

Social Capital and the Success of Harvest Cooperatives in the New England Groundfish Fishery

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Abstract *In May of 2010 a new management system based on harvest cooperatives called “sectors” was implemented in the U.S. Northeast Multispecies Groundfish Fishery. Sectors are self-organized, self-managed groups of fishermen that receive annual catch entitlements. We hypothesize that the success and longevity of these sectors is likely to depend, in part, on the relationships amongst the members including their degree of trust and ability to collaborate. The value of these relationships and the ability to cooperate is commonly referred to as social capital. Prior to the implementation of the new sector system, we conducted a survey to derive baseline measures of social capital for individual groundfish permit holders and sectors. We construct indices of bonding, bridging and linking social capital, information sharing, and trust. We explore correlations between these social capital indices, characteristic of the vessels in the sectors, and various measures of economic performance of sectors.*

Key words Social capital, cooperatives, co-management, fishery.

JEL Classification Code Q22.

Introduction

Amendment 16 to the Northeast Multispecies Fishery Management Plan dramatically changed the structure and dynamics of the New England groundfish (GF) industry, replacing a management system that indirectly managed catches using effort controls with a catch share system that strictly limits catches for self-selecting harvest cooperatives referred to as “sectors.” The prior management system based on individual transferable allocations of days at sea (DAS), closed areas, and trip limits had become increasingly complex and restrictive over time. It failed to eliminate overfishing on all species despite progressive re-

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ductions in DAS allocations and trip limits that severely undermined profitability of much of the fleet. The prospect of even stricter limits in response to new requirements in the Magnuson-Stevens Fishery Management and Conservation Act (MSA) to end overfishing led most of the industry to move to the sector system despite considerable uncertainty and trepidation about how it would work (Holland, Pinto da Silva, and Wiersma 2010).

Beginning in the 2010–2011 fishing year, catch quotas comprising over 95% of total commercial groundfish quotas were granted to 17 sectors. Each year each sector is granted a share, denominated in pounds, of the total annual catch limit (ACL) of up to 16 different groundfish stocks. Sector allocations are based on the catch history of the sector's members between 1996 and 2006. These species and stock-specific catch limits are referred to as annual catch entitlement (ACE).¹ Sectors must constrain their catches (including discards) of all regulated groundfish species to their ACE allocations, but they are exempted from effort controls and trip limits that had been the primary means of constraining catch. Individuals not enrolled in a sector remained in the 'common pool' of the fishery regulated under the DAS system. Permit holders remaining in the common pool, though numerous, are largely inactive or involved in other fisheries and had relatively low catch history as a group. Since allocations were granted to sectors based on catch history this left a very small share of total catch quotas available for the common pool.

Sectors are managed by a 'sector manager,' a non permit holder hired by the sector, who serves as a boundary agent between sectors and the federal government's fisheries management institution—the National Marine Fisheries Service. Sector managers also coordinate the development of sector operations plans and manage ACE trades, among other critical duties. Although sectors have flexibility in how they manage their allocations to ensure they do not exceed ACE allocations and achieve other objectives, most sectors at least initially distributed their ACE to their individual members based on their catch history (Holland and Wiersma 2010). Sector members can then fish their allocations themselves or trade them with other sector members. Trades of ACE between sectors are also allowed but must be approved by sector managers and regulators.

Twelve of the 17 sectors created under Amendment 16 were organized by the Northeast Seafood Coalition (NSC), a large and emergent fishermen's organization in New England. The NSC continues to provide policy services to this diverse group of sectors and developed a separate entity called the Northeast Sector Service Network (NESSN) that provides day-to-day management, coordinating, and operating services to these sectors. All NSC member sectors are also a member of the NESSN and pay annual dues to each entity. NSC sectors are limited by some self-imposed internal constraints beyond those specified by regulations. For example, trades to sectors outside the NSC "network" of sectors can only occur after ACE is offered both within the sector and within the NSC network.

Sectors represent a significant departure from the prior management system. The prior system did not require collaboration amongst fishermen or joint accountability nor did it strictly limit total catch of any particular species, relying instead on indirect measures designed to achieve target fishing mortalities. All sector members now must abide by a legally binding operations plan, and sector members are jointly and severally liable for the sector exceeding its allocated ACE, for not abiding by other fishing regulations such as zero discarding of legal size fish, and for misreporting catch. Although sector contracts all specify penalties for members that break sector rules (and most include indemnity clauses), sectors have limited ability to monitor and enforce compliance by their members and thus are somewhat reliant on moral suasion and reciprocal trust amongst members. Economic

