Evolution of Social Capital and Economic Performance in New England Harvest Cooperatives

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ABSTRACT

In 2010 a new management system based on harvest cooperatives called "sectors" was implemented in the US Northeast Multispecies Groundfish Fishery. We hypothesize that success of individual sectors might depend on their social capital. Sector members were surveyed prior to the implementation of the policy to develop baseline measures of social capital for each sector and again after the sectors had been operating for three years. We construct indices of bonding, bridging and linking social capital, information sharing, and trust and explore how these indicators of social capital have changed since the implementation of the sector program. We also evaluate the relationship between these social capital indicators and various measures of economic performance of sectors. The result suggests that the relationship between social capital and economic performance has strengthened over time. Profitability is associated with broader community and fishery-wide connections as well as bonding social capital within sectors.

Key words: Social capital, cooperatives, co-management, fishery.
JEL Codes: Q22.

INTRODUCTION

In 2010, the New England Fishery Management Council implemented a new management system in the New England groundfish fishery based on harvest cooperatives called "sectors." Catch quotas comprising over 95% of total commercial groundfish quotas were granted to 17 sectors. Each year, each sector is granted annual catch entitlements (ACE) of up to 16 different groundfish stocks, based on the collective catch history each member brings to the sector. Sectors must keep their total catch of each fish stock below their ACE allocation, but each sector can develop their own internal rules for managing their members' activities. The preferred approach taken by all the sectors to date is to provide individual allocations to each member, effectively creating internally managed individual fishery quota (IFQ) systems (Holland et al. 2013; Holland and Wiersma 2010). Sector members can fish their internally determined allocations themselves or trade them with other sector members. Transfers of ACE between sectors are also allowed but must be approved by sector managers and regulators.

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The sector program eliminated the need for individuals to compete for a share of the total allowable catch but required, by design, that permit holders collaborate in order to develop the necessary infrastructure to essentially self-govern and avoid penalties associated with joint accountability. The shift to sectors involved the creation of new organizations and institutions effectively transforming well-established relationships between and among permit holders as well as between permit holders and managers (Holland and Wiersma 2010; Olson and Pinto da Silva 2014). The transition took place as new rules were being implemented that would strictly limit total catch and substantially reduce it for some key species. Most permit holders were leery of joining sectors, at least initially, but felt they had little choice due to the coming regulatory changes that seemed likely to create a race-for-fish amongst those who remained outside of sectors (Holland, Pinto da Silva, and Wiersma 2010).

Sector membership is voluntary, and permit holders can join, leave, or switch sectors each year, though a sector need not accept a new member if it does not want to. There have, in fact, been substantial changes in sector rosters between 2010 and 2013, and a few additional sectors were created as permit banks that supply ACE to fishermen in other affiliated sectors. There were 761 permits enrolled in sectors in 2010. Some 683 permits remained in the "common pool" fishing under effort controls and competing for about 5% of the total allowable commercial catch. Note that many vessel owners have multiple permits, and many permits are no longer associated with an active fishing vessel. Thus, the number of active vessels is far fewer than the number of permits both in sectors and the common pool. Over 100 permits that had been in the common pool in 2010 were enrolled sectors in 2011. Only a few permits exited sectors and rejoined the common pool. Transitions between sectors were more common, with 165 permits enrolled in a sector in 2010 changing to another sector at least once between 2011 and 2013. Some of these enrollment changes were associated with sale of permits rather than an individual deciding to move to another sector, and many were the result of moving permits into permit bank sectors that held and traded ACE but did not have any active fishing vessels.

We hypothesize that the economic success of sectors and their ability to retain members is likely to be determined, in part, by the strength of the relationships between permit holders within sectors, among sectors, and among sectors and government agencies and nongovernmental organizations. The value of these relationships is commonly referred to as social capital (Putnam 2000). Social capital is particularly relevant to the success of co-management systems, which rely on co-operative behavior among fishers and between fishers and regulators and government agencies (Jentoft, McCay, and Wilson 1998; Gutierrez, Hilborn, and Defeo 2011). Social capital enhances the ability to resolve conflicts, share information, and devolve responsibilities from regulators to fishermen, all leading to improved resource management (Grafton 2005; Adams et al. 2003; Pretty 2003).

Greater social capital in a broad sense might be expected to both lead to and follow from effective and efficient operation of sectors. However, it is less clear how important specific types of social capital are and the means by which they promote better economic performance. The proper way to measure social capital and determine whether and how it impacts economic performance of fishing cooperatives is also not well developed in the literature. Using responses to a telephone survey conducted prior to sector implementation, Holland et al. (2013) created baseline measures of several types of social capital and evaluated the relationship between them and economic performance in the first two years of sector operation. The survey included a set of questions that were designed specifically to measure key components of social capital,

including trust and bonding, bridging, and linking social capital. The survey also included questions related specifically to information sharing, which were expected to be a particularly important form of cooperation for fishermen. The questions were adapted from questions used in other social capital surveys but tailored to the fishery cooperative context. Many of the questions were based on questions included in the World Bank household questionnaire (Krishna and Shrader 2002; Grootaert et al. 2004).[1] Holland et al. (2013) found significant statistical correlations between some of these measures of social capital and various measures of economic performance, but also found correlations between performance and vessel characteristics that were, in turn, correlated with social capital making it difficult to identify causality.

In the fall of 2013, after sectors had been operating for three full fishing years (which run from May–April), we conducted a follow-up social capital survey. Owners of vessel permits enrolled in sectors were contacted by phone and asked the same set of questions that were used to construct baseline social capital indices prior to sector implementation.[2] As with the original survey, a census of the full population of permit holders enrolled in sectors was undertaken. We construct social capital indices for each sector based on the new survey responses and evaluate how social capital has evolved over time. We then replicate the analysis of relationships between social capital, sector characteristics, and economic performance presented in Holland et al. (2013) using the 2013 social capital survey data and economic performance data collected by NMFS. We also explore how social capital changed and how that related to changes in performance.

As with the original survey, we expected to find positive relationships between some measures of social capital and economic performance. We also expected that sectors, at least successful ones, would increase their social capital over time. Finally we expected that higher levels of social capital and increases in it would make sectors more likely to stay together. The results suggest that the relationship between social capital and economic performance has indeed strengthened over time but evolved with a reduced role of information sharing. It also appears that trust among sector members has increased substantially over time, though it is not clear that this has promoted better economic performance.

The remainder of the paper proceeds as follows. The next section discusses some of the determinants of economic gains and stability of fishing cooperatives supported by theoretical and empirical studies and relates these findings to the measures of social capital and other characteristics of sectors explored in this study to identify some general hypotheses. The methodology of the survey and analysis based on it are then described. Results of the analysis are presented in the penultimate section. Conclusions are discussed in the final section.

1. A copy of that survey can be found at: http://siteresources.worldbank.org/INTSOCIALCAPITAL/Resources/Social-Capital-Assessment-Tool–SOCAT-/annex1C.pdf.

2. Due to a programming error in the phone survey software, two questions from the original survey that were part of the bonding index were inadvertently dropped for most respondents. One question from the bridging index and one from the linking index were also dropped deliberately. Consequently, when comparing scores for social capital indices from the 2010 survey to those in the 2013 survey, the 2010 indices were recalculated with only the questions that were included in both surveys. The dropped questions are listed below.
General Bonding: How important is your (self-defined) fishing community to you?
General Bonding: How many of the groundfish fishermen in the fishing community do you trust?
Bridging: Do members of these organizations come from diverse backgrounds?
Linking: Would you say the science that fisheries management decisions are based on is accurate?

