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Evolution of Norms and Conservation Rules in Two Fisheries

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Principal Investigator: Acheson, James M. **Award ID:** 0821968

Organization: University of Maine

Submitted By:

Acheson, James - Principal Investigator

Title:

Evolution of Norms and Conservation Rules in Two Fisheries

Project Participants

Senior Personnel

Name: Acheson, James

Worked for more than 160 Hours: Yes

Contribution to Project:

James Acheson's involvement in the project did not change. He supervised the project staff and is carried out all of the sub project goals outlined in the proposal. With the unexpected death of Roy Gardiner in January 2011, he had to assume additional responsibilities with regard to jointly-authored articles that were in preparation and under review for publication.

Name: Acheson, Ann

Worked for more than 160 Hours: Yes

Contribution to Project:

Ann Acheson did the tasks described in the original proposal. In addition, she supervised the administration and data entry for the lobster fisherman survey, a task she assumed due to reallocation of time availability of the staff person at the Margaret Chase Smith Policy Center who had originally been scheduled to do this. This past year she has been involved in analysis, write-up of results, and editing of project publications.

Post-doc

Graduate Student

Name: Snyder, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

Robert Snyder, a Ph.D. candidate at York University, received his degree in 2009. For this project, he interviewed groundfishermen and did ethnographic fieldwork in the fishing communities of the Saint George Peninsula, Maine (south of Rockland). He also interviewed officers of the groundfishing lobbying organizations in New England, including the Penobscot East Fishermen's Association, the Mid-Coast Fishermen's Association, the Gloucester Seafood Coalition and the Chatham, Massachusetts Hook Fishermen's Association. He was paid from project funds in the first year of the grant. He did not work on the project this last year (20010-11).

Undergraduate Student

Name: Martin, Michelle

Worked for more than 160 Hours: No

Contribution to Project:

Michelle Martin did a great deal of work on the groundfish survey. She stuffed envelopes for our mail survey, called fishermen, and entered data in SPSS when the survey forms were returned. She also did a good deal of archival work on the history of groundfish management using newspapers, primarily Commercial Fisheries News. She analyzed data from the survey and archival study and used some of these data in her undergraduate Honors thesis. She received highest honors for this thesis. Michelle was paid, in part, from project funds. Her work on this project ended in 2009.

Technician, Programmer

Other Participant

Name: Gardner, Roy

Worked for more than 160 Hours: No

Contribution to Project:

Roy Gardner (Professor of Economics, Indiana University) was involved in organizing and running the experimental games portion of our project. He supervised Dymtro Zhosan, then one of his graduate students in Economics at Indiana University, who was also involved in this part of the study. The experimental games session with fishermen was carried out January 9, 2009. Dr. Gardner ran one of the two groups at that session. Since that time, he did part of the analysis of the data, and co-authored three articles with James Acheson and one with Dymtro Zhosan. He was paid from project funds as a consultant. Roy Gardner died unexpectedly on January 10, 2011.

Name: Zhosan, Dymtro

Worked for more than 160 Hours: No

Contribution to Project:

Dima Zhosan was involved in the experimental games section of the project. He spent the fall of 2008 organizing the materials and computer program for the games session. On January 9, he was involved in running one of the groups at the experimental games session with lobster fishermen and groundfishermen. Data from these games sessions were used in his Ph.D. dissertation. He also conducted additional experimental games with students from Bates College and Ripon College. He was paid from project funds as a consultant.

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Most of our efforts this last project year have gone to collaborating with each other (i.e., other people on this project) to get the results of our research analyzed and written up for publication.

Carl Wilson, who is the head lobster biologist for the State of Maine, and James Acheson are working on a joint article to bring together data that was collected on the lobster industry during the course of this project with data that Wilson collected in a 2009 survey of the lobster industry sponsored by the Maine Department of Marine resources.

Of course we have had contact with hundreds of groundfishermen, lobster fishermen and personnel of the Regional Council, the National Marine Fisheries Service, and the Maine Department of Marine resources. All of these people served as key informants; they were not collaborators in the usual sense of the word.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:

The students involved in this project have learned a good many research skills. Robert Snyder (Ph.D., Social Anthropology, York University) has done a great deal of key informant interviewing and has administered surveys to groundfishermen. Dymtro Zhosan (Ph.D., Economics, Indiana University)gained experience in organizing and running a big experimental games session. Both used data from this project in their dissertations. Both have completed their degrees. Zhosan defended his dissertation in the summer of 2009, and Snyder had his defense in September 2009. University of Maine undergraduate Michelle Martin did all of the jobs involved in survey research (mailing, calling respondents for follow-up, data entry), and has done a good deal of archival research; she received Highest Honors in May 2009 for her undergraduate Anthropology Honors thesis. Four other undergraduate work-study students played an important role in processing and tracking lobster fishermen survey forms and entering the data, learning to use several different programs in the process: EPI Info, Excel and Access; they also learned a good deal about research methods in the process.

Outreach Activities:

James Acheson and Carl Wilson, lobster biologist in the Maine Department of Marine Resources, are engaged in comparing and contrasting research results obtained in two separate studies of the lobster industry done in 2008-2009. They hope to publish a paper on this work soon.

Robert Snyder, who works for the Island Institute, has kept that organization abreast of our activities.

Two short articles about our research have appeared, both authored by reporters. One was in a University of Maine magazine, 'Coming Up Empty,' by Aimee Dolloff, UMaine Today, Winter 2009. http://www.umaine.edu/magazine/past-issues/winter-2009/coming-up-empty/ The other was in a printed and on-line newspaper geared toward the fishing industry, 'The Fishermen's Dilemma: NE Management Declared Disaster,' by Laurie Schreiber, Fisherman's Voice, June 2010, Vol. 15(6). http://www.fishermensvoice.com/index.html

Normally, social scientists do not publish in fisheries management articles. We have several articles published or coming out in journals where they will be seen by large numbers of fisheries managers. In the near future we will make an effort to get findings of this project publicized in places where fishermen, resource managers and members of the legislature will see them.