¹ The New England Fisheries Management Council (NEFMC) voted via Amendment 16 to allocate the 16-stock groundfish fishery using a formula based on the total catch history between the years of 1996–2006. Using these baseline years, each fishing permit was assigned a Potential Sector Contribution (PSC), which is a percent share of the total fishing history between these baseline years. As long as the fishing permit is enrolled in a sector, this PSC may be converted to sector ACE—which is then re-distributed back to the sector member as a quasi-catch entitlement.

performance of sectors and their members may also be improved by cooperation and information sharing within and amongst sectors, but this cooperation can be undermined when the interests of individuals and the cooperative diverge (Haynie, Hicks, and Schnier 2009). Sharing information about where fish are, and trading ACE internally and between sectors, can boost efficiency by increasing catch per unit effort and reallocating ACE to the most efficient vessels. Sharing information about how to avoid catching certain species with low total quotas may be particularly important to minimize the degree to which quotas of these species constrain catch of other species for which ACE allocations are not limiting.

New England lobstermen are well known for their long-standing co-management institutions (Acheson 2003; Wilson, Yan, and Wilson 2007). Conversely, the ability of groundfish fishermen to create similar co-management structures to manage the groundfish fishery was uncertain. Improved collaboration and coordination among fishermen in the region was occurring prior to the implementation of sectors (Pinto da Silva and Kitts 2006). Two groundfish sectors existed prior to 2010 and some groundfish fishermen were involved in a pilot sector in the Rhode Island fluke (summer flounder) fishery. However, the challenges involved in organizing and building the necessary institutions to support the sector program were generally new and represented a tremendous learning curve for most participants. Additionally, given tight deadlines, many prospective sector members needed to commit to a sector prior to knowing what their ACE would be. Sectors formed around a number of different types of common bonds. Some were centered around business interests or other more practical reasons, such as geographic proximity, while others built on existing collaborative efforts or around social relationships (friendship/kinship/past fishing together). Although most sectors were associated with existing industry organizations to varying degrees, most sector members did not have a history of formal collaboration that affected the way they ran their fishing operations. An added challenge to permit holders was the need to create these organizations and institutions in less than a year.

Given the importance of collaborative behavior in the development and operation of sectors, we hypothesize that the economic success of sectors and long-term sustainability of group membership 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 non-governmental organizations. This includes the depth and breadth of relationships and the degree of trust, collaboration, and information sharing. The value of these relationships, networks, and public participation is commonly referred to in social and economic literature as social capital (Putnam 2000).

Putnam (2000) distinguishes between two primary forms of social capital: “bonding” and “bridging.” Bonding social capital denotes strong ties between people in similar situations, such as immediate family, close friends, and neighbors. Putnam (2000) defines bonding social capital as exclusive, or inward looking, which has a tendency to reinforce exclusive identities and homogenous groups. Bonding social capital constitutes a kind of “sociological superglue” (Putnam 2000). It facilitates cooperation based on relationships within a homogeneous group (Woolcock and Sweetser 2002).

Bridging social capital in contrast encompasses more distant “weak” ties of like persons, such as loose friendships and workmates (Granovetter 1973). Bridging social capital refers to connections to people who are not like you in some demographic sense (Woolcock and Sweetser 2002). It tends to bring together people across diverse social divisions (Field 2003). Putnam (2000) defines “bridging” social capital as inclusive. Bridging social capital may be more outward looking and encompass people across different social divides. If “bonding” social capital is super glue that holds same communities together, “bridging” social capital may be thought of as a type of “sociological lubricant” that brings different communities together (Putnam 2000). Bridging social capital enhances access to and exchange of information, enforcement of contracts, and focusing on a shared vision and collective goals (Nahapiet and Goshal 1998) and can provide a critical mechanism for the diffusion of knowledge and innovation (Grafton, Knowles, and Owen 2004).

Another dimension of social capital is one that extends past the relationships and trust of people in like situations or roles to include relationships with individuals and institutions outside one's peer group, often in positions of influence or power. These relationships, referred to as "linking social capital," may be thought of as vertical ties. Woolcock (2001) defines linking social capital as reaching out to unlike people in dissimilar situations, such as those who are entirely outside of the community, thus enabling members to leverage a far wider range of resources than are available in the community. Linking social capital also includes vertical connections to formal institutions. According to Woolcock and Sweetser (2002), "linking social capital pertains to connections with people in power, whether they are in politically or financially influential positions." Whereas bridging social capital might connect two groups of fishermen, linking social capital could connect the fishing group to fishery scientists, managers, and regulators.