THE PATH AND PITFALLS TO GAINS FROM COOPERATION

The potential benefits of fishing cooperatives depend on a number of factors, not least the degree of rent dissipation occurring under the previous management system and the causes and form of rent dissipation. In fisheries where vessels compete for limited total allowable catch, rents are often dissipated by a race-for-fish that leads to excess harvesting and processing capacity, input stuffing, inefficient operation of vessel due to competition and congestion, and reduced product quality and value (Homans and Wilen 1997, 2005). Cooperatives, as well as individual quota systems, can generate rapid and substantial rent gains simply through consolidation, slower and more careful harvest and handling of catch, and better timing of landings to avoid market gluts or hit peak demand periods. For example, Wilen and Richardson (2008) describe substantial rent generation by the Alaskan Pollock Conservation Cooperative as a result of reducing capacity and slowing down catch and production allowing for increases in product recovery rates and higher product quality. Deacon, Parker, and Costello (2013) show that the Chignik salmon cooperative in Alaska was very successful at increasing profitability by reducing costs through consolidation and improving harvest efficiency and by increasing quality and value of fish by coordinating harvesting with processing capacity. Although there had not been a race-for-fish under the individual effort control system that preceded sectors in the Northeast groundfish fishery, there was excess capacity and opportunities to reduce costs through consolidation. There were also opportunities for cooperatives to increase overall catch by avoiding species for which ACE was likely to be constraining thereby allowing fuller utilization of quotas for other underutilized species (e.g., haddock and redfish).

Many of the gains described above could be achieved by self-serving behavior of individuals incentivized by simply allocating individual catch privileges either in an IFQ system or by cooperatives allocating shares of their overall allocation to individual members and allowing transferability. However, other potential gains depend on cooperation that may not be realized without some institutional structure to foster or even require cooperation (Holland and Wiersma 2010). For example generating and sharing information about where fishing is good or where bycatch hotspots are can improve overall fleet efficiency or avoid premature closure of the fishery, allowing higher utilization of target species quotas. Coordinating the deployment of fishing effort may help reduce congestion externalities and avoid rent-dissipating competition for fish. In the case of the Chignik salmon cooperative, some of the rent gains resulted from a coordinated approach to the spatial deployment of nets that limited harvest activities to the Chignik lagoon where it is most efficient. Harvests were also paced to match processing capacity (Deacon, Parker, and Costello 2013). Rents may be increased by cooperative marketing efforts and brand building that can be undermined by participants who fail to meet quality standards. Notably, in New Zealand where nearly all fisheries are managed with IFQs, quota holders have formed commercial stakeholder organizations that provide research, coordinate and sometimes curtail harvest, and provide other services, such as stock enhancement (Holland and Wiersma 2010).

Rent gains that depend on cooperation may, however, fail to materialize if the gains are not distributed so as to maintain individual incentives to fully cooperate. Evans and Weninger (2014) use a game theoretic analysis to show that a cooperative, even with profit sharing, will not create incentives for efficient levels of search activity and information sharing without an internal governance structure and remuneration scheme that distributes information rents to maintain

incentives to undertake costly search. Evans and Weninger use a two-period, two-player game and focus on Nash equilibrium. The decision to produce and share information about highly uncertain catch and bycatch rates may be better represented by a repeated game with a network of players, which may be able to generate cooperative behavior. It has been shown that networks that involve reciprocal "gift" exchange can be stable and efficient even when reciprocity is not direct, but realized over the larger network (Kranton 1996; Bramoullé and Kranton 2007). Kranton (1996) finds that gift exchange (e.g., sharing valuable information) is more likely to persist when it takes place among many interconnected individuals, particularly when non-cooperative behavior can be observed and punished (e.g., by exclusion from the network).

While an extended time commitment and the likelihood of repeated exchanges may promote cooperative behavior, this is not a forgone conclusion. Abbott and Wilen (2010) found that a voluntary program by the Alaskan bottom trawl fleet known as SeaState that aimed to reduce bycatch of prohibited species and thereby lengthen seasons did not appear to be more successful than non-participating vessels at reducing bycatch. Haynie, Hicks, and Schnier (2009) found that the information supplied by SeaState was apparently used to avoid bycatch during part of the fishery, but the level of cooperation generally fell as the season progressed and total bycatch approached the cap. This same group of vessels was more successful at avoiding bycatch, thereby allowing higher utilization of target quotas, after a formal cooperative was created with secure allocations of both target species and prohibited species dedicated to the cooperative as a whole and distributed to individual members by internal contract (Abbott, Haynie, and Reimer 2015). Though the cooperative was clearly successful at reducing bycatch and increasing utilization of target species allocations, it is unclear whether production and sharing of information within the cooperative was optimal and potential gains were fully realized.

Fostering cooperation within cooperatives, particularly when desired behaviors conflict with individual short-run incentives, is unlikely to be successful unless individuals believe they will gain more from cooperation in the long run and that others will cooperate. The governance structure of the cooperative and the systems to observe and enforce compliance with rules are also critical (Ostrom 1990). Social capital may also play an important role, not least in creating confidence that others will cooperate and reciprocate, and that the cooperative will persist through time ensuring that short-term investments will yield longer-term gains.

Creating governance arrangements and rules for behavior or profit sharing that incentivize cooperative behavior is likely to be more challenging for larger, more heterogeneous sectors. Group size and homogeneity are often cited as critical factors for the survival and success, as well as the emergence, of common property institutions (Ostrom 1992). These two factors are likely to be correlated, since smaller groups tend to form from larger ones on the basis of shared ideas, goals, etc. As Jentoft (1989) asserts "Organizations with a relatively homogenous socioeconomic membership will have less internal conflicts of interest and this will make decision-making easier." Jentoft also notes that "the success of co-management is contingent on fair and equal distribution of resource benefits. When the membership is homogenous, equal distribution will also be fair distribution." Similarly, Scott (1993) states that though homogeneity is not typically listed in the literature as a prerequisite for self-government, heterogeneity embeds two important factors that make self-government difficult. These are inadequate or asymmetric information and distributional issues. These issues are interdependent since solving the information problem may require agreement on distribution of costs and benefits. All of these problems

increase to the extent that the group is heterogeneous. Deacon, Parker, and Costello (2013) found that while increases in profits might have been sufficient to leave all fishermen better off had everyone joined the Chignik salmon cooperative, the profit sharing formula used by the cooperative would have left some of the most efficient fishermen worse off if they had joined. This eventually led to the elimination of the cooperative following a court case brought by fishermen who felt they were disadvantaged by it.

By their very nature, the success of common property institutions relies on the forbearance of individuals from activities that would be profitable for them if others abstain. Thus, achieving compliance is critical to the survival of institutions. Typically, the honor system provides an insufficient compliance strategy. A naïve view of compliance might suggest that compliance will be achieved if the penalty for an infraction multiplied by the probability of detection is greater than or equal to the benefit from breaking the rule. However, the literature provides a richer theory of what makes a compliance system effective and efficient. Perceived fairness of rules and penalties and consistent enforcement are shown to be critical to achieving compliance. Common property institutions may offer some significant advantages over externally imposed rules. As Sutinen and Kuperan (1999) note, compliance is greater when the rules and the enforcement of them are viewed as legitimate by the user group. Peer pressure also can be a major factor; being ostracized by one's peers can provide incentives every bit as important as a fine. This suggests that social capital, particularly bonding social capital and trust within the sector, might promote higher compliance with its rules which, in turn, may be important to economic success and stability.

A final point made by Ostrom (1992) raises an issue of particular concern for fisheries. She notes that the survival of common property regimes is less likely if they are subjected to rapid exogenous change. This could clearly be a problem for marine fisheries, which are often subject to large fluctuations in resource abundance resulting from environmental stimuli and management failures. The Northeast groundfish fishery has, in fact, faced large cuts in total allowable catch of key species, most notably cod, during the first few years of operation. This suggests that effective mechanisms for adaptation and conflict resolution will be critical to the effective operation and survival of sectors.

