries to market competition. Private businesses as well as cooperatives may be eligible for concessions. The cooperatives are therefore very aware that concession renewal is not guaranteed, adding considerable insecurity to their property rights, but also creating a motive to strive to maintain a reputation as good stewards and exemplars of "co-responsibility" (Costello and Kaffine, 2008).

As in the case of Fogo Island, Newfoundland, outsiders and the "globalization" they represent have been critical to the Pacifico Norte fisheries, helping to provide resources for coping and adaptation. This is clear in the intervention of NGOs to help the cooperatives gain eco-certification for their lobster fisheries. In addition, for many years, scientists from academic and government research institutions have worked with the cooperatives, especially on abalone biology, and they have played important roles from time to time in politics and fisheries management decisions. Regional and international NGOs and wealthy US-based foundations also have been involved. In addition, the decisions of the separate cooperatives and the federation of cooperatives are strongly influenced by standards and norms of international fisheries science through the training of technicians and scientists and the use of particular stock assessment models. Finally, the cooperatives were able to attract scientists, including social scientists, from both the United States and Mexico to

carry out a large interdisciplinary research project, which is helping efforts towards providing annual reports on and eventual renewal of eco-certification (Shester, 2008) and, it is hoped, concession renewal.

Case Study 3: US Surfclam Fishery

Surfclam fisheries of the Mid-Atlantic region are part of the Northeast Continental US LME, an expansive, sloping continental shelf marine system strongly influenced by the Gulf Stream and coastal estuaries and rivers. After at least two decades of stability in terms of management and harvests, surfclam populations are now experiencing serious die-offs, which are being attributed to global warming effects. The US surfclam fishery represents a case of distinct signs of the effects of global warming on marine resources, and one in which the human and institutional components of the system appear on the brink of significant change. Response to the effects of climate change is still in its early stages. It is also different from the two other cases in that access and use rights have been privatized at the level of individuals, and they are fully marketable, unlike the case of concession rights, which are held by the collective organization and are not transferable through market mechanisms.

The US surfclam harvesters rely on large vessels, 60–150 feet in length, equipped with hydraulic dredges to harvest surfclams (*Spisula solidissima*) from the sandy bottom of the continental shelf. The canned and frozen clam products that result from this industry are not high-valued luxury foods as are Mexican lobster and abalone, but the scale of the clam harvests is very large and a great deal of money is at stake in the management of the fishery. Although long situated in certain ports, there are no local communities that are dependent on this fishery; the fishing ports of the region are located within fully gentrified and/or industrialized coastal communities. Harvesters, owners, and processors are spread out over a large area and intersect with numerous place-based communities, no one of which is dependent on this fishery or even fishing in general. But there is a kind of community that arises out of the industry itself, a small, very competitive, but tightly networked one with considerable vertical integration between harvesters and processors. It also arises from long-term involvement in the fishery management system for the region (McCay and Creed, 1990, Creed and McCay, 1996); and from the myriad of relationships engendered by trading within the ITQ system. Unlike the Fogo Island fishers and the Pacifico Norte fishers of Mexico, the surfclam fishers have not formed cooperatives that buy their product and run processing facilities.

The surfclam fishery of the northeast region of the United States is much more industrialized and much less connected with local communities than are the other two cases. It is similar to the lobster fishery of the Pacifico Norte case in having been relatively sustainable over a long period of time, in terms of overall landings and harvestable biomass (MAFMC, 2008). This is due partly to the intensive government-directed program of management; this fishery was one of the very first in the United States to be managed after the 200-mile limit was enacted in 1976, and it was the first to have both quota controls and limited access, by the late 1970s. From that point to the present it has been managed through quota limits, plus various effort limitations, and the management rules and landings have been relatively stable in recent decades (MAFMC, undated).

Whereas the biological dimension of this fishery had been fairly stable until about 1999, its property rights system had gone through dramatic changes. The open access condition changed in 1978, when access was restricted by a moratorium or ban on new vessels and catches were limited by quotas, time limits, and other means. In the late 1990s, the surfclam fishery became the first in US federal waters (outside 3 miles) to be managed with individual transferable quotas (ITQs). Already an industrialized fishery dominated by a few vertically integrated firms, the small owner-operator fleets disappeared very quickly as the harvesting sector consolidated to gain the efficiencies promised by ITQs (McCay and Brandt, 2001).