In the context of sectors, bonding social capital might be expected to strengthen cooperation and encourage compliance within a sector, while bridging and information sharing social capital might foster inter-sector cooperation and mutually beneficial trading of information and ACE. Linking would relate to the strength of the relationship between sector groups and regulatory bodies where value might be gained through improved information exchange, coordination, and access to fisheries managers (figure 1).

Increasingly, it has been argued that the level and types of social capital possessed by communities matter in the management of collective resources, as they provide structure and foster trust and norms of reciprocity for cooperation and coordinated actions (Uphoff 2000; Pretty 2003). Knack and Keefer (1997) find that trust and civic cooperation are associated with stronger economic performance. As Grafton (2005) explains, greater social capital can improve fishery management and governance leading to better compliance and lower management costs, higher economic returns, and improved sustainability. 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, to share information, and to devolve responsibilities from regulators to fishermen, all leading to improved resource management (Adams *et al.* 2003; Pretty 2003).

Prior to the implementation of the new sector system we conducted a telephone survey of Northeast multispecies GF permit holders to derive baseline measures of social capital. We attempted to survey all members of each of the groundfish sectors, as well as a sample of permit holders that did not join a sector and remained in the common pool fishery. 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. We also included questions related specifically to information sharing, which we expected to be a particularly important form of cooperation for fishermen. The questions are adapted from questions used in other social capital surveys but tailored to our specific fishery cooperative context. Many of the questions are based on questions included in the World Bank household questionnaire (Krishna and Shrader 2002; Grootaert *et al.* 2004).²

Based on survey responses, we construct several indices of social capital. These include measures of bonding social capital and trust that relate specifically to relationships between sector members; a more general bonding index related the self-defined fishing community; and information sharing, bridging, and linking social capital indices that relate to relationships with other fishermen and non-fishermen both inside and outside the sector. Scores for these indices are computed at the individual and sector levels. We present and compare these measures of social capital and evaluate whether and how these indices correlate with several measures of economic performance based on the first two

² A copy of that survey can be found at: <<http://siteresources.worldbank.org/INTSOCIALCAPITAL/Resources/Social-Capital-Assessment-Tool--SOCAT-/annex1C.pdf>>.

years of sector operations. We also explore correlation of sector vessel characteristics with social capital indices and the economic performance measures.

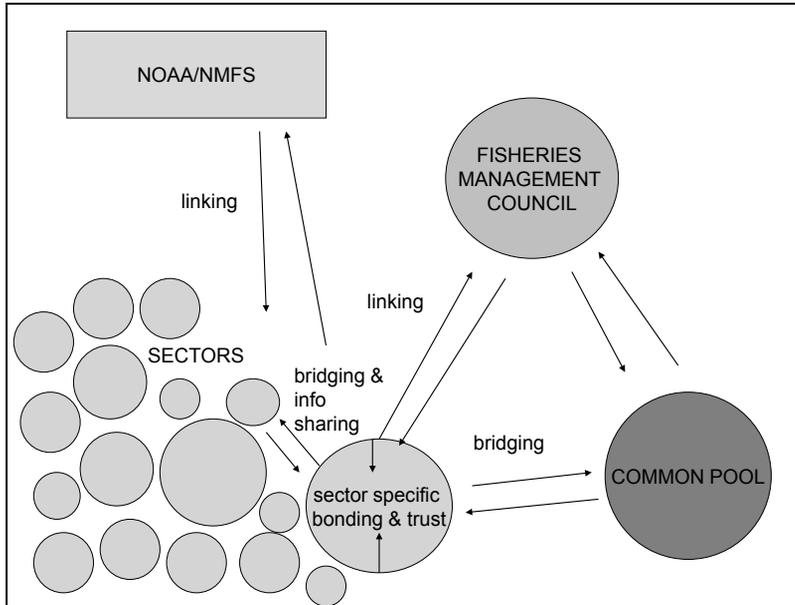


Figure 1. Bonding, Linking, and Bridging Social Capital

The rest of this article is organized as follows. The next section describes the methodology of the study, including: survey design and implementation, response coding and variable transformations, construction of social capital indices and performance measures, and methods used for analysis. The following section presents results of the survey, including the measures of social capital derived for the sectors and an analysis of the relationship between the social capital measures and the economic performance of the sectors in the 2010–2011 fishing year. The final section concludes the article with a discussion of results and plans for additional research, including a follow-up survey.