The discussion above suggests a number of hypotheses that relate social capital and other sector characteristics at least indirectly to the economic performance of sectors and their likelihood of persisting and increasing social capital. Because the implementation of sectors coincided with major reductions in allowable catch and general tightening of catch restrictions, we do not attempt to determine whether sectors increased absolute rents relative to some counterfactual. Rather, we utilize the natural experiment of simultaneous creation of 17 sectors with variable characteristics and social capital to evaluate how these factors affected relative performance. We hypothesize that all of the forms of social capital we measure should contribute to better economic performance by fostering cooperation and communication. In particular, we expect to see a positive correlation between information sharing and performance as found by Holland et al. (2013). We expect that sectors will increase social capital over time as a natural consequence of interaction and cooperation, but that greater increases (decreases) in profitability over years would result in increases (decreases) in social capital and vice versa, creating a virtuous (vicious) cycle between the two. Finally we expected that heterogeneity in sector membership would tend to complicate governance arrangements and may undermine cooperation, economic gains, and formation of social capital.

METHODOLOGY

SURVEY DESIGN AND IMPLEMENTATION

In the fall of 2013, a telephone survey of Northeast multispecies fishery (groundfish) permit holders was conducted to replicate the measures of social capital that were estimated from a survey prior to sector implementation (see Holland et al. 2013 for details). We attempted a census of all permit holders enrolled in sectors during the 2012–2013 fishing year, which runs May through April. When a working telephone number was called, the person who held the groundfish fishery permit was identified and interviewed. A total of 256 permit holders were interviewed. The overall response rate was 50%, and ranged from 36 to 69% by sector (table 1). Note that the total sample is smaller than the number of permits enrolled in sectors since some permit owners hold multiple permits but were surveyed only once. Also Sustainable Harvest Sector 3 is excluded from table 1 and the analysis since it acts as a permit bank and has no actively fished permits.

CONSTRUCTING MEASURES OF SOCIAL CAPITAL

Like the baseline survey, the follow-up survey included survey questions that were designed to measure the quantity and strength of the relationships associated with different types of social capital (e.g., bonding, bridging, and linking social capital, information sharing, and trust). Questions are grouped together to create six composite indices as shown in table 1. There are two indices that relate specifically to social capital within sectors. The sector-specific bonding index includes questions designed to measure the extent and strength of relationships among members within a sector. The trust index includes questions that measure the level of trust the respondent has in fellow sector members and sector leadership. There are four indices not directly related to sectors, including measures of bonding social capital, bridging social capital, linking social capital, and information sharing. Questions in the non-sector-specific bonding social capital index relate to ties with others in the individual's self-defined fishing community, which may include, but also extend beyond, fellow sector members. The bridging social capital index measures social and business ties beyond the individual's self-defined fishing community. The linking social

Table 1. Sample Size and Response Rate by Sector Groupings

2012 Sector	Complete	Total Sample	Percent Complete
Fixed-gear sector	31	64	48
NCCS	15	25	60
Port Clyde community groundfish sector	22	32	69
Sustainable harvest sector 1	36	59	61
Tri-state sector	5	11	45
NEFS 2	24	57	42
NEFS 3	24	52	46
NEFS 5	14	26	54
NEFS 6	3	8	38
NEFS 7,8,9	28	59	47
NEFS 10	13	36	36
NEFS 11,12	18	35	51
NEFS 13	14	32	44
Total	247	496	50

capital index measures involvement with the management of the fishery. The information sharing index measures the size, strength, and importance of information sharing networks relevant to the fishing business.

Each index includes a set of questions that relate to that social capital measure. The indices include questions with a binary yes/no response, ordinally scaled questions (e.g., with responses: Strongly Agree-Agree-Disagree-Strongly Disagree), and questions requiring a numerical response (e.g., How many of your close friends are commercial groundfish fishermen?). To construct indices we first normalize responses to all questions so that responses range from 0 to 1, with zero indicating the lowest contribution to social capital and 1 the highest. For example the question, "How concerned are you that not all members of your sector will abide by all specific rules in your contracts?" had responses coded as follow: very concerned = 0, somewhat concerned = 0.5, and not concerned = 1. Similarly, a question that asks "What percentage of your sector's members do you not know at all?" would be coded as one minus the response. A question with a yes/no response is coded 0 or 1, while a question with an ordinal response with four possible answers is coded 0, 0.33, 0.67, and 1.0, respectively. For questions with continuous response variables, the responses are first categorized in 3 to 5 discrete categories and then normalized to between 0 and 1. For example, the response to the question, "How many generations of commercial fishermen does your family represent?" is coded as follows: 1–2 = 0, 3–4 = 0.5, 5–8 = 1.0.

We calculate index scores for each individual and for each sector based on the responses of sector members. Each index score is calculated by taking the average score of the normalized response to the questions in the index. If an individual did not answer a particular question, the missing value is replaced with the mean responses of other members of that sector. To generate scores for the indices at the sector level, we first calculate average scores for the questions in the index for each individual then calculate an average of each index for the members of each sector. The questions associated with each index and the average index values across individuals are shown in table 2. Following Holland et al. (2013), two New Hampshire-based sectors are combined because they share similar characteristics (shared a sector manager and had similar boards of directors, trading rights, geographic port of landings, areas fished, costs, and home towns), and the number of survey responses from each is low. Three sectors based in New Bedford, MA, are combined for similar reasons. A total of 13 sector groups are analyzed. Holland et al. (2013) calculated sector indices in the same way, but also calculated indices based on principal components of the index questions weighted by factor loadings. However correlations with economic performance were qualitatively the same as the indices based on equal weighting of questions, so we present only results with even weighting of questions.

SECTOR PERFORMANCE MEASURES

One of the primary motivations for undertaking the survey and constructing measures of social capital is to determine if higher levels of specific types of social capital (e.g., bonding, bridging, linking), contribute to better performance of sectors and the fishery as a whole under sector management. We focus herein on the measures of sector-level financial performance used in Holland et al. (2013) in order to determine whether and how relationships between social capital and performance have changed over time.

Table 2. Social Capital Questions and Indexes and Average Scores in 2010 and 2013

Social Capital Index and Associated Questions	2010 Average	2013 Average	T-Stat	Sig.
General Bonding	0.46	0.48	1.30	
How many immediate family members also work in the New England groundfish industry?	0.18	0.22	1.90	*
How many extended family members also work in the New England groundfish industry?	0.15	0.18	1.06	
How many generations of commercial fishermen does your family represent?	0.28	0.24	(1.11)	
How many close friends are also commercial groundfish fishermen?	0.49	0.57	2.10	**
Are the fishermen you trust the most the ones that fish in the same fishing community?	0.85	0.77	(2.16)	**
Have you ever gone into business with another fisherman?	0.38	0.37	(0.05)	
Do most fishermen look out for the welfare of those whom they consider to be similar (ethnic-cultural)?	0.46	0.55	3.78	***
Do you agree that fishermen generally trust one another in matters of lending and borrowing?	0.73	0.70	(1.35)	
If you needed business help would you feel comfortable asking another fisherman in the community?	0.64	0.68	1.61	
General Bridging Index	0.51	0.51	0.26	
How many of the groundfish fishermen outside your fishing community do you trust?	0.69	0.72	1.33	
Have you ever gone into business with another fisherman?	0.38	0.37	(0.05)	
How important to you are social or religious organizations?	0.46	0.46	0.01	
What commercial fishing organizations do you belong to?	0.40	0.50	3.01	***
How often in the past year have you joined in a public meeting, rally or protest relevant to fisheries?	0.62	0.50	(3.37)	***
General Linking Index	0.64	0.61	(1.21)	
How often in the past year have you attended a public meeting on fisheries management?	0.64	0.60	(1.23)	
Have you ever participated in a cooperative research project as a primary partner?	0.39	0.37	(0.53)	
Have you ever participated in a cooperative research project in a minor way?	0.89	0.87	(0.73)	
General Information Sharing Index	0.72	0.69	(2.19)	**
Do you have a network of friends that on whom you rely to share useful information about fishing?	0.94	0.93	(0.76)	
How many individuals are in this network?	0.39	0.36	(1.05)	
How often do you share useful information about fishing with this network?	0.85	0.80	(2.11)	**
How important is information you get from other fishermen to your fishing success?	0.74	0.62	(3.85)	***
How often do you use the internet for purposes relevant to your fishing business?	0.69	0.75	1.69	*
Sector-Specific Bonding Index	0.47	0.46	(0.47)	
How involved were you in the formation of your sector?	0.35	0.40	1.21	
What percentage of your sector's members do you know very well?	0.55	0.59	1.47	
What percentage of your sector's members do you not know at all? (score=1-response)	0.65	0.74	2.88	***
What percentage of your sector's members are part of your fishing community?	0.55	0.51	(1.32)	
Do your family members interact socially with family members of other members of your sector?	0.48	0.32	(3.53)	***