Journal Publications

James Acheson and Roy Gardner, "The Evolution of Conservation Rules and Norms in the Maine Lobster Industry.", Ocean and Coastal Management, p. 524-534, vol. 53, (2010). Published,

James Acheson, "Co-Management in the Maine Lobster Industry: A Study in Factional Politics", Conservation and Society, p. , vol. , (2011). Accepted,

James M. Acheson and Roy Gardner, "The Evolution of the Maine Lobster V-notch Practice: Cooperation in a Prisoner's Dilemma Game", Ecology and Society, p. 41, vol. 16, (2011). Published, http://www.ecologyandsociety. org/vol16/iss1/art41/

James M. Acheson, "Coming Up Empty: Management Failure of the New England Groundfishery", MAST (Maritime Studies), p. 57-86, vol. 10, (2011). Published,

James Acheson and Roy Gardner, "Modeling Disaster: Management Failure of the Gulf of Maine Groundfishery", North American Journal of Fisheries Management, p. , vol. , (2011). Accepted,

James M. Acheson and Ann Acheson, "Factions, Models and Resource Regulation: Prospects for Lowering the Maine Lobster Trap LimitT", Human Ecology, p. 587-598, vol. 38, (2011). Published,

Dymtro Zhosan and Roy Gardiner, "Problems of the Commons: Group Behavior, Cooperation and Punishment in a Two Harbor Experiment", Journal of Environmental Economics and Management, p. , vol. , (2011). Submitted,

James M. Acheson, "Ostrom for Anthropologists", International Journal of the Commons, p. , vol. , (2011). Accepted,

James M. Acheson and Roy Gardner, "Failure and Success in Fisheries Management in the Gulf of Maine", Rationality and Society, p. , vol. , (2011). Submitted,

Books or Other One-time Publications

James Acheson, "Cooperation and the Development of Conservation Law: The Case of the Maine Lobster Industry", (2010). Book, Published
Editor(s): Robert Marshall
Collection: Cooperation, Hierarchy and Social Life
Bibliography: Altamira Press

James Acheson, "The Future of the Maine Lobster Industry", (2010). Conference proceedings, publication staus undetermined as yet
Editor(s): Gulf of Maine Lobster Foundation
Collection: Do not know at present
Bibliography: Publisher not yet determined

James Acheson, "Territoriality in the Maine Lobster Industry", (2009). conference proceedings, publication status not yet determined
Editor(s): Not yet determined
Collection: Not yet determined
Bibliography: Pew Fellowship Program Meeting, Sebasco Estates, Maine Oct 16, 2009

Web/Internet Site

Other Specific Products

Product Type:

Meeting presentation

Product Description:

Paper presented at Experimental Games Workshop, Atlanta, GA, June 2009. Author: Dymtro Zhosan. Title: "Problem of the Commons: Group Behavior, Cooperation and Punishment in a Two-Harbor Experiment."

Sharing Information:

Presentation will be further refined and submitted for publication.

Contributions

Contributions within Discipline:

One of our major objectives was to contribute to the literature on how and why rules are developed. This is a very basic question in the social sciences, and one that has not been adequately answered. There is, in fact, no consensus, on the reasons rules come into being and the mechanisms involved. This project has allowed us to contribute to this very important body of ideas at the forefront of the social sciences. It also has some practical implications because it is very important to devise rules to effectively conserve resources in a world where resources are being over-exploited at a rapid rate. In the second and third years of the project we concentrated on writing up the data from our research to produce several articles on the factors promoting effective conservation legislation in the lobster industry and blocking the development of such rules in the groundfishery. We have used an evolutionary game theory model to analyze the data used in these articles. I believe our bringing together data and evolutionary models to understand the solution to the prisoner's dilemma problem faced by both of these industries will be a unique contribution of this research project.

To date, we have made several specific contributions to these ends.
(1) James Acheson and Roy Gardner have written two articles explaining the failure of groundfish management ('Coming up Empty' and 'Modeling Disaster'). We show that a large number of variables have raised the costs of developing high quality rules making it impossible for the groundfishing industry to solve the prisoner's dilemma they face.
(2) Two articles have been written using our model on the evolution of the conservation ethic in the lobster industry (J. Acheson 'Evolution of Conservation Rules and Norms in the Maine Lobster Industry' and J. Acheson and R. Gardiner 'The Evolution of the Maine Lobster V-Notch practice: Cooperation in a Prisoner's Dilemma').
(3) James Acheson has written 'Co-management in the Maine Lobster Industry: a Study in Factional Politics,' documenting the progress of the all-important Lobster Zones Management governance system--one of the best co-management systems in the world. This article specifically mentions the problems that this governance system has overcome to obtain conservation rules, and those remaining to be solved.
(4) James and Ann Acheson have written 'Factions, Politics and Resource Regulation,' documenting the ongoing efforts to get stricter trap limits for the Maine lobster industry.
(5) Robert Snyder's work documents the way in which groups of fishermen have self organized to develop additional markets, and, in the process, have come to lobby for more restrictive management rules.
(6) Dymtro Zhosan's work on experimental games suggests that cultural differences influence the way that lobstermen and groundfishermen played these games. Moreover the decisions of fishermen are different from those of students playing the same games, which again emphasizes that experience and cultural differences influence cooperation.

All of these efforts should serve to show anthropologists how evolutionary games and rational choice theory can be applied to problems of interest to anthropologists.

Contributions to Other Disciplines:

Our research makes contributions to three bodies of literature.

(1) Our work on the problem of how rules are developed will be of interest to the large number of social scientist from anthropology, economics, sociology and political science interested in rational choice theory and evolutionary game theory. Many have a major interest in understanding the circumstances under which people cooperate to devise rules to regulate the use of natural resources.

(2) Our work on successes and failures of fisheries management will be of interest to all those concerned with practical aspects of fisheries management. Many efforts to manage fisheries sustainably have failed. If managers are going to improve their performance, it is crucial to know what has worked, what efforts have failed, and why. Our work on lobster management provides a case study of successful management. Our case study on the management of the groundfishery provides sobering study in management failure.

(3) Roy Gardner and Dymtro Zhosan's work has contributed to the economics literature on coordination and common-pool resource appropriation problems by using experimental games with students, lobster fishermen and groundfishermen. Their work has demonstrated that there is evidence to support the ideas that lobster fishermen behave differently than groundfishermen. More specifically, their experiments provide evidence for 3 of 4 of our hypotheses concerning cooperation in allocating a common-pool resource. They also found that people who have real-life experience in fisheries behave differently in the experimental games than students who participated in similar games in a university setting. Culture and experience influence the ability to solve collective action dilemmas.