Methodology

Survey Design and Implementation

In the spring of 2010, prior to implementation of the new sector system of management for most of the fishery, a telephone survey of Northeast Multispecies (groundfish) permit holders was conducted to develop baseline measures of social capital in the groundfish fishery.³ We attempted a census of all permit holders that had joined sectors. A sample of

³ The survey was managed by the lead author (Holland) while he was a research scientist at the Gulf of Maine Research Institute and funded by a grant from the Cooperative Institute for the North Atlantic Region. The other authors collaborated on survey design, and the survey was implemented by Market Decisions, a market research firm based in Portland, Maine.

the remaining vessels that chose to continue fishing in the “common pool” was also surveyed with a limited set of questions not specific to sectors. When a working telephone number was called, the person who held the groundfish fishery permit was identified and interviewed. Up to 35 attempts were made to contact and interview each permit holder. If a permit holder on the list who was part of a sector did not complete the interview by phone, they were mailed a paper survey. A total of 542 permit holders were interviewed. This total included 244 permit holders who had signed up for sectors, 56 active vessel owners who were not planning to participate in the sector program, and 242 permit holders who were not active in the groundfish fishery in 2009. The overall response rate was 64%, and a 50% or greater response rate was achieved for 14 of the 16 sectors with active fisherman.⁴ Most sector response rates were between 50% and 70%, with NCCS (100%), NFS XII (80%), and Port Clyde Community (74%) responding above 70%. Detailed results from the survey, which included questions about attitudes toward the prior management system and sector management, are detailed in Holland, Pinto da Silva, and Wiersma (2010).

While the general nature of social capital in commercial fisheries may be similar to other economic communities, the structuring of social and business relationships, the benefits they provide, and thus the appropriate way to measure various types of social capital is likely to differ from other settings. Fishermen may cultivate relationships based on communities defined by where they live or the port they fish from; however, they may also form ties based on communities of interest structured around shared fishing grounds or the types of vessels and gear they use.

Early in the survey respondents were asked: “How would you define the fishing community you feel most a part of?” This was an open ended question, but responses were categorized as one or more of the following: the town where you moor your vessel; the geographic region where you mostly land fish; the town you and your family reside in; the harbor town closest to where you and your family reside (not necessarily where you moor your vessel); the fishermen who fish in the same area as you; fishermen who belong to the same industry association as you; or other. These same categories were also available to the interviewer and provided as prompts if the person being interviewed asked for clarification. Many of the questions in the survey then refer back to this self-defined fishing community. Respondents were not limited to a single way of defining their fishing community and most gave multiple definitions (table 1). Notably, respondents were more likely to define their fishing community by where and who they fish with or where they tie up their vessel than by where they reside.

The interdependencies and opportunities created by sector membership created new risks and benefits associated with the strength of interpersonal relationships, trust, and information sharing between fellow sector members. We attempt to measure the initial level of social capital for individuals and groups in this fishery using a variety of questions that elicit information about the number and quality of relationships that the respondents have with individuals inside and outside of their self-defined fishing communities and also inside and outside their sectors.

⁴ Response rates for two sectors with primarily Portuguese speaking fishermen were 38% and 40%, although the survey was translated into Portuguese and mailed to them. One sector holds quota for lease only and was not surveyed. There was a 17th sector that leased out its entire ACE allocation whose members were not interviewed.

Table 1
Survey Respondents' Definitions of Fishing Community

Community Definition	Sector Respondents (%)	Common Pool Respondents (%)
The town in which you tie up your vessel	69	64
The geographic region where you mostly land fish	61	57
The town in which you and your family reside	29	21
The harbor town closest to where you & your family reside	32	21
The fishermen who fish in the same area you fish	64	49
The fishermen who belong to the same industry association as you	35	28

Note: Most respondents gave multiple responses.

Constructing Measures of Social Capital

Although we base many of our survey questions on previous surveys designed to measure social capital, the literature provides little guidance on how to construct indicators or measures of specific types of social capital, and the broader social capital indices that have been created to compare social capital across communities seem less applicable and informative for our purposes. Nevertheless, the literature conveys a reasonably consistent view of the types and scope of relationships and bonds associated with different types of social capital which we use to group questions for creation of composite indices. We included survey questions that were designed to measure the quantity and strength of the relationships and bonds associated these different types of social capital (*e.g.*, bonding, bridging, and linking social capital), and we grouped questions together to create six composite indices as described below (table 2). There are two indices that relate specifically to social capital within sectors. The sector bonding index includes questions designed to measure the extent and strength of relationships between sector members. The trust index includes questions that measure the level of trust the individual 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 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. Note that when the word "community" is used in a question it refers to the individual's self-defined fishing community, and respondents were reminded of this frequently during the survey. 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=.5, and not

concerned=1. 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 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.