Table 2 *(continued)*

Social Capital Index and Associated Questions	2010 Average	2013 Average	T-Stat	Sig.
Including yourself, how many of your family members are permit owners in your sector?	0.15	0.11	(1.76)	*
Besides your family, how many close friends are also permit holders in your sector?	0.38	0.37	(0.17)	
Would you say that your sector has an important role in preserving the fishing community you are a member of?	0.65	0.67	0.66	
Sector-Specific Trust Index	0.78	0.88	7.47	***
Do you trust that the board of your sector will make decisions in the best interest of the whole sector?	0.79	0.87	2.85	***
Do you trust the sector will have a fair system set up to deal with violations of sector rules?	0.81	0.91	3.65	***
Do you trust that most members of your sector would avoid a stock if sector running low?	0.88	0.96	3.78	***
Do you trust that the other members of your sector will avoid exceeding their individual quota?	0.90	0.98	3.83	***
If you ran out of your individual quota other sector members would sell or trade you some of their quota?	0.63	0.78	6.31	***
If another member of your sector ran out of his individual quota would you sell or trade some of your quota?	0.72	0.84	6.90	***
How concerned are you that not all members of your sector will abide by all specific rules in your contracts?	0.71	0.86	5.41	***

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

We construct two performance measures based on estimates of net revenue. Net revenue is defined as the revenue received from the sale of all species landed on groundfish trips plus the net value of ACE traded out of a sector (value of ACE leased out minus the cost of leasing in) less the trip costs incurred on groundfish trips.[3] The groundfish trip costs are estimated based on vessel characteristics and effort. They include estimates of the cost of fuel, oil, ice, supplies, bait, food, water, and damage. We also include organizational costs of sectors estimated at $0.04/pound in trip costs. We think of these net revenue measures as the overall value realized from the allocation of ACE (the combined value of either fishing the ACE and/or leasing it to another sector). A sector's total net revenue is partially determined by its size. To remove this influence, net revenues were expressed on a per-entity basis as net revenue per active vessel. We also consider the ratio of net revenue to the value of the ACE portfolio initially held by the sector. We think of this measure as analogous to a return on net assets. An additional performance measure we use is the ratio of gross revenues from the sale of all species landed on groundfish trips to the variable costs associated with taking those trips. We proposed this as a measure of efficiency or cost-effectiveness. We estimate correlations between our measures of social capital and these economic performance measures and also correlations with the average vessel characteristics of the sectors. We also evaluate the relationship of economic performance with each sector's average vessel characteristics.

3. See Kitts et al. (2011) for details on the methods used to estimate costs, net revenues, and the value of ACE traded using information from ACE sales between sectors.

RESULTS

EVOLUTION OF SOCIAL CAPITAL FROM 2010 TO 2013

Average responses to the individual questions in the survey used to construct social capital indices, and the average scores for the indices, exhibited varying degrees and directions of change. Most indices include questions for which scores increased significantly and others that decreased or remained unchanged. Four of the six composite indices (General Bonding, General Bridging, General Linking, and Sector-specific Bonding) averaged across all respondents did not exhibit a significant change from 2010 to 2013. The most striking change is the significant positive increase in all of the questions related to trust among sector members and the consequent increase in the sector trust index (table 2). Increased trust is particularly notable given that the first three years of sector operation has been a turbulent, difficult time characterized by large cuts in total allowable catch.[4] These cuts have caused economic hardship that might have been expected to undermine trust amongst sector members. The increase in trust may be a natural result of sector members interacting and getting to know each other. The average percentage of fellow sector members that respondents said they "did not know at all" decreased significantly, though the change in percentage they said they know well did not increase significantly.

It is also notable that several of the questions relating to information sharing and the information sharing index decreased significantly, suggesting a general drop off in information sharing. This is somewhat surprising given that sectors and individuals faced reduced ACE allocations for so-called "choke" species, particularly cod, which may have inhibited their ability to fully utilize ACE allocations for other species. Sharing information on how to avoid these choke species would presumably have mitigated this problem, allowing greater utilization of ACE and higher profits. Furthermore, secure catch privileges should have reduced the need to compete for fish and, thus, the motivation to withhold information.

Since response rates for the social capital scores were not 100% in either the baseline or follow-up survey, differences in average social capital scores could be due, in part, to differences in who responded. However, relative changes in average responses of the 113 permit holders who participated in both surveys, where significant, are consistent with changes in average responses for all respondents, though fewer changes are statistically significant due in part to the smaller sample size (Appendix table A1).

While there have been some directional shifts in the average responses to the social capital questions and the indices, those changes vary across sectors. Some indices have increased for some sectors while others have declined (figure 1). For example, one sector that had over 40% increases in the bridging and linking indices had more than a 20% decline in information sharing and more than a 40% decline in the sector-specific bonding index (see dotted line in figure 1).

Seeing changes in the social capital indices, particularly the sector-specific ones, is not surprising. Many sector participants joined sectors because they felt like they had little choice, and had not been involved in the development of the sector and/or did not know fellow sector

4. Reductions in ACLs for cod have been particularly difficult, as cod was a primary source of revenue for many of sectors. The ACL for Gulf of Maine cod dropped from 4,292 mt in 2011, to 2,084 mt in 2012 and then down to 720 mt in 2013. Georges Bank cod dropped from 3,129 mt in 2011 to 1,488 mt in 2012.

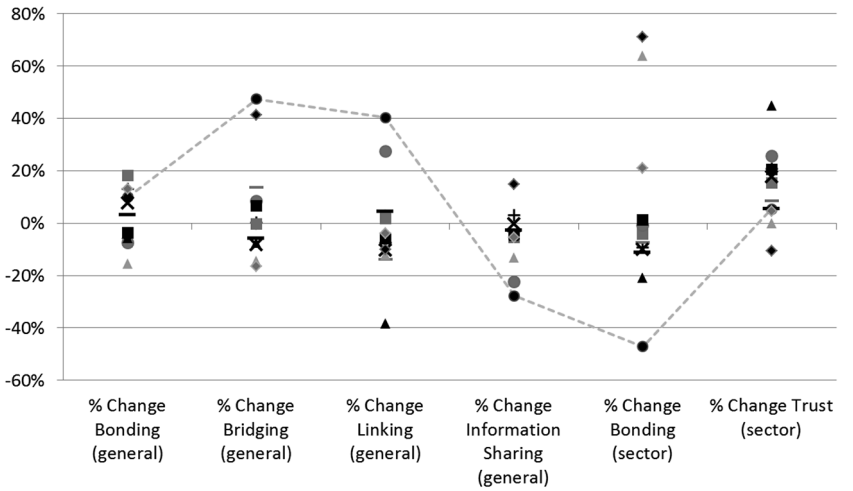

Figure 1. Percentage Change in Social Capital Indices for Individual Sectors (symbols consistent for each sector across indices)

members well. Significant increases in all of the trust questions and the sector-specific trust index suggest that increased interaction between sector members over the last three years has strengthened those relationships.