The surfclam resource had increased from lows in the early 1980s to record highs in the late 1990s, and catches were mainly constrained by market limitations. Though it may seem bizarre to outsiders imbued with the notion that fishermen are inherently "risk-prone" rather than "risk-averse" and want the highest allowable catch they can get (Ludwig *et al*., 1993), almost every year, until about 2000, the surfclam industry asked the regional fishery management council to keep the overall total allowable catches (TACs) considerably below what would be allowed if the biological models were used as strictly to guide quota setting. Given that the clams are long-lived and that the fishery is an ITQ system, keeping the quota low can be seen as a good business decision. Hence, the fishery's sustainability may also be related to the strong presence of the industry in the management arena, which in the United States is highly participatory, making it open to an industry such as this that is fairly small and able to organize itself to affect management decisions. Consequently, at times the industry has been able to translate the concern about limited markets for product of many of its members into management council decisions to impose lower quotas than what is biologically recommended.

Beginning in about 2000, the surfclam fishery began to experience declining catches, as expressed in landings per unit effort and, in particular, what is interpreted as a recent and dramatic die-off of clams in the southern part of their known range, correlated with a rise in sea surface temperatures (Weinberg *et al*., 2002, Weinberg, 2005). Being so market-oriented, with little evidence left of fishing community allegiance, the industry can and has begun to respond by moving boats closer to the more northern clam beds, and even by shifting where the clams are sent for processing, as predicted in spatial choice economic models (Hicks *et al*., 2004). But there are other uncertainties beyond the community impacts that such a response to change will create: the market situation and a problem with the distribution of the clams. Surfclams and ocean quahog products – frozen and canned – have global but limited markets, with strong competition. Price is inelastic even as catch efficiencies decline and the costs of fuel, insurance, and other inputs increase. This is forcing out even more of the smaller companies, creating a situation that has prompted calls for addressing a question that was left open when ITQs were legislated in 1990: what is an "excessive share" of the quota? Among the vulnerable in this situation are also those small-holders who opted to remain in the fishery as "sealords," leasing out their ITQs, but finding it difficult to find lessees or even buyers. The most vulnerable are workers in clam processing plants, the forgotten participants (many of whom are either immigrants from Central America and Southeast Asia or rural African-Americans). As surfclams in the southern part of their range die off and the boats move north, these workers are left behind. A large processing plant in the State of Virginia cut back workers in recent years and finally moved to New England in the spring of 2008, removing one of the last sources of jobs in its rural area.

The problem of clam distribution is that whereas clams appear to be dying off in the southern part of their range, correlated with a rise in sea surface temperatures – a possible signature of global warming – they do not seem to be increasing in the southern New England parts of their range where temperatures should still favour this bivalve. This is possibly because one of the large submarine canyons of the region serves as an effective barrier to larval transport and successful recruitment (Powell, 2008). Vessels are responding to this state of affairs by focusing on a smaller area for fishing and may be endangering the healthier subpopulations of clams. As of early 2009 the situation has not called for major reassessment of the stocks or changes in the quota (MAFMC, 2008), but industry members, managers, and scientists are concerned, a major stock assessment is underway, and people have begun to talk about adopting temporary or rotating area closures to alleviate pressure on the healthier clam beds.

The question is, as it was in the case of northern cod and in the case of abalone, whether a major change will actually take place in managing this fishery – either significant decline of the quota or area-based management, or both – to reduce the risk of unsustainable harvesting, or will the *status quo* persists? How will the ITQ structure of the surfclam industry and management systems and its history of experiences influence the outcome? Scholarship and experience would suggest that the ITQ system creates incentives to care enough for the future that people will act both privately and collectively to protect the resources involved (Scott, 1993, 1996). A recent worldwide survey suggests that ITQs and similar restricted catch allocation systems are somehow linked to improved stewardship, not just efficiency (Costello and Deacon, 2007; Costello *et al*., 2008). Indeed, the surfclam industry had formed a committee to explore the situation and alternatives facing it, including creating a self-governed system of rotating closures, following the example of the sea scallop fishery of the region (Valderrama and Anderson, 2005), but to this date (March 2009) had not come to agreement on such a system nor on including such measures in the next formal management plan.