We also construct indices based on the principal components of the questions in each group. Following OECD (2008, pp. 61–1) we conduct a principal components analysis on the individual level data and create composite indices (at the individual level) using factor loadings to weight normalized principal components of the questions associated with each index. Averages of these composite indices are then calculated for members of each sector or group of sectors to use in the correlation analysis. The principal component analysis provides a less arbitrary way of weighting the different questions in each index, but the resulting indices are less intuitive than those created with an equal weighting of questions. As we discuss below, the results of correlation analysis using these indices differ very little from results using the equal weight indices.

For our analysis, 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 New Bedford-based sectors are combined for similar reasons. A total of 13 sector groups are analyzed.

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. While it is our intention to evaluate how social capital relates to a variety of social and economic performance measures over the long term, we focus herein on short-term measures of economic performance of individual sectors and sector groupings. A follow-up survey is planned for mid-2013 (three years since the initial policy implementation) that will enable us to measure not only the development of social capital by sectors and relate baseline social capital and social capital development to economic performance but also other performance measures, such as well being and satisfaction of fishermen in sectors and longevity or stability of sectors.

There are many possible ways to measure economic performance, but we focus herein on objective quantitative measures of sector-level financial performance. The first 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 might think of this as a measure of efficiency or cost effectiveness.⁵ The groundfish trip costs are estimated based on vessel characteristics and effort. They include estimates of the cost of fuel, oil, ice, supplies, bait,

⁵ 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.

food, water, and damage. We also include organizational costs of sectors estimated at \$0.04/pound in trip costs. We construct several 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. 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 permit, per active vessel, and per owner (some owners operate multiple vessels). However, we would expect that these net revenue measures are still impacted by vessel characteristics (especially average vessel size), which differ across sectors. 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 similar to a return on net assets ratio. We measure correlations between our measures of social capital and these economic performance measures and also correlations with the average vessel characteristics of the sectors.

Results

Summary of Responses to Social Capital Survey

The mean values across all individuals for sector-specific bonding and trust indices based on equal weighting of the questions in each index are 0.54, 0.78, respectively, and the mean values for the non-specific bonding bridging, linking, information sharing, and trust indices are 0.47, 0.50, 0.51, 0.71, respectively (table 2). What these values mean individually and/or collectively in terms of whether social capital is high or low is difficult to interpret. However, the survey results, when viewed independently of the index values, suggest that the industry as a whole may have had a substantial level of social capital prior to sector implementation as measured by criteria such as numbers and breadth of interpersonal relationships within fishing communities, trust in fellow fishermen, levels of cooperation and information sharing, and participation in the management process. Most permit holders have been involved in the groundfish fishery for over a decade; 70% indicated that they first captained a vessel over 10 years ago, and 60% said they bought their first vessel over 10 years ago. The families of survey respondents have been involved in commercial fishing for an average of 2.7 generations. Interviewed fishermen placed high importance on their fishing communities. Respondents defined their fishing communities in different ways, including: where they moor their vessel (67%); the areas they fish (59%); where they live (27%); the harbor town nearest their domicile (30%); and by the fishermen who belong to the same industry association as they do (33%). Respondents had 17 close friends who were also commercial groundfish fishermen, on average.

The majority of fishermen interviewed (71%) said they trusted "most" other fishermen in their self-defined fishing communities, while another 17% said they trusted "many." This trust extends to financial dealings within the community; 83% of respondents agreed or strongly agreed with the statement: "Do fishermen in the community trust one another in matters of lending and borrowing?". Although only 35% of fishermen surveyed had ever gone into business with another fisherman, of those who did, 85% had a positive experience. Outside of their own communities, trust among fishermen is lower; 33% of respondents indicated that they trust "most" fishermen not in their community, 41% said they trust "many," and 17% responded "a few."

Information sharing networks are important to almost all fishermen. Nearly 93% of fishermen surveyed have a network of friends who share information about fishing. The average network size is 12 individuals, and 71% of the fishermen surveyed said that they share useful information about fishing "a lot," while another 27% "sometimes" share information.