Changes in social capital are correlated with a number of sector characteristics (table 3). The percentage change in general bridging and linking social capital from 2010 to 2013 is positively correlated with the coefficient of variation (CV) of vessel length (i.e., the standard deviation of lengths of all vessels registered to the sector divided by the average length). The percentage change in linking social capital is also positively correlated with average trip length. The percentage change in information sharing is negatively correlated with average trip length, but positively correlated with the CV of trip length. This may suggest more information sharing between vessels that did not compete as directly. The percentage change in sector-specific bonding indices is negatively correlated with average trip length. Finally, the percentage change in sector-specific trust is positively correlated with the number of homeport states.

Table 3. Correlation of 2012 Sector Characteristics with Percent Change in Sector Social Capital Index Scores

Sector Characteristics	Percent Change Bonding (general)	Percent Change Bridging (general)	Percent Change Linking (general)	Percent Change Information Sharing (general)	Percent Change Bonding (sector-specific)	Percent Change Trust (sector-specific)
CV vessel length (all vessels)	0.32	0.56**	0.63**	−0.34	−0.36	−0.18
Average trip length	0.10	0.27	0.54*	−0.65**	−0.51*	0.34
CV trip length	0.15	0.24	−0.23	0.73***	0.33	−0.28
Number of homeport states	0.05	0.04	0.14	−0.15	−0.28	0.52*

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

This is likely due to the fact that sectors with more homeports had a lower level of trust at the beginning and increased that trust over time to levels similar to more homogenous sectors. Sectors with a larger number of active permits also saw greater increases in trust; trust had been negatively correlated with the number of active permits in 2010. No correlations between changes in social capital and average length of sector vessels were significant, so these correlations are not shown table 3.

SOCIAL CAPITAL AND ECONOMIC PERFORMANCE

Several social capital indices are significantly correlated with indicators of economic performance (table 4, figure 2). The sector averages of the general bonding, bridging and linking indices, and the sector-specific bonding index are all positively correlated with net revenue per active vessel. The sector-specific bonding index is also positively and significantly correlated with the ratio of net revenue to ACE value, though correlations with other social capital indices are insignificant. None of the social capital indices show significant correlation with the ratio of gross revenues to trip costs; the measure of cost effectiveness.

These results contrast with results from the 2010 social capital survey. Holland et al. (2013) found no significant correlations between the 2010 general bonding, bridging and linking social capital indices and net revenue per active vessel in 2010 and 2011 (table 4). However they found a positive correlation with the information sharing index, which has a negative (though not significant) correlation in the updated analysis. Holland et al. (2013) also found negative correlations between net revenue per active vessel and sector-specific bonding and trust indices, while the updated survey revealed a positive correlation between sector-specific social capital and net revenue per active vessel. While the 2013 social capital indices have no significant correlations with the ratio of gross revenues to trip costs, Holland et al. (2013) found gross revenues over trip costs in 2010 and 2011 to be negatively correlated with the general bonding index and positively correlated with sector-specific bonding index measured prior to sector implementation.

Table 4. Correlation between Sector Average Social Capital Scores and Economic Performance

Performance Measure	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector-specific)	Trust (sector-specific)
2012 Sector Performance and 2013 Sector Social Capital Index Scores						
Net revenue per active vessel	0.60 **	0.51*	0.73***	−0.41	0.47*	−0.39
Net revenue/value of ACE	0.34	0.21	0.27	0.21	0.66***	0.01
Gross revenue/ trip costs	−0.23	0.02	−0.17	0.07	0.32	−0.16
2010 and 2011 Sector Performance and 2010 Sector Social Capital Index Scores						
Net revenue per active vessel	0.22	−0.2	0.17	0.33*	−0.42**	−0.35*
Net revenue/ value of ACE	0.08	0.15	0.23	*0.63***	−0.33*	−0.47**
Gross revenue/ trip costs	−0.47**	−0.03	−0.21	−0.27	0.58***	0.06

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

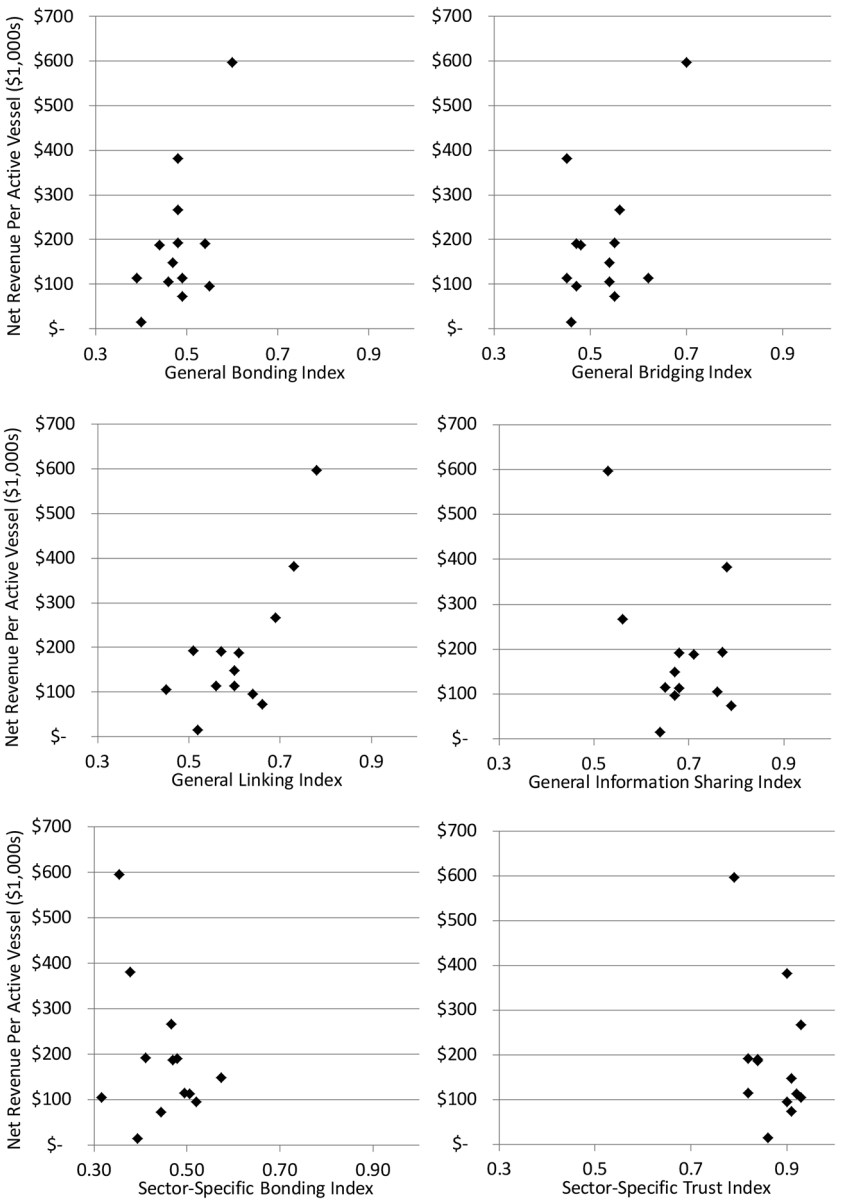

Figure 2. Scatter Plots of 2013 Sector Average Social Capital Index Scores and Net Revenue Per Active Vessel in the 2012 Fishing Year

Taken together, the results from the initial study and the current one suggest an increasing positive influence (or at least correlation) of most measures of social capital with net revenue per active vessel, with information sharing as a notable exception. The prior study had suggested that sectors with higher sector-specific bonding tended to have lower net revenue per vessel but were more cost efficient; however, that no longer appears to be the case. As noted above, sectors with a high sector-specific bonding index in 2013 (that had exhibited higher cost efficiency) tended to have greater reductions in cost efficiency (table 5), which may