Game theorists usually operate as if people are relatively uniform and respond only to differences in circumstances. Cultural differences are generally not considered. The results of Zhosan and Gardner's experimental games strongly suggest that culture plays a key role in common pool resource allocational decisions.

Contributions to Human Resource Development:

The project has provided financial support and experience to two advanced Ph.D. candidates, one in Anthropology (as a research assistant, primarily doing interviewing of fishermen and officials of fishermen's organizations), and the other in Economics (as a consultant, doing game theory experiments with students, lobstermen and groundfishermen). One undergraduate student received financial support and participated in data collection and analysis, resulting in an Honors thesis in Anthropology. Four other undergraduate students were employed through the work-study program to process surveys and do data entry for the large-scale lobster fisherman survey, where they learned to use a data-entry program (EPI-INFO)and databases (Access and Excel).

Contributions to Resources for Research and Education:

No contributions to physical, institutional and information resources for research and education.

Contributions Beyond Science and Engineering:

When the publications from this project appear, we will make sure they are made available to people involved in fisheries management (i.e., legislature, agency personnel, leaders of the fishing industry). We hope that this will result in changes in fisheries management practices and policies. If it does nothing else, it should help government agencies and industry groups avoid some of the mistakes they have made in the past.

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

Any Web/Internet Site

Any Conference

ACTIVITIES

We have done several separate sets of activities connected to our four project components.

(1) Study of Current Social Organization and Culture. We carried out two mail surveys: (a) a survey of groundfishermen in which we had a return of 110 survey forms (out of about 600); (b) a study of lobster fishermen, from whom we received 702 forms (from a sample of 3,000). We also did a good deal of key informant interviewing with people in both of these industries. We collected a good deal of data on attitudes towards conservation and current problems in these industries.

In addition, during the course of analysis of groundfish data, a number of questions came to the fore and several gaps in our information became apparent. James Acheson contacted 21 agency personnel and New England Regional Fisheries Management Council members (past and present) to get additional information on these issues.

In the third year of the project, 129 lobster fishermen who returned the 2009 lobster survey and said they would be amenable to giving additional information were interviewed over the phone. They were asked to comment on four issues of current importance in the industry. These were: (1) their views on a stricter trap limit; (2) the operations of the zone management system; (3) current economic problems; and (4) their views on offshore wind power. These interviews were very successful and the data collected will be used in future publications.

(2) The History Study. On this project we did a lengthy study of groundfish management over the course of the past 40 years, using the archives of the *Maine Commercial Fisherman* and *Commercial Fisheries News.* We also did key informant interviews with past and present officials involved with groundfish management and officers of fishermen's organizations. We completed our study of the history of lobster management. This included key informant interviews with 21 older lobster fishermen who were between 85 and 100 years old. We also did a substantial work in the Maine State Archives. In the Archives, we focused especially on the "Correspondence of the Commissioner" and Department of Marine Resources Annual Reports.

(3) Experimental Games. The experimental sessions were conducted at multiple locations starting in 2009. On January 9, 2009 a session involving a population of professional Maine lobstermen and groundfishermen was held at The Darling Marine Center of the University of Maine. Dymtro Zhosan and Roy Gardner ran this session. The experiments went very well. These data were analyzed by Zhosan and Gardner. Dymtro Zhosan ran other sessions involving students at Bates College and Ripon College at later dates. The additional data for the experimental game project was collected from Ripon College students in the spring and summer of 2011 to augment the number of game runs done in the earlier sessions. This was done to satisfy reviewers of the article submitted to the *Journal of Environmental Management and Economics*.

(4) Evolutionary Game Theory. We have used a three parameter model developed by Roy Gardner to bring together our experiments with the historical data and ethnography to understand the factors involved in affecting conservation legislation in the lobster and groundfish industries. This part of the project resulted in a good deal of information on the factors influencing the differential development of conservation rules and norms in the lobster and groundfish industries.

FINDINGS

The objective of this project was to explain the differential success of the Maine lobster industry, where catches in recent years have been at record highs, with that of the groundfish industry where catches and stock levels have been very low. Our studies show that that the essential difference is that the lobster industry has a conservation ethic which has allowed it to develop rules to control fishing effort; the groundfish industry has not been able to do this. This takes us into one of the most important questions facing social scientists—namely under what conditions do groups of people develop norms and rules and why they do so. We have approached this question from the perspective of rational choice theory and evolutionary game theory. Not only has this body of theory illuminated our case study and historical material, but we have been able to make some contribution to these bodies of ideas.

Our data and analysis indicate that a very large number of interactive factors played a role in developing a conservation ethic in the lobster and impeding the development of such an ethic in the groundfish industry. Among the most important are: fishing effort and catch levels; industry support for new rules and enforcement of them; industry heterogeneity; industry consensus on policies; bureaucratic complexity and delay; technical and biological factors of the respective fisheries; science and the views of fishermen; and the scale at which management is attempted.

I will first describe the history of the way that rules developed in the lobster industry and then describe the reasons rules did not develop in the groundfishing industry. After this I will describe the model we developed to account for these facts in general terms. Then I will go deeper into the evolutionary theory to explain the events in these two industries.

Historical and Ethnographic Perspective

The development of a conservation ethic in the lobster industry was the result of an evolutionary process in which a number of interactive variables worked to move the industry from a pirate ethic to the conservation ethic. In the early years of the 20th century, many fishermen, perhaps the vast majority, adhered to the pirate ethic. They took short lobsters in large numbers and scrubbed the eggs off egg-bearing females. The pirate ethic was reinforced by the additional income violators received from the short lobster trade. Those who obeyed the law sacrificed income, and those who tried to uphold the law were sanctioned. Under these conditions, many fishermen ceased to obey the law in an effort to get their share. Fishermen assumed that exploitation by humans did little to damage the resource.