Table 2
 Questions Used to Construct Social Capital Indices with Averages of Individual Scores

Social Capital Questions and Indices	Average
Bonding Social Capital (sector specific)	
How involved were you in the formation of your sector?	0.35
What percentage of your sector's members do you know very well?	0.54
What percentage of your sector's members do you not know at all (scoring reversed)?	0.65
What percentage of your sector's members are part of your fishing community?	0.55
Do your family members interact socially with family members of other members of your sector?	0.48
Including yourself, how many of your family members are permit owners in your sector?	0.16
Besides your family, how many close friends are also permit holders in your sector?	0.38
Would you say that your sector has an important role in preserving the fishing community you are a member of?	0.65
Trust (sector specific)	
Do you trust that the board of your sector will make decisions that are in the best interest of the whole sector?	0.79
Do you trust the sector will have a fair system set up to deal with violations of sector rules?	0.82
Do you trust that sector members would make an effort to avoid a species the sector is low on ACE for?	0.88
Do you trust that the other sector members will make their best effort to avoid exceeding their individual quota?	0.90
If you ran out of your individual quota other sector members would sell or trade you some of their quota?	0.63
If another member of your sector ran out of his individual quota would you sell or trade some of your quota?	0.72
How concerned are you that not all sector members will abide by sector rules (scoring reversed)?	0.71
Bonding Social Capital (general)	
How many immediate family members also work in the New England groundfish industry?	0.19
How many extended family members also work in the New England groundfish industry?	0.16
How many generations of commercial fishermen does your family represent?	0.28
How many close friends are also commercial groundfish fishermen?	0.49
How important is your (self-defined) fishing community to you?	0.95
How many of the groundfish fishermen in the fishing community do you trust?	0.87
Are the fishermen you trust the most the ones that fish in the same fishing community?	0.86
Have you ever gone into business with another fisherman?	0.36
Do most fishermen look out for those whom they consider similar (ethnic-cultural) ahead of those who are not?	0.45
Do you agree that fishermen in your fishing community would generally trust one another in matters of lending and borrowing?	0.72
If you needed business help would you feel comfortable asking another fisherman in the community?	0.64

Table 2 (continued)
 Questions Used to Construct Social Capital Indices with Averages of Individual Scores

Social Capital Questions and Indices	Average
Bridging Social Capital (general)	
How many of the groundfish fishermen outside your fishing community do you trust?	0.69
Have you ever gone into business with another fisherman?	0.36
How important to you are social or religious organizations?	0.46
What commercial fishing organizations do you belong to?	0.37
Do members of these organizations come from diverse backgrounds?	0.64
How often in the past year have you joined others in your community in a public meeting, rally, or protest relevant to fisheries management?	0.60
Linking Social Capital (general)	
How often in the past year have you attended a public meeting on fisheries management?	0.63
Would you say the science that fisheries management decisions are based on is accurate?	0.15
Have you ever participated in a cooperative research project as a primary partner?	0.36
Have you ever participated in a cooperative research project in a minor way?	0.88
Information Sharing (general)	
Do you have a network of friends on whom you rely to share useful information about fishing?	0.94
How many individuals are in this network?	0.36
How often do you share useful information about fishing with this network?	0.85
How important is information you get from other fishermen to your fishing success?	0.73
How often do you use the internet for purposes relevant to your fishing business?	0.70

Most fishermen are active to some degree in the fishery management process and also in cooperative research. Over the past year, 32% of respondents had attended fishery management meetings frequently, 41% a couple of times, 11% only once, and 16% never. Over one-third (35%) of the respondents had participated in cooperative research as a primary partner, and 86% had participated in a minor way (e.g., returned a cod tag).

Fishermen who had joined sectors were asked a number of questions about their involvement and knowledge of these sectors. Since the sectors had not yet begun operation, many of the fishermen still had only limited information about how their sectors would operate and no experience operating under sector management. Respondents' experiences were mixed; 17% indicated that they were "very involved," 36% "somewhat involved," and 46% "not involved at all" in development of their sector. Only about one-fifth (21%) said they understood their sector's operations plan "very well," 39% understood their sector's plan "somewhat well," and 38% responded "not well." On average, fishermen knew 56% of their sector's members very well, but didn't know 35% of their sector's members at all. When asked if their sector was important in preserving their fishing community, 65% of sector respondents agreed or strongly agreed, while 21% disagreed or strongly disagreed.

Sector members were relatively confident in their sector's leadership and in their fellow sector members. Most (89%) feel that there was a member in their sector who "is a well-recognized fishing leader in the community or region," 67% believe that their sector's Board of Governors will make decisions that are in the best interest of the whole sector, and 72% feel that their sector has (or will establish) a fair system to deal with sector rule violations.

Asked if members of their sector would (or do) work well together, 67% of sector respondents said yes, 6% answered no, and 27% were not sure. Of the fishermen surveyed, 85% indicated that members of their sector will make their best effort to avoid exceeding their individual quota allocations,⁶ and 81% responded that most or all of their sector members of their sector would avoid fishing a stock if the sector ACE allocation for that stock was running low. Additionally, 69% felt that if they ran out of their individual allocation for a stock, other sector members would sell or trade them quota, and 79% said they would sell or trade some of their quota to another sector member who needed it. Sector members are both jointly and individually liable for violations of some fishery regulations and for overages of sector catch limits. Forty-five percent of sector respondents were concerned that not all members would abide by all the rules in the sector contracts, while 48% were not concerned.