Table 5. Correlation between the Percentage Change in Economic Performance Indicators between the 2010 and 2012 Fishing Years and Sector Average Social Capital Scores in 2013 and with the Change in Social Capital Scores

Performance Measure	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector-specific)	Trust (sector-specific)
Percent change net revenue per active vessel	0.41	0.50*	0.11	−0.04	0.10	−0.55*
Percent change net revenue/ value of ACE	−0.17	−0.30	−0.29	0.18	0.03	−0.08
Percent change gross revenue/ trip costs	−0.40	−0.05	−0.42	0.16	−0.58**	0.00
Performance Measure	Percent Change Bonding (general)	Percent Change Bridging (general)	Percent Change Linking (general)	Percent Change Information Sharing (general)	Percent Change Bonding (Sector Specific)	Percent Change Trust (Sector Specific)
Percent change net revenue per active vessel	0.14	0.72***	0.29	0.24	0.13	−0.62**
Percent change net revenue/ value of ACE	0.09	−0.40	−0.23	0.31	0.13	−0.24
Percent change gross revenue/ trip costs	−0.53*	0.08	−0.38	0.20	0.68**	−0.40

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

explain why the relationship between 2013 sector-specific bonding and gross revenue over trip costs is no longer significant.

The 2013 general bridging index is also positively and significantly correlated with the change in net revenue per vessel between the 2010 and 2012 fishing years (table 5), but there is a negative correlation between the sector-specific trust index and the change in net revenue per active vessel. The 2013 sector-specific bonding index is also negatively correlated with the percentage change in gross revenues over trip costs, suggesting that sectors with relatively higher sector-specific bonding scores in 2013 tended to have a greater than average decline in cost efficiency.

The fact that the trust index is no longer significantly correlated with net revenue per active vessel while it was in the initial analysis (table 4) seems to be largely due to the fact that the sectors with low trust scores had increases in trust so that there in now much less variation in the trust index across sectors. It is notable that the sector trust index from the baseline survey was negatively correlated with the net revenue per active vessel which, in turn, was correlated with average trip length and number of homeport states. The sector trust index from the baseline survey was also negatively correlated with number of homeport states, though the correlation was not significant. The percentage change in sector-specific trust is positively correlated

with each sector's number of homeport states. It is also positively correlated with the number of active vessels in the sector. In sum, it seems that sectors that are more geographically dispersed, and also tend to be more profitable, had a greater increase in trust than more geographically concentrated ones, eliminating the earlier negative relationship between trust and profitability (table 2).

Net revenues per vessel decreased between 2010 and 2012 for all but five of the thirteen sectors, while the net revenue per value of ACE and the ratio of gross revenues to trip costs decreased for all but three sectors (figure 3). These decreases are not surprising given the substantial reductions in total allowable catches (TACs) for several important fish stocks, particularly TACs of Gulf of Maine and Georges Bank cod, which both declined by more than 50% between the 2010 and 2012 fishing years. Four of the five sectors that increased net revenue per active vessel did so despite having reductions in the ratio of gross revenues to trip costs of 30–40% (figure 4). In other words, increasing profitability was mainly a question of increasing landings and revenues rather than being more efficient.

Sectors with larger active vessels and longer trip lengths tend to be more profitable in terms of net revenues per active vessel but less cost efficient (table 6). The cost efficiency disadvantage appears to be outweighed by the ability of the sectors with longer trip lengths to not only maintain but increase overall revenues and, consequently, profitability. There is also a strong positive correlation between net revenue per active vessel and the CV of length of all vessels registered to the sector (including inactive vessels). This appears to contradict the hypothesis that heterogeneity would undermine cooperation and, consequently, economic performance. The reasons for this are not completely clear, but it may be partly because sectors with a more diverse make-up of registered permits have a more diverse or better balanced portfolio of ACE. For example some of the smaller vessels in these sectors may have brought relatively high allocations of Gulf of Maine cod and pollock to the sectors, which may have been critical for allowing greater utilization of some of the other species with less constraining TACs. These sectors may also have been better able to adapt to changes in TACs and fish distributions.

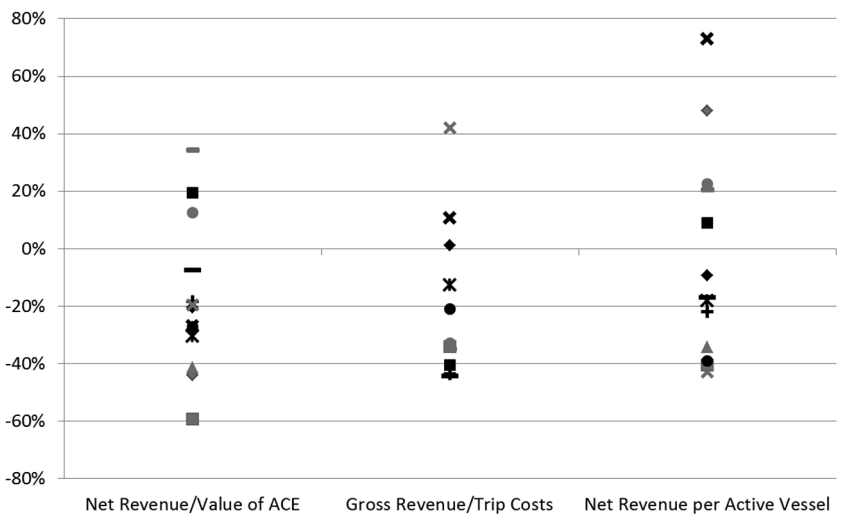

Figure 3. Percent Change in Economic Performance Metrics Between 2010 and 2012 Fishing Years by Sector

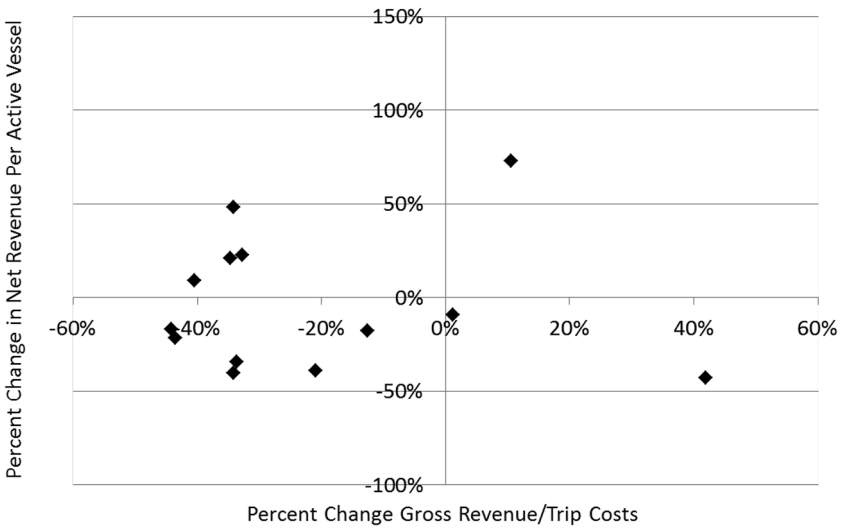

Figure 4. Scatter Plots of Percent Change in Net Revenue Per Active Vessel vs. Percent Change in Gross Revenues and Gross Revenue/Trip Costs

Correlations between these sector characteristics and economic performance were similar in 2010 and 2012 (table 6). The relative change in net revenue per active vessel is uncorrelated with any of the sector characteristics; however, the change in net revenue per value of ACE and the ratio of gross revenues to trip costs are both negatively correlated with the average vessel length of active vessels, average trip length, and number of homeport states (table 7). Notably, while net revenue per active vessel was correlated with overall estimated value of ACE holdings in 2010, this was no longer the case in 2012. Together, the results of tables 6 and 7 suggest that while vessel size and mobility continued to be drivers of profitability, these vessels also had a larger drop in return on their ACE portfolios and in cost efficiency.