The lobster bust of the 1930s was a catastrophe for the lobster industry, causing 40 percent of the lobster fishermen to go out of business. It buttressed a message that Commissioner Horatio Crie and biologist Francis Herrick had been preaching for years—namely that the industry was damaging the resource by illegal activity and that a double-gauge law was needed to protect the breeding stocks. As the Depression wore on, increasing numbers of fishermen became convinced that piracy was seriously damaging the stock—a process that Henrich and Henrich (2007) call "cultural learning." An increasing cascade of fishermen began to report violators of the law, which made the wardens more effective. This resulted in more convictions and led to the end to the massive interstate trade in illegal lobsters (Acheson and Gardner 2010)

This change in attitudes concerning the benefits of conservation also increased support for the double-gauge law to the point where the legislature was finally able to pass it in 1933. A shift in the number of people favoring a particular course of action can have a decisive effect on

the development of rules. In the early decades of the 20th century, there was not enough industry support to pass the double-gauge law. By the 1930s enough fishermen had become convinced that illegal activity was damaging the stock and support for the double-gauge law increased sharply by 1933. This, in turn, led to the formation of a powerful coalition of fishermen, tourist-industry representatives, the commissioner of the Department of Sea and Shore Fisheries, and legislators. They won in the legislative arena against a less powerful coalition of fishermen who wanted to maintain the high minimum size measure. The passage of the double-gauge law is a classic example of the process described by Knight—a case where a rule came about in the aftermath of an acrimonious distribution fight over who would get the resource. As Knight (1992) predicts, the more powerful faction won.

By the end of the 1930s, there was an increase in catches. Many fishermen and biologists credited the decline in illegal activity and the double gauge for the catch increase. This reinforced the idea that the secret of lobster conservation was conserving the breeding stock. After World War II, returning veterans gave conservation a push forward by voluntarily supporting the V-notch practice, which put even more large females in a sanctuary category. [The law states that no egg-bearing female may be taken. When a fisherman catches an egged female he may put a notch in her tail. That animal may not be taken as long as the notch lasts, which may be several molts. This is a voluntary program, since no one knows whether you have done this. Thousands of fishermen do it. Fishermen generally believe that the V-notch practice is the backbone of lobster conservation.] The result was that lobster catches increased and then stabilized at approximately 20 million pounds per year after 1947. Many fishermen began to operate with a low-discount-rate strategy as they became increasingly convinced that investing in lobster conservation rules would benefit them with higher future catches (Acheson and Gardner 2010).

In recent decades, the upward spiral continued. In the 1970s, efforts to get an escape vent bill received support of a majority of fishermen, and in the late 1990s, efforts to get trap limits and limited entry rules for the lobster zones were passed with huge majority votes (Acheson and Gardner 2010). The lobster industry played a key role in the passage of all of these new laws. By 2009, the vast majority of fishermen had become convinced that the conservation rules were working (see Acheson and Gardner 2010). Although not the majority, a large percentage of fishermen favor even stricter trap limits than the trap limit rules in place in their zones. In summary, the upward spiral to a conservation ethic in the lobster fishery was fueled by the passage of rules, more enforcement, and increasing catches. This led lobster fishermen to a conviction that they knew how the ocean worked, a low-discount-rate strategy, and a conviction that more rules were in their interest. They supported the development of such rules.

While lobster management is quite successful, our studies found two areas where lobster management might be improved. First, the co-management system (i.e., the zone management system) has failed to address several important problems in the past few years. I analyze the factors affecting the performance of the co-management system in an article (Acheson in press). Second, there is reason to believe that stricter trap limits would result in considerable savings in fuel, bait and labor. Many lobstermen understand this and support a stricter trap limit; others, paradoxically, do not in spite of the gains it would bring them (Acheson and Acheson 2010).

The groundfishery presents a picture of failure. From 1977 to the present, a number of different management plans, ranging from quotas and gear restrictions to seasons, closed areas, days at sea, and sectors, have been tried on the New England groundfishery. Unfortunately, nothing seems to have worked (Acheson 2011).

When management of groundfish began in 1977 after the passage of the Fisheries Conservation and Management act, the stocks were already low and fishing pressure was high. After imposition of the Hague Line in 1984 American boats could no longer fish on the Grand Banks, in the gulf of Saint Lawrence and parts of Georges Bank where they had fished for centuries. Many of them switched to fishing throughout the year in the Gulf of Maine, further devastating the stocks in that a region. Fishing pressure on the stocks was increased further by the federal loan programs designed to build up the US fleet (Acheson 2011). Furthermore, the unselective fishing technology and fish biology leads to high mortality of caught fish.

Since fishermen did not choose the rules governing the groundfishery and perceived the rules as costly, unenforceable, ineffective, and based on a false scientific model, they responded with opposition, lawsuits, and illegal activity. This opposition, combined with bureaucratic complexity and jurisdictional disputes within the National Marine Fisheries Service (NMFS), caused the New England Fisheries Management Council (NEFMC) to stall in imposing effective rules (Apollonio and Dykstra 2008). Delay was probably deadly.

Groundfishermen have a short-term perspective, and nothing in the institutional structure of the management regime gives them an incentive to invest in high-quality conservation rules. Faced with falling stocks and ineffective management, they are not inclined to invest in conservation rules that have no assurance of working. Rather, they focus on staying in business in the short run and hope stocks will not be unduly damaged by fishing. Widespread cheating further undermines conservation efforts; those who conserve fish are sacrificing, while the rewards are being taken by the "free riders."

New England groundfish management follows a familiar pattern. Scientists issue a stock assessment indicating that the stocks have fallen and tighter regulations are needed. The NEFMC and NMFS, after years of deliberations and negotiations, put out new regulations, which are strongly opposed by the industry. After a time, the regulations prove ineffective, stocks decline further, and the pattern is repeated. The failure reinforces the groundfishermen's opinions about the poor quality of science and the ineffectiveness of the rules. A gold-rush mentality, cheating, ineffective regulations, political opposition, and stock decline follow each other in an ever more desperate downward spiral.

Both fishermen and the management bureaucracy must share the blame for this failure. Who is to blame for this downward spiral? The NEFMC and NMFS made mistakes, and the groundfishermen generally responded in ways to block effective management rules whenever possible.

Why has the New England groundfish industry failed so far to develop high quality rules to conserve the stocks of fish? There are four different factors involved, which I will describe below, in very general terms. One is the balance of benefits of investing in a better quality rule that would conserve fish as opposed to the costs of doing so. In the groundfish industry, the benefits of devising high quality rules are lower than the costs. Under these conditions, people have a strong incentive to play the dominant strategy, and block efforts of the NEFMC to pass more stringent rules. In the lobster industry the benefits of a high quality rule are higher than the costs, which lead to a willingness to devise better rules and enforce them.