Measures of Social Capital

There is substantial variability in the measures of social capital we constructed amongst individual survey respondents. Individual scores for the different social capital indexes range from near or equal to zero to near or equal 1.0. Exceptions are for the bonding (non-sector specific) index, for which individual scores range from 0.18 to .85 and the bridging index, with scores ranging from 0.07 to 1.0. However, when individual scores are averaged by sector, the range of values is much narrower (see table 3 and figure 2). F-tests from one-way ANOVAs show that, at a critical value of 0.05, the 13 sector groups⁷ do not have significant between-group variation for the general bonding, bridging, and information sharing indices. However, there is significant between-group variation for the sector-specific social capital measures and linking social capital. The F-test for be-

⁶ The sector management system allocates annual catch entitlements (ACE) to sectors, not individual quotas. However, all of the sectors have subdivided their ACE into individual allocations. We refer to these in the survey as quota, since that term appeared to be more commonly understood than ACE.

⁷ Where two New Hampshire sectors and three New Bedford sectors were combined as described in the previous section.

tween-group variation in sector-specific bonding is significant at the 5% level ($p=0.049$), and the F-test for between-group variation in the Trust measure is significant at 1% ($p=0.010$). The linking social capital index also shows significant between-group variation ($p=0.029$).

Table 3
Average, Minimum, and Maximum of the Social Capital Score Averages for Sectors using the 13 Sector Groupings (*i.e.*, average of averages for sectors)

Social Capital Index	Min.	Avg.	Max.
Bonding SC Index 1 (average of non-sector specific bonding social capital questions)	0.49	0.55	0.61
Bonding SC Index 2 (average of sector-specific bonding social capital questions)	0.31	0.46	0.57
Bridging SC Index (average of bridging social capital questions)	0.40	0.51	0.58
Linking SC Index (average of linking social capital questions)	0.44	0.52	0.64
Information Sharing Index (average of information sharing questions)	0.66	0.71	0.80
Trust Index (average of trust questions)	0.63	0.78	0.92

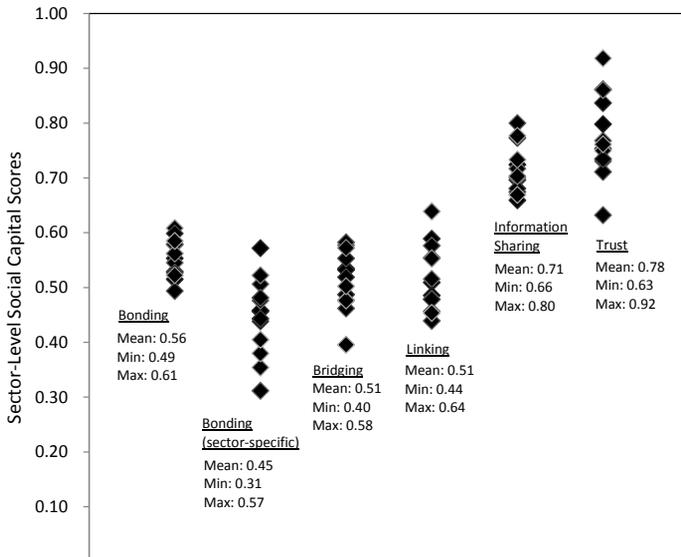


Figure 2. Average Social Capital Scores for 13 Sectors and Sector Groups

Some of these measures of social capital at the sector level appear to correlate with average characteristics of the vessels involved in them and the way they operate. The sector-level score for our general measure of bonding social capital has a significant positive correlation with average trip length, and the information sharing measure is correlated with average vessel size (table 4). In direct contrast, there is a significant negative correlation between the sector-specific measure of bonding social capital and average vessel length, and average trip length. Sectors whose vessels are more widely distributed geographically (as measured by the number of different states in which vessel owners declare on federal fishing permit applications as their vessel's main port of operation), tend to have lower sector-specific bonding scores and higher information sharing scores.

Table 4
Correlation between Social Capital and Sector Vessel Characteristics

Sector Characteristics	Bonding SC (general)	Bridging SC (general)	Linking SC (general)	Information Sharing (general)	Bonding SC (sector specific)	Trust (sector specific)
Average vessel length	0.43	0.18	0.10	0.48*	-0.64**	-0.39
Average trip length	0.62**	-0.17	0.10	0.43	-0.83***	-0.35
# Homeport states	0.15	0.07	0.38	0.59**	-0.76***	-0.44

* p-value ≤ 0.10 , ** p-value ≤ 0.05 , *** p-value ≤ 0.01 .