Table 6. Correlation between Sector Performance and Sector Vessel Characteristics

Sector Characteristics	Net Revenue Per Active Vessel	Net Revenue/ Value of ACE	Gross Revenue/ Trip Costs
2012 Sector Performance with 2013 Sector Vessel Characteristics			
Average vessel length (active vessels)	0.58**	0.21	−0.64**
CV vessel length (all vessels)	0.85***	0.06	−0.06
Average trip length	0.79***	0.04	−0.60**
# Homeport states	0.29	0.09	−0.61**
2010 Sector Performance with 2010 Sector Vessel Characteristics			
Average vessel length (active vessels)	0.56**	0.77***	−0.55*
CV vessel length (all vessels)	0.78***	0.38	−0.04
Average trip length	0.64**	0.69***	−0.57**
# Homeport states	0.74***	0.58**	−0.61**

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

Table 7. Correlation in Percentage Change in Sector Performance Between 2010 and 2012 with 2013 Sector Vessel Characteristics

Sector Characteristics	Percent Change in Net Revenue Per Active Vessel	Percent Change in Net Revenue/Value of ACE	Percent Change in Gross Revenue/Trip Costs
Average vessel length (active vessels)	−0.07	−0.74***	−0.27*
CV vessel length (all vessels)	0.28	−0.40	−0.37
Average trip length	−0.15	−0.68**	−0.35**
Number of homeport states	−0.35	−0.66**	−0.28**

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

Some of the sector characteristics correlated with economic performance are also correlated with social capital scores (table 8), which makes it difficult to assess the causal relationships between social capital, sector characteristics, and economic performance. For example, the CV of vessel length, which is positively correlated with net revenue per active vessel, is positively correlated with general bonding and linking social capital. General bonding and linking social capital are, in turn, positively correlated with net revenue per active vessel. Similarly, average trip length is correlated with net revenue per active vessel and with linking social capital which is, in turn, correlated with net revenue per active vessel. Notably the correlation between social capital and CV of vessel length appears to contradict our hypotheses that heterogeneity tends to undermine formation of social capital.

CONCLUSIONS

There were a number of changes in the relationships between the sectors' average social capital indices and economic performance indicators that suggest increased importance of multiple types of social capital. General bonding, bridging and linking indices of social capital, and the sector-specific bonding index are now all positively correlated with net revenue per active vessel. This appears to support our hypothesis that diverse types of social capital may contribute to more effective operation of the sectors and cooperation leading to better economic performance. Within-sector trust has increased, particularly for the more geographically dispersed sectors. This has eliminated the negative correlation between this index and net revenues per

Table 8. Correlation of 2012 Sector Characteristics and 2013 Sector Social Capital Index Scores

Sector Characteristics	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector-specific)	Trust (sector-specific)
Average vessel length (active vessels)	0.45	0.47	0.39	−0.03	0.13	0.13
CV vessel length (all vessels)	0.51*	0.36	0.64**	−0.40	0.42	−0.42
Average trip length	0.44	0.40	0.65**	−0.42	0.27	0.07
Number of homeport states	0.08	0.00	0.16	0.06	−0.05	0.18

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

active vessel shown in the earlier analysis, but it is not clear that trust has promoted better economic performance.

Surprisingly, information sharing appears to have declined generally, and the information index is now negatively, though not significantly, correlated with net revenues per active vessel and the change in net revenues per active vessel. This is contrary to our hypothesis that information sharing would promote better performance (which was supported by the initial survey and analysis). If anything, we expected information sharing to play a greater role than in the previous analysis, since quotas of many species declined, putting a premium on efficient operation. The reasons for this result are unclear, but one possibility is that the sectors were simply unable to overcome the disincentives individuals face for costly production and sharing of information. As we noted in the discussion on determinants of cooperation, cooperative behavior that leads to optimal levels of information provision and sharing is unlikely to emerge unless individuals believe they will gain more from cooperation in the long run and that others will cooperate. We suggested that good governance structures, social capital, and prolonged activity with opportunities for reciprocity among the network of sector members would make this cooperation more likely, but it may be this was insufficient to override short-run individual incentives.

Our analysis suggests that sectors with larger active vessels that take longer trips achieve higher net revenues per active vessel. This is not surprising. However, the fact that heterogeneity in the sectors, as measured by the CV in the length of vessels enrolled in the sector and geographical dispersion in homeports, is also associated with higher levels of net revenue per active vessel appears to conflict with our hypotheses that heterogeneity would tend to undermine cooperation and consequently economic performance. It appears that any disadvantage or challenge this might have created for more diverse sectors was more than offset by the advantages of this diversity. More diverse membership is likely to bring with it a more diverse ACE portfolio, which may mitigate the risks of reductions in quota, catch rates, or prices of individual species. Diversity in the size of vessels and types of gear may also enable sectors to adapt more easily to changes in the distribution of stocks or relative sizes of quota. We surmise that the combination of having a more diverse, balanced ACE portfolio and a more diverse, geographically dispersed fleet of vessels increased the ability of these sectors to adapt to changes and exploit fishing opportunities where they emerged (e.g., to reduce dependence on weaker stocks with declining quotas and increase exploitation of underutilized stocks).

These more diverse sectors have also increased their social capital over time, particularly the more outward-looking forms bridging and linking social capital. The degree to which these coincident increases in social capital contributed to increases in profitability is unclear, however. Well-designed, contractually based organizations may not only have reduced dependence on voluntary cooperation, but engendered greater social capital over time—as the common saying goes, good fences make good neighbors. While structuring cooperatives around geographic communities and homogeneous fleets might seem intuitively appealing to engender trust and cooperation, it seems advisable to allow cooperatives to build diverse memberships that allow them to respond to changing circumstances.

Our analysis looks only at correlations between social capital and economic performance. The sectors with better economic performance also appeared to have greater gains in certain forms of social capital, though this may be because they simply began with lower levels. While increases in some forms of social capital might have contributed to better economic performance, the causality is unclear. Economic performance may be driven primarily by sector

characteristics, such as the length of active vessels, trip length, and the ACE portfolio the sector has available to it. Some of these sector characteristics are correlated with the social capital indices that are, in turn, correlated with profitability, making causal relationships difficult to distinguish. The fact that sector characteristics were already correlated with higher profitability in 2010 when the social capital indices were not, would seem to weaken the hypotheses that social capital is driving profitability; however, without a counterfactual we cannot rule out the possibility that social capital augmented or at least preserved the profitability of these sectors, perhaps enabling them to better respond to the changing opportunities and challenges resulting from fluctuating fish stocks and ACE allocations. Social capital may also have been critical to keep the sectors together and operating without discord. None of the sectors disbanded by between 2010 and 2012, though one did in 2013.

Our motivation for measuring social capital at the sector level and evaluating its relationship with economic performance was driven by the expectation that sector members would likely need to cooperate, share information, and likely redistribute ACE to make best use of their limited ACE allocations as TACs were constricted. We also expected that since sector members face joint liability for regulatory infractions and joint determination of discard rates (which are deducted from ACE along with catch, thereby reducing potential catch), trust and cooperation would be important to dissuade activities that might be in the interest of individuals at the expense of other sector members. While these hypotheses may be generally accurate, well-designed, monitored, and enforceable operations plans and contracts are probably equally, if not more, important. The formal contractual structure of sectors mimics harvest cooperatives previously developed in West Coast and Alaskan fisheries. Sector organizers were aware of the structure of the West Coast and Alaskan cooperatives and even consulted with the lawyer that helped develop them.[5] The sectors, through contracts, created de facto individual transferable catch privileges, and they created internal monitoring systems and mandatory rules and operating procedures with financial penalties for non-compliance and indemnification clauses to mitigate joint liability. As such, these governance institutions rely more on the incentives associated with the creation of private property rights and less on those considered essential for collaboratively managed common-property resources.