There are several different kinds of factors that influence fishermen's assessment of the costs and benefits of cooperation. Two of the most important I will discuss here, and the others when I discuss the evolutionary model below. One set of factors affects the time horizons of fishermen. As a general principle, if it is unlikely that resources will be there in the future or if investment in resources will not bring future benefits, there is little incentive to sacrifice current

harvests for future rewards. Rational-choice theorists have long recognized that a high discount rate lowers the willingness of people to get rules and invest in the preservation of a resource (Ostrom 1990).

There are a number of factors that make it rational for groundfishermen to have a very short time horizon. One is the fact that there is a good deal of illegal activity in the fishery which makes it less likely that one will receive a benefit from conservation rules. Another is a long history of declining catches, which reminds fishermen that tomorrow's catches are likely to be less than those one gets today. A third is lack of faith in science which fishermen believe means that the stocks are not likely to improve. Last is the need of fishermen for income now to pay off mounting debts. Many fishermen, in short, cannot afford to invest in the future of the fishery given the high costs and low benefits such an action would entail. Under these circumstances, one is only being rational to take all the fish possible as fast as possible. Why sacrifice present gains when you believe the fishery is in inexorable decline, and neither you nor your children will reap the benefit of any sacrifices made (Acheson and Gardner in press)?

It should be noted that some factions did try, on occasion, to get such rules. Groundfishermen worked to get what they considered high quality rules in framing the first attempt to get the first comprehensive groundfish plan in 1985, but NMFS "disapproved" this plan (Acheson and Gardiner in press). Some factions of fishermen tried to negotiate rules when amendments 13 and 16 were being developed. Most were badly frustrated (Hall-Arber 2006; Snyder 2006). Most of the time, fishermen resisted attempts to manage their fishery. Given their perception that the NEFMC's efforts to manage their fishery are likely to produce little, their actions have a certain logic.

In the lobster industry, by way of contrast, there is good compliance with the law and comparatively little illegal activity; lobster catches have been stable since 1947 save for the past 20 years when catches have been at historic highs; and generally the lobster fishing industry has experienced good profit margins, motivating a general move into the industry. Moreover, the lobster industry has a good deal of faith that the existing laws are working so that future catches will be good. They have a long time horizon (see Acheson and Gardner 2010: 530).

Another set of factors influencing the willingness to support the development of high quality conservation laws are transaction costs. That is, not all costs and benefits are monetary. Some involve the time and effort to get rules to conserve resources (Williamson 1986). It is axiomatic among rational-choice theorists that characteristics of the community influence transaction costs and thus play an important role in the development of norms and rules. People will be more likely to provide themselves with rules leading to joint benefits if they know each other's past performance, if the game is played repeatedly, and if the rules can be enforced (Elster 1989; North 1990; Ostrom 1990, 2000a, 2000b; Taylor 1990; Knight 1992). Under these circumstances, people know who is likely to cooperate, can monitor behavior, and can sanction free riders. For this reason, norms and rules are more likely to be produced by people in small, homogenous communities with a long history and a sense of community (Ostrom 2000a). Lobster fishing is highly territorial so that these fishermen spend their working lives in a small area of ocean which they exploit jointly with a small group of fishermen from nearby harbors. These fishermen know each other very well and they are able to monitor each other closely. This helps to make lobster conservations rules self enforcing.

The groundfish industry has virtually none of the community characteristics that lower transaction costs. Fishermen are scattered throughout New England and constitute a loose social

network. Most do not know many other people in the industry, and they do not form a community with a long history.

Transaction costs are also affected by industry heterogeneity. The groundfishery is highly heterogeneous. People fish for different species with different types of gear from different size boats at sea for different lengths of time. There is also ethnic heterogeneity (Doeringer et. al. 1986). As a result of these several types of heterogeneity, it is impossible for the industry to frame conservation rules informally. It is also impossible for government agencies to generate rules that everyone considers fair. Different factions have lobbied the NEFMC to get rules that benefit them at the expense of other factions. There is nothing unusual in this situation (see Knight 1992), but these factional disputes have made it impossible for the industry to present a united front and have caused a good deal of conflict during the process of developing regulations in the NEFMC. (See Acheson 2011 for more on the development of New England groundfish management regulations.) All of these factors have lowered the benefits to be obtained from investing in more effective conservation rules.

The lobster industry, by way of contrast, is highly homogenous. The boats are approximately the same size, everyone uses lobster traps baited with fish remnants, and the boats are equipped with hydraulic haulers and much the same kinds of electronic gear. As a result, rules will generally affect all lobster fishermen in a region in much the same ways, making it much easier to come to consensus on the desirability of a given proposed rule.

Transaction costs are also raised by the top-down nature of the management system in place. Rational-choice theorists have considerable evidence that effective resource-management rules arise if local-level communities have a hand in developing the rules (Ostrom 2000b). People who play a role in developing resource-management rules will promulgate rules they consider effective in conserving the resource when they do not impose undue costs. Such rules can be self-enforcing (Ostrom 2000a). There is a growing body of evidence that top-down management does not work well (Acheson 2006). The rules to manage the groundfishery were put in place by the NEFMC, which was pushed in many directions by a variety of groups and organizations. To be sure, industry factions have tried mightily to influence the NEFMC and the rules it promulgated. However, the NMFS, judges, the U.S. Congress, scientists, and conservationists have also had a great deal of influence. Some very important parts of the groundfish plan (i.e., amendments) were the result of lawsuits by conservation organizations, and others were motivated by the finding of federal scientists. At one point, the fate of Amendment 13 was in the hands of a federal judge. This is the antithesis of bottoms-up management. Fishermen trying to lobby for better rules have spent enormous amounts of time and effort with little to show for it. Again, this raised the costs of working for rules that would be acceptable to the industry and reduced the benefits of such an effort. The industry has resorted to trying to stall the imposition of stricter rules by the NEFMC.

In the Maine lobster industry the rules were put in place by the legislature, usually in response to heavy lobbying in the lobster industry (Acheson 2003, Acheson and Gardner 2010). If the industry is united against a bill, it will not be enacted into law. Since 1995, many important rules (i.e., fishing times, limited entry, trap limits) are put in place by zone councils, elected by the lobster fishermen in each of seven areas along the coast. These councils propose referenda. If the proposed rule or rule change passes with 2/3 of the vote, it becomes part of the regulations of the department of Marine resources and is enforced by the warden force.

Experimental Games

Originally, we had hoped that the results of the games experiments would demonstrate that there was a cultural difference between lobster fishermen, who have conservation ethic, and groundfishermen, who do not. Our experiments did support this initial supposition, but not as strongly as we'd hoped. Several hypotheses were tested in the experimental setting.