Outsider engagement has influenced the surfclam fishery and its options for adapting and responding to environmental change in this as in the other cases. Much wealthier overall than the local industries in the Newfoundland and Mexican cases, the US surfclam industry has not depended on NGOs for assistance. However, during the 1980s, economists who promoted and reviewed ITQs in other countries helped create the surfclam ITQ system (Anderson, 1989a,b). In addition, the surfclam industry established close relationships with academic and government scientists.

The industry itself has been able to generate both collective action and financing to address problems and opportunities, and the capacity to do this may be attributed at least partially to incentives created by the market-oriented form of enclosure. With fewer "owners" and clear identification of stakeholders due to ITQs, it has been possible for this industry to present a united front in fisheries management (by meeting early to decide on what they will ask of the management council) and to invest in research, as predicted by fisheries economist A. Scott (1993). Industry-supported research became a priority when evidence was found of a major discrepancy in a key parameter in the stock assessment carried out by government scientists. The industry persuaded a university biologist to help them obtain cooperation from the government fisheries agency to do side-by-side analyses of catchability, which resulted in a major correction in stock assessment (Bochenek *et al*., 2005; Johnson, 2007).

Consequently, the surfclam industry is prepared to collaborate with university and government biologists in monitoring effects of warming on the resource and in exploring options for both adapting to and mitigating the effects of observed and anticipated changes. It has the organizational capacity to do this, through a committee created for earlier projects that obtains and manages contributions from industry companies for research projects. The chances are good that the surfclam industry will find a way to adapt to the effects of climate change on the resource, at least in the short term, and thus join the ranks of "deviation-mitigating" fisheries. The wealth of fishery "owners" is not only used to help pay for research but also to explore problems linked to climate change. Indeed, one of the industry leaders has also taken a leadership role in developing offshore wind farms off the New Jersey coast (Fishermen's Energy www.fishermensenergy.com), an important step towards responding correctively to the larger issue of anthropogenic emissions into the atmosphere.

Conclusion: Enclosures, feedback, and the future

The Mexican case and the Newfoundland case represent two faces of place-based or community-based fishing, although many Newfoundland fishers may have found themselves in the position of having to extend their activities far beyond the local territories where they once worked and their communities are undergoing associated changes (Ommer and Team, 2007).

Enclosures of different types have played a major role in transitions in fisheries, including the ability to cope with and adapt to global changes in environments and markets. In the Newfoundland case, the key "enclosure" at first was the moratorium on cod fishing, which has been in place since 1992 with only small openings for commercial and subsistence fishing. That has been a failure, or at least a big disappointment, in terms of northern cod recovery. It is possible that the cod fishery will never come close to what it was in the past, given the greater market value of crab and shrimp and the strong cultural claim for early reopening of the cod fisheries (Shelton, 2007). A cod fishery may be sustainable, but at a very low level. Meanwhile the inshore fishers and plant workers are even more vulnerable and resilience is attained mainly through outmigration of the young and able, responding to higher wages in the oil, gas, and mining industries of western Canada. Not mentioned here but extremely important is the enclosure that has occurred through licensing and other policies of the government (Matthews, 1993), including a new policy that encourages the remaining inshore fishing enterprises to "combine," removing more people from the fishery and therefore from a direct stake in creating a more sustainable future.

In the Pacifico Norte case in Mexico, the enclosure that has most transformed the nature of resource use is the concession, which grants to local fishery cooperatives exclusive rights to fish for the most lucrative species, particularly abalone and lobsters, within clearly demarcated areas adjacent to settlements. The concession, to which are attached contractual obligations and the threat of non-renewal, is one of the tools for the development and sustainability of practices that enable both sustainable fishing for lobster and some protection for and restoration of abalone. These include local involvement in monitoring stock status and contributing in other ways to research and knowledge production. A longer

history of co-management, or what is called there "co-responsibility", plays a role as well and comes out of earlier efforts to cope with the effects of dramatic environmental changes, the El Niño events. This combination, as well as factors such as isolation and autonomy, contributes to the evident success of the Pacifico Norte cooperatives in achieving certification for sustainable fisheries even in the context of global environmental change and globalized markets. The role of isolation in these accomplishments points to the likely vulnerability of the system to the effects of tourist-led and other coastal development. At the same time, a new Fisheries Law in Mexico may be used to support regional systems of management that may help bolster systems such as that of the Pacifico Norte (Diario Official de la Federación, 2007; Ramirez-Sanchez *et al*., 2008).