5. This assertion is based on personal knowledge of the lead author, who was involved in providing technical support to the organizations while they were developing the sector operations plans and contracts. Many of the future sector organizers also attended a workshop organized by the University of Maine, Marine Law Institute in 2007, at which Joe Sullivan, the primary architect for the West Coast and Alaskan cooperative contracts, spoke about the structuring of those organizations and contracts.

APPENDIX

Table A1. Statistically Significant Changes in Average Responses to Social Capital Questions by 113 Permit Holders Who Participated in both the 2010 and 2013 Surveys

Category	Question	2010 Avg.	2013 Avg.	Sign	Sig.	Sig.
General bonding	Do most fishermen look out for the welfare of those whom they consider to be similar?	0.44	0.57	+	***	***
Linking	How often in the past year have you joined in a public meeting relevant to fisheries management?	0.58	0.47	–	**	**
Info sharing	How important is information you get from other fishermen to your fishing success?	0.76	0.62	–	***	***
Info sharing	How often do you use the internet for purposes relevant to your fishing business?	0.69	0.77	+	*	*
Sector bonding	What percentage of your sector's members do you not know at all? (score=1–answer)	0.62	0.73	+	**	**
Sector bonding	Do your family members interact socially with family members of other members of your sector?	0.54	0.32	–	***	***
Sector bonding	Including yourself, how many of your family members are permit owners in your sector?	0.21	0.11	–	**	**
Sector trust	Do you trust that the board of your sector will make decisions that are in the best interest of the whole sector?	0.77	0.87	+	**	**
Sector trust	Do you trust the sector will have a fair system set up to deal with violations of sector rules?	0.82	0.89	+	*	*
Sector trust	Do you trust that most or all of the members of your sector would make an effort to stay off the stock if sector running low?	0.89	0.95	+	**	**
Sector trust	Do you trust that the other members of your sector will make their best effort to avoid exceeding their individual quota?	0.91	0.99	+	***	***
Sector trust	If you ran out of your individual quota other sector members would sell or trade you some of their quota?	0.64	0.77	+	***	***
Sector trust	If another member of your sector ran out of his individual quota would you sell or trade some of your quota?	0.74	0.84	+	***	***
Sector trust	How concerned are you that not all members of your sector will abide by all specific rules in your contracts?	0.70	0.85	+	***	***

* p-value <= 0.10; ** p-value <= 0.05; *** p-value <= 0.01.

REFERENCES

Abbott, J. K., A. C. Haynie, and M. N. Reimer. 2015. "Hidden Flexibility: Institutions, Incentives and the Margins of Selectivity in Fishing." *Land Economics* 91:169–95.

Abbott, J. K., and J. E. Wilen. 2010. "Voluntary Cooperation in the Commons? Evaluating the Sea State Program with Reduced Form and Structural Models." *Land Economics* 86(1):131–54.

Adams, W. M., D. Brockington, J. Dyson, and B. Vira. 2003. "Managing Tragedies: Understanding Conflict Over Common-pool Resources." *Science* 302:1915–16.

Bramoullé, Y., and R. Kranton. 2007. "Risk-sharing Networks." *Journal of Economic Behavior & Organization* 64:275–94.

Deacon, R. T., D. P. Parker, and C. Costello. 2013. "Reforming Fisheries: Lessons from a Self-Selected Cooperative." *Journal of Law and Economics* 56(1):83–125.

Evans, K. S., and Q. Weninger. 2014. "Information Sharing and Cooperative Search in Fisheries." *Environmental and Resource Economics* 58:353–72.

Grafton, R. Q. 2005. "Social Capital and Fisheries Governance." *Ocean & Coastal Management* 48:753–66.

Grootaert, C., D. Narayan, V. N. Jones, and M. Woolcock. 2004. *Measuring Social Capital: An Integrated Questionnaire*. Washington, DC: The World Bank.

Gutierrez, N. L., R. Hilborn, and O. Defeo. 2011. "Leadership, Social Capital and Incentives Promote Successful Fisheries." *Nature* 17:470(7334):386–9.

Haynie, A. C., R. L. Hicks, and K. E. Schnier. 2009. "Common Property, Information, and Cooperation: Commercial Fishing in the Bering Sea." *Ecological Economics* 69(2):406–13.

Holland, D. S., A. Kitts, P. Pinto da Silva, and J. Wiersma. 2013. "Capital and the Success of Harvest Cooperatives in the New England Groundfish Fishery." *Marine Resource Economics* 28(2):133–53.

Holland, D. S., P. Pinto da Silva, and J. Wiersma. 2010. "A Survey of Social Capital and Attitudes toward Management in the New England Groundfish Fishery." US Department of Commerce *Northeast Fish Science Center Reference Document* 10–12; 13 p. http://www.nefsc.noaa. gov/nefsc/publications.

Holland, D. S., and J. Wiersma. 2010. "Free Form Property Rights for Fisheries: The Decentralized Design of Rights-based Management through Groundfish "Sectors" in New England." *Marine Policy* 34(5): 1076–81.

Homans, F. R., and J. E. Wilen 1997. "A Model of Regulated Open Access Resource Use." *Journal of Environmental Economics and Management* 32(1):1–21.

———. 2005. "Markets and Rent Dissipation in Regulated Open Access Fisheries." *Journal of Environmental Economics and Management* 49(2):381–404.

Jentoft, S. 1989. "Fisheries Co-management: Delegating Government Responsibility to Fishermen's Organizations." *Marine Policy* 13(2):137–54.

Jentoft, S., B. J. McCay, and D. C. Wilson. 1998. "Social Theory and Fisheries Co-management." *Marine Policy* 22(4–5):423–36.

Kitts, A. W., J. Bing-Sawyer, J. Walden, C. Demarest, M. McPherson, P. Christman, S. Steinback, J. Olson, and P. Clay. 2011. "2010 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2010–April 2011)." US Department of Commerce, *Northeast Fish Science Center Reference Document* 11–19; 97, 2011. http://www.nefsc.noaa.gov/publications/crd/crd1119.

Kranton, R. E. 1996. "Reciprocal Exchange: A Self-Sustaining System." *American Economic Review* 86 (4):830–51.

Krishna, A., and E. Shrader. 2002. "The Social Capital Assessment Tool: Design and Implementation." In *Understanding and Measuring Social Capital: A Multidisciplinary Tool for Practitioners*, eds. C. Grootaert and T. van Bastelaer, 17–40. Washington, DC: World Bank.

Olson, J., and P. Pinto da Silva. 2014. "Changing Boundaries and Institutions in Environmental Governance: Perspectives on Sector Management of the Northeast US Groundfish Fishery." *Maritime Studies* 13:3.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge University Press.

———. 1992. "The Rudiments of a Theory of the Origins, Survival, and Performance of Common-Property Institutions." In *Making the Commons Work: Theory, Practice and Policy*, ed. D.W. Bromley, 293–318. San Francisco, CA: ICS Press.

Pretty, J. 2003. "Social Capital and the Collective Management of Resources." *Science* 302:1912–4.

Putnam, R. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon and Schuster.

Scott, A. 1993. "Obstacles to Fisheries Self-government." *Marine Resource Economics* 8(3):187–200.

Sutinen, J. G., and K. Kuperan. 1999. "A Socio-economic Theory of Regulatory Compliance." *International Journal of Social Economics* 26(1/2/3):174–93.

Wilen, J. E., and E. J. Richardson 2008. "Rent Generation in the Alaskan Pollock Conservation Cooperative." In *Case Studies on Fisheries Self-Governance*, eds. R. Townsend, R. Shotton, and H. Uchida, 361–68. *FAO Fisheries Technical Paper* 504. Rome: FAO.