First, we hypothesized that the introduction of an enforced (through a moving cost) geographic separation in the game would increase the appropriation efficiency on the commons even without an outside authority assigning the subjects to specific areas. While final experiments to complete the testing of this hypothesis are currently being conducted, the data to date allow us to conclude that introducing the enforced separation increases the efficiency significantly in a simulated CPR environment. Just by solving the coordination problem with five people fishing in one area and three people fishing in another area, the subjects were able to achieve a level of efficiency of at least 75%, and the average efficiencies were around 80% - much higher than in experiments with no separation. Also, once reached, the 5-3 allocations were quite stable with subjects seldom trying to move to a different area, even if the other area had a slightly higher payoff.

Second, we hypothesized that introducing communication within fishing areas would increase efficiency significantly. While this is a known result in the literature, the increase in efficiencies we obtained was much higher than any previously reported, with efficiencies increasing to close to 100% across all groups – students and professional fishermen. Since most of the groups were able to achieve high cooperation levels and maintain them without a typically observed decrease in cooperation close to the end of a session, we can conclude that by creating smaller groups geographic separation allows for a better group identity, and thus diminishes the incentives to cheat on a group agreement. We have also hypothesized that introduction of an informal punishment mechanism (where a subject being punished does not lose anything financially, but is merely informed that others are not satisfied with their actions) would increase efficiency by lowering the defection rate on group agreements. With 7 of 8 groups showing an increase in efficiency once the sanctioning was introduced, we can conclude that the mechanism was effective. Also, the specific mechanism design proved to be effective even in the later rounds of the games, even though previous research shows the decrease in the effectiveness of informal punishment closer to the end of an experiment.

When it comes to specific subject pools, we had two working hypothesis before the experiments were run. While the number of samples utilizing professionals is too small to make any statistically significant inferences, some behavioral observations can be made.

First, we hypothesized that fishermen will be able to achieve higher efficiency than the students, simply based on their experience in a similar real-life environment. The data seem to offer some degree of support to this hypothesis. In the settings where communication and punishment were not available, the fishermen were able to achieve average efficiencies of between 5.65% and 19.5% higher than the students, showing that experience does matter, and that fishermen who are used to limiting their effort in real life tend to do the same in the lab. Additionally, relatively more fishermen than students were able to correctly identify that the optimal strategy would be to fish for less than the full available effort. As institutions became more complicated (communication and punishment were introduced) the difference in efficiencies between students and professionals became insignificant, demonstrating that institutions can replace experience (a case for co-management on a commons).

Second, we hypothesized that lobstermen would be more cooperative and would achieve higher efficiencies in the experiment than groundfishermen. While the numbers (and limited sample size) do not allow us to make conclusions about the efficiencies, lobstermen clearly were more cooperative than groundfishermen. Any deviations from equilibrium allocation of subjects in the communication rounds among lobstermen were a result of a group agreement to try and find the way to "outsmart the system" rather than individuals' efforts to cheat on group agreements. At the same time, among groundfishermen a single individual refused to communicate and cooperate with the others claiming "…this is not how we do it in real life. In real life we keep our decisions secret and do not share with the others." Only when faced with a possibility of losing points (about $1 per point when converted to money) due to punishment did this person start cooperating. Punishment was never used among the lobstermen, indicating a higher degree of group identity.

Evolutionary Game Theory

Generating rules to effectively manage resources is a difficult task. Earlier analysts saw the problem in terms of the common property nature of fish stocks and the oceans (Hardin 1968; Acheson 1989). Since fish stocks are owned by no one, it is in no one's best interest to protect these resources or invest in them. Under these conditions, it is only rational that one takes as many fish as possible as quickly as possible. Why protect a stock of herring at 0800 when someone else will just take them before noon?

A more modern way of phrasing the problem is in terms of a collective-action dilemma. These are situations where rational action by individuals leads to disaster for a larger collectivity (Elster 1989; Hardin 1982; Hawkes 1992; Olson, 1965; Ostrom 1990; Taylor 1990). In collective-action dilemmas, it is not rational for individuals to cooperate in limiting their exploitive effort even though rules to conserve the resource will bring positive results for all. The essence of the problem is that there is a divergence between what is rational for individuals and what is optimal for the society. Marine fisheries present the quintessential collective action dilemma. It is in the self-interest of skippers to catch as many fish as possible and to resist establishing rules to conserve the stocks. The result, all too often, is overfishing, destruction of the breeding stocks, stock failure, low incomes for fishermen, and high prices for consumers. All skippers have acted rationally, but the result is negative for everyone. In most fisheries, effective conservation rules have not been developed and large numbers of fish stocks are dangerously overexploited. Such failures to solve the collective-action problem have been documented in great detail in the literature on fisheries and common property resources (Acheson 1989; McGoodwin 1990; Ostrom 1990). The New England groundfishery is a classic case of management failure. The industry has not been able to constrain exploitive effort by informal means, which Taylor (1990) calls a "decentralized solution." Efforts of the government to get formal rules, "a centralized solution," have been rebuffed by the industry.

One of the most common solutions to collective-action dilemmas is to create rules to sanction people for behaving in ways that are not socially optimal. Unfortunately, it is not clear under what conditions such rules arise or what processes are involved.

Collective-action dilemmas can be modeled as various types of games (Dixit and Skeath 2004: 383-393). The dilemma facing those who would manage the New England groundfishery is thrown into sharp relief by framing the problem in terms of a prisoner's dilemma game. In the grammar of the prisoner's dilemma game, both players have a dominant strategy, but if both players playing the dominant strategy they end up with a worse payoff than if they had played

their dominated strategy.

For heuristic purposes we have made up a set of payoff inequalities that conform to those required for a prisoner's dilemma game, which are presented in Figure 1.

Figure 1. Hypothetical Payoff Matrix for Prisoner's Dilemma

		Player 2	
		Cooperate	*Defect*
Player 1	*Cooperate*	*5,5*	*1,7*
	Defect	*7,1*	*2,2*

If both players cooperate, both get good rewards (i.e., 5 each). If both defect, the result is very low payoffs (2 each). Unfortunately, if one defects and the other does not, the defector gets a large reward (7) and the other gets a very low payoff (1). The very high reward for defection motivates both players to defect. Defect/defect is the dominant strategy. The result is that they get the worst of all possible total payoffs, 2 each. In the case of some fisheries, it is rational not to cooperate to produce effective conservation rules. But if all players act rationally, the result is low total payoffs. A rule that one must cooperate (i.e., avoid the dominant strategy) results in higher playoffs. However, it is difficult to motivate people to cooperate. After all, it is rational to defect—at least in the short run (Dixit and Skeath 2004: 397-398).