In the US surfclam case, enclosure is in the form of quasi-private property rights, or individual transferable quotas, which have intensified the strong market-orientation and may have diminished the place-based community orientation of this fishery, although many owners continue to try to keep local people employed. Those remaining in the industry have strong incentives it seems, to contribute to knowledge production through collaborative research, some of which is totally funded by the industry. They also have the facility to shift their operations to respond to the apparent demise of clams in their southern range. The smaller operations are less able to do so, and all are constrained by market limitations, but the most vulnerable are the processing plant workers.

Enclosure and the property rights implied by it are critical to these cases but only part of the story. Knowledge and community are key variables as well. A question that deserves fuller attention is the production and use of knowledge in uncertain, complex, and conflicting situations, which some have identified as the conditions of "post-normal science" (Funtowicz and Ravetz, 1993; Tognetti, 1999; Ravetz, 2004) or "wicked problems" (Rittel and Webber, 1973), which call into question the fundamentals of inherited ways of doing things, including fisheries management (Ludwig, 2001). In such conditions, the scope of knowledge producers needs to go beyond professional experts to include non-professional experts such as fishers, fishery workers, and others who have traditional and experience-based knowledge and wisdom (Power, 2002; Neis and Felt, 2002). Our three cases show much greater integration of non-professional expertise into decision-making in the Mexican and United States cases than in the Newfoundland case. This may be explained by the fact that the scale of the fish stocks in the Newfoundland case is so large compared with the experiential scale of fishers, but it also appears related to the strongly entrenched top-down structure of fisheries management, which has been only modestly altered to incorporate the views of fishers and other stakeholders in recent years.

We have used the language of negative and positive feedback, of deviation-amplifying and deviation-mitigating responses to environmental change, in presenting these cases. The critical question is what enables or prompts a switch to the mitigating or conserving strategies. In popular language, we are searching for "tipping points" (Gladwell, 2002), or conditions that lead people who are experiencing hard times to take stock, to learn and explore alternatives, and to make changes that help them adapt to the hard times better by finding ways to cope and to reduce vulnerability to the effects of environmental change. This is what "adaptation" appears to mean in climate change discourse. Diversifying fisheries and other income opportunities is a clear example of adaptation. But they may also be led to make changes that help make the situation better; "mitigation" in climate change discourse.

The Baja California cooperatives are mitigating the effects of El Niños when they close abalone banks or reduce allowable harvests in those years. If the surfclam fishing industry agrees to a rotational system, it may be able to mitigate, or reduce, the effects of climate warming on the surfclam populations.

Making the transition from responses that make matters worse to ones that enable adaptation or mitigation is no small accomplishment. Our cases support those who argue for the importance of some form of "enclosure" or exclusivity of rights to exploit fishery resources, because secure and exclusive rights provide stronger incentives for future-oriented actions than do systems with relatively loose or insecure rights. This has recently been found in a very large-scale survey, where exclusive catch shares have a statistically significant negative correlation with collapsed fish stocks. Our cases add some sense of the range of conditions that may lead to this outcome: not just the market-oriented, privatized ITQs of the surfclam case, but also the community-oriented, exclusive concessions of the Pacifico Norte cooperatives.

It is intriguing and it may be telling that in addition, in both these cases, representatives of the fishing industries have argued for stricter measures – closed periods and areas in Mexican case, lower quotas in the US case – than were suggested by government scientists. We could add the Newfoundland inshore fishers from the 1980s, in that many of them were involved in an effort to get the government to reduce allowable catches. However, the big difference is that the Newfoundlanders failed in this quest, forced instead to be involved in continued overfishing when they knew better. The US surfclammers and the Mexican cooperative fishers instead have succeeded, at least at times, and this speaks to a critical factor: power. Simply, the structure of decision-making in the Newfoundland case had no place for the say of the fishers who experienced problems and asked for solutions, whereas in the Pacifico Norte, the cooperatives had long had semi-autonomy and were able to negotiate management agreements with government agencies. Similarly, in the US surfclam case, although the industry groups do not have formal decision-making authority, they do have power within the participatory management system. Consequently, our cases lead us to agree with both those who argue for more exclusive and secure property rights and those who argue for stronger local autonomy and co-management power.

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