The difference between the groundfishery and the lobster industry is that the people in the groundfishery have not solved the prisoner's dilemma they face; the people in the lobster fishery have. The groundfishermen are behaving in a rational fashion and are playing their dominant strategy. The people in the lobster industry are doing something very unusual –namely they have been able to play their dominated strategy, which is very difficult to do.

What factors have allowed the lobster industry to overcome the dilemma it faces while blocking the groundfishery from doing so? To answer this question, we have developed a simple evolutionary model that permits analysis of the changes in the industry (see Appendix 1, Acheson and Gardiner 2010 for an abbreviated version of this model).

There are two aspects of the lobster and groundfish industry historical case studies that are highlighted by this model. First, this is a tipping point model which has been used to predict the levels of cooperative behavior. If a high percentage of a population cooperates, others will follow; if only a few cooperate, then smaller and smaller numbers will cooperate to avoid being a "sucker" (Poteete et al. 2010). It means that the payoffs to fishermen depend greatly on the behavior of others. If no one or only few fishermen adopt a high quality rule (strategy 0 in the model), then the number who will do so eventually declines.

In the case of the lobster industry, the model indicates that if the population starts out with nearly all fishermen having a pirate ethic, then evolution will lead to a population with all fishermen having that set of attitudes and behavior—that is the evolutionary stable strategy. If the population starts out with nearly all fishermen having a conservation ethic, then evolution will lead to a population with all fishermen having that ethic. The payoffs increase along the evolutionary path towards a good equilibrium. In the lobster fishery, that tipping point has been

reached. Under these conditions, players cooperate and adhere to a high quality conservation practice (strategy 1 in the model). We use the same argument in the case of the V-notch practice in the lobster industry (Acheson and Gardiner 2011). They have escaped the prisoner's dilemma, which is a difficult feat. This gives them high joint benefits (Axelrod 1984; Samuelson 2002; Gardner 2003; Dixit and Skeath 2004).

Our model and the literature on evolutionary game theory suggest it takes a major event, a shock to the system, to change the system from one equilibrium to another. Key-informant interviews indicate the lobster bust of the 1930s was an experience that decisively shifted the lobster fishery to developing a conservation ethic. This devastating event convinced many in the industry that the wholesale violation of the existing laws was causing serious harm. There is a good deal of historical evidence that once the number of people adhering to the rules had reached a critical adoption size, then there was a cascade of others joining the effort to get better laws and enforce them. Increased enforcement made it ever more risky to violate the law. However, it is very important to note that this depended on a change in the culture of lobstering. Many fishermen would have had to be convinced that illegal behavior was detrimental to their own best interests; that enhancing the size of the breeding stock could be accomplished by preserving large females; and that V-notching gave large, joint benefits (Acheson 2003; Acheson and Gardner 2011). The switch from one strategy to another can happen quickly as the "evolution of cooperation is strongly affected by the presence of punishment" (Boyd and Richerson 2005: 244). In short, the cost of defecting from the high-quality rule grew rapidly as the probability of being apprehended grew.

No such conversion occurred in the groundfishery despite the record low levels of fish stocks, the increasingly tightened regulations, and numbers of boats going out of business. All of the evidence suggests that most groundfishermen know that stocks have been overfished. Many of those remaining in the industry would like to do something to conserve groundfish stocks, but they are unwilling to invest much. When they worked for what they considered sensible rules in 1985, the NMFS refused to consider them. Groundfishermen do not think that the most recent management effort, Amendment 16, will succeed in rejuvenating the stocks. Moreover, their financial situation is so desperate they cannot afford to sacrifice current catches for future gains (Acheson 2011).

Second, the model indicates that fishermen have an engage in a high quality practice when the benefits of cooperating are higher than the benefits of staying with a poor-quality practice. In terms of the model, this is case 1, where $b/n > c$. Only under these conditions do fishermen have a strong incentive to play their dominated strategy (i.e., V-notch) (see Appendix 1, Acheson and Gardiner 2011).

The ethnography indicates there are several kinds of costs and benefits involved in adopting high quality rules. I will use the lobster industry V-notch practice to explain these. First, there are benefits in terms of larger catches which are likely to materialize in the future. These gains come far in the future and are shared by everyone. The extent of those benefits depends on the proportion of fishermen who V-notch. Second, those who V-notch when everyone else is doing so get a benefit in terms of increased reputation. Fishermen who do not V-notch when many others are doing so suffer some loss in reputation. Third, fishermen who V-notch get a psychic benefit for conserving the resource by ensuring a way of life for themselves and their communities. Fourth, everyone who V-notches pays a cost in terms of time spent, but the costs are reasonably low. It only takes 30 seconds to V-notch a lobster, an average daily loss

of 10 minutes. Adoption of the oversize measure in the 1930s brought another set of benefits and costs.

It is always difficult to solve prisoner's dilemmas. Unfortunately, the three most common explanations for why cooperation can occur in the face of a prisoner's dilemma do not explain the practice of V-notching. (See Acheson and Gardner 2011 for a detailed discussion of why these explanations do not apply.)

There is a growing amount of new work on cooperation, however, that gives insight into the reasons that people may cooperate in the face of a prisoner's dilemma. There are two ideas stemming from new work on social evolution that are helpful in explaining V-notching, one concerning reciprocity and the other the discount rate.

Axelrod (1984) argues that two factors can induce cooperation in a prisoner's dilemma game in addition to rules. One of these is altruism, which involves teaching people to put the welfare of others ahead of purely selfish gain. Another is reciprocity. Recently other authors have extended these ideas in ways that help to explain the reason many fishermen V-notch lobsters.

Nowak and Sigmund make a distinction between direct reciprocity and indirect reciprocity, or third-party altruism. Direct reciprocity is based on the principle "You scratch my back and I will scratch yours," so that both achieve a greater net benefit. Indirect reciprocity or third-party altruism refers to a situation in which there is no necessary reward for the people who help others: "You scratch my back and I will scratch someone else's" (Nowak and Sigmund 2005). The V-notch falls into the category of indirect reciprocity, and indirect reciprocity is difficult to understand. Nowak and Sigmund (2005) and Nowak (2006) stress that indirect reciprocity is rewarded by less tangible factors, including a reward in terms of greater reputation.

Gachter and Fehr (1999: 341) have found that approval incentives such as better reputation "alone are not sufficiently strong to cause a reduction in free-riding." In combination with some minimal social familiarity, however, approval incentives generate a significant increase in cooperation and a reduction in free riding. Most lobstering communities have a long history. They are small, homogenous places with a strong sense of community. Many people in them know each other well. If the work of Gachter and Fehr is correct, it is in such communities that having a higher reputation could result in more cooperation and less free riding.

The discount rate, or what Axelrod (1984) calls the "shadow of the future," can influence the willingness to cooperate. He says that mutual cooperation can be stable if the future is sufficiently important relative to the present. According to Axelrod (1984:109), "in a Prisoner's Dilemma, the player has a short-run incentive to defect, but can do better in the long run by developing a pattern of mutual cooperation with the other." However, the player will only do this when he or she is convinced that the discounted benefits of future cooperation to be obtained over time outweigh the one time immediate benefits to be had from defection (see Dixit and Skeath 2004).

There are two factors that make lobster fishermen operate with a low discount rate and invest in the future. First, they are convinced that conserving the breeding stock results in greater future catches if enough people are involved. Second, they are convinced enough fishermen are abiding by such high quality rules to produce those benefits. High quality rules such as the V-notch practice involve a leap of faith. There is nothing to ensure that an egged lobster will ever produce eggs again, or that enough other fishermen are V-notching to increase future catches appreciably. If this is true, then the underlying cause of V-notching can be traced to cultural factors.

There is a third possibility, which is development of a conservation ethic by changing the subculture of the industry. Among game theorists, the technical term for this is "social preferences," where a player's payoff no longer depends just on his or her economic result, but more broadly on the overall outcome. In game theory, the term "social preferences" refers to the concern (or lack thereof) that people have for each other's welfare. It encompasses a wide variety of behaviors, including altruism, reciprocity, an interest in equality and justice, and a willingness to punish those who deviate from norms or laws. A review of the literature finds a growing number of cases where people are more cooperative than would be predicted based on games such as the prisoner's dilemma (Ostrom et al. 1994; Nowak, May and Sigmund 1995; Fehr and Gachter 2000; Camerer 2003). Henrich and his colleagues say that "researchers from across the social sciences have found consistent deviations from the predictions of the canonical model of self interest in hundreds of experiments from around the world" (Henrich et al. 2005). They go on to show that culture plays an important role in determining game strategies leading to cooperation (Henrich 2000; Henrich and Henrich 2007).

It is possible to develop an industry sub-culture with a conservation ethic. This has occurred in the Maine lobster industry which has supported conservation rules and good enforcement, and has seen catches rise to record-high levels (Acheson and Gardner 2010). Under the right circumstances the groundfishery of New England might get out of its dilemma by following the lead of the lobster industry.

However, as a practical matter, it would be difficult for groundfishermen to develop a conservation ethic because this would mean a thorough makeover of their beliefs, values and behavior (i.e., the culture). This can only occur if the institutional framework permits experimentation and allows people to accept the rules that work and reject those that do not (Axelrod 1986; Ostrom 1990, 1999). In the process, there is a reassessment of beliefs and knowledge in which new cultural values are adopted. Institutions matter and have an important link to beliefs and values (Boyd and Richerson 2005; Poteete et. al 2010). If the institutional framework is too restrictive, experimentation and learning do not take place. Unfortunately the groundfishery of New England finds itself enmeshed in an increasingly rigid top-down management system mandated by the two reauthorizations of the FCMA. These call for annual catch limits, stock-rebuilding timetables, mandated management techniques, and habitat protection closures. The kinds of cultural changes needed to develop a sense of stewardship do not develop in such an environment. Ostrom has pointed out that such top-down policies "frustrate the development of private provision of public goods," including rules and the subcultures that give rise to them (Ostrom 2000a:38).

Occasionally, opportunities have arisen which could have led to the development of a conservation ethic. Amendment 16, for example, which went into effect in May 2010, might have provided an institutional structure that could have allowed groups of groundfishermen to experiment. This might alter beliefs, values, and behavior and lead to a conservation ethic. Amendment 16 calls for sector management, with groups of fishermen receiving a quota and deciding among themselves the rules by which those fish would be taken (*Commercial Fisheries News* 2007). (See Acheson 2011.) Since there is increasing evidence that groundfish stocks are quite localized (Ames 2004; Steneck and Wilson 2010), some groups of fishermen, including those involved in the Area Management Council led by Maine fisherman Craig Pendleton, wanted sectors that involved discrete areas and permit banking (Snyder 2006). The "Downeast Initiative," composed of fishermen from the Stonington, Maine area, had a similar plan (Pinto daSilva and Kitts 2006). Such plans would have meant that a group of fishermen would be

allocated a quota by the NEFMC and a bounded area of the ocean where they alone could fish. They would have been allowed to buy up permits and retire them permanently or to temporarily reduce fishing pressure in this bounded area. Under these conditions fishermen would have an incentive to conserve since they would gain all of the benefits if the fish stocks in that area revived. These increases in catches and income would presumably have lead to a positive attitude toward conservation and a willingness to enforce the rules. This could have led to a greater willingness to cooperate with the NEFMC.

Unfortunately this was not to be. The NEFMC decided to impose sectors, but to allow fishermen to roam the American sector of the Gulf of Maine and take fish anywhere (Plante 2010). Under these conditions, fishermen will have no incentive to constrain themselves to get larger future stocks; efforts to get more effective conservation rules will not be supported by fishermen; and the gold-rush mentality will continue. If this occurs, then actions of the government will have produced exactly what should be avoided—attitudes antithetical to conservation. It is ironic that some of the impetus for the downward spiral has been produced by actions of government agencies that sincerely want to conserve the fish. Development of stewardship and a conservation ethic depends on having the right kind of institutional framework. Such a framework does not exist in the groundfishery of New England.

We suggest that New England groundfishermen will not support government initiatives to manage the stocks until they develop a different sub-culture, a conservation ethic, motivating them to cooperate in producing effective rules. Unfortunately the day when that kind of cooperation is common has yet to arrive.

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