Social Capital and Economic Performance

Some of our measures of social capital at the sector level are correlated with measures of economic performance. However the results are complex and the causality of the relationships is unclear, since as we discuss below, some performance measures are also correlated with vessel characteristics which are, in turn, correlated with the social capital measures. Among the 13 sector groups analyzed, there are no significant correlations of our measures of bridging and linking social capital with economic performance (tables 5 and 6). The general bonding social capital index is negatively correlated with gross revenue over trip costs. Information sharing has a statistically significant positive correlation with all of the net revenue measures (tables 5 and 6, figure 3). There is a statistically significant positive correlation between sector-specific bonding and the ratio of gross revenue to trip costs. However, there is a significant negative correlation between both the sector-specific bonding and trust measures and all of the net revenue measures.

The signs and significance of correlation between social capital indices and economic performance measures is not meaningfully different for indices constructed with principal components of question groups weighted by factor loadings (tables 5 and 6). Results are also fairly consistent between years (see the Appendix for annual results). As noted earlier, there are correlations between average trip and vessel length and some of the social capital measures; *e.g.*, trip length is positively correlated with general bonding, social capital, and information sharing and negatively correlated with sector-specific bonding (table 4, figure 4). There are also statistically significant correlations between sector characteristics and the economic performance measures (table 7). For example, average vessel length by sector is negatively correlated with gross revenue over trip costs and positively correlated with net revenue per value of ACE. Average trip length and number of homeport states are negatively correlated with gross revenue over trip costs and posi-

tively correlated with net revenue measures. Average vessel length, average trip length, and number of homeport states are also correlated with each other. Roughly speaking it appears that sectors with mostly smaller vessels that take shorter trips and draw members from a smaller geographic area tend to be more cost effective as measured by gross revenues over trip costs, but tend to have lower absolute net revenues. In contrast, sectors with larger vessels that take longer trips and have a more geographically dispersed membership tend to generate higher absolute net revenues and a higher return on the value of their ACE portfolio, but have a lower ratio of gross revenues to trip costs. As shown in table 4, some of these sector characteristics are also correlated with some of the social capital measures. Roughly speaking, the sectors with smaller, less geographically dispersed vessels tend to have high sector-specific bonding, while the sectors with larger, more dispersed fleets tend to have higher scores for general bonding and information sharing but significantly lower scores for sector-specific bonding. These cross-relationships between social capital scores, sectors characteristics, and performance measures suggest that we must exercise caution in interpreting correlations between social capital measures and economic performance.

While our primary interest is to evaluate how social capital impacts sector performance, we also calculated social capital scores for each permit holder and evaluated correlations of the different social capital indices with the economic performance indices at the individual level.⁸ However, none of these correlations proved significant.

Table 5
Correlation between Social Capital Measures and Performance Indicators at the Sector Level

Sector Characteristics	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector specific)	Trust (sector specific)
Gross revenue/trip costs	-0.47**	-0.03	-0.21	-0.27	0.58***	0.06
Net revenue/value of ACE	0.08	0.15	0.23	0.63***	-0.33*	-0.47**
Net revenue/permit	0.16	-0.04	0.22	0.57***	-0.53***	-0.59***
Net revenue/active vessel	0.22	-0.20	0.17	0.33*	-0.42**	-0.35*
Net revenue/owner	0.10	-0.12	0.22	0.50**	-0.47**	-0.51***

* p-value ≤ 0.10, ** p-value ≤ 0.05, *** p-value ≤ 0.01.

Table 6
Correlation between Social Capital Indices Principal Components and Performance Indicators at the Sector Level

Sector Characteristics	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector specific)	Trust (sector specific)
Gross revenue/trip costs	-0.49***	-0.04	-0.14	-0.49***	0.70***	0.02
Net revenue/value of ACE	0.06	0.09	0.20	0.49***	-0.13	-0.49***
Net revenue/permit	0.22	0.04	0.25	0.53***	-0.33*	-0.60***
Net revenue/active vessel	0.26	-0.12	0.22	0.32	-0.28	-0.37*
Net revenue/owner	0.16	-0.05	0.26	0.44**	-0.28	-0.52***

* p-value ≤ 0.10, ** p-value ≤ 0.05, *** p-value ≤ 0.01.

⁸ Performance measures used at the individual level were net revenue per day, total net revenues, and gross revenue per trip costs. The net revenue metrics did not include any net proceeds from ACE trading since information on ACE trading with sectors is not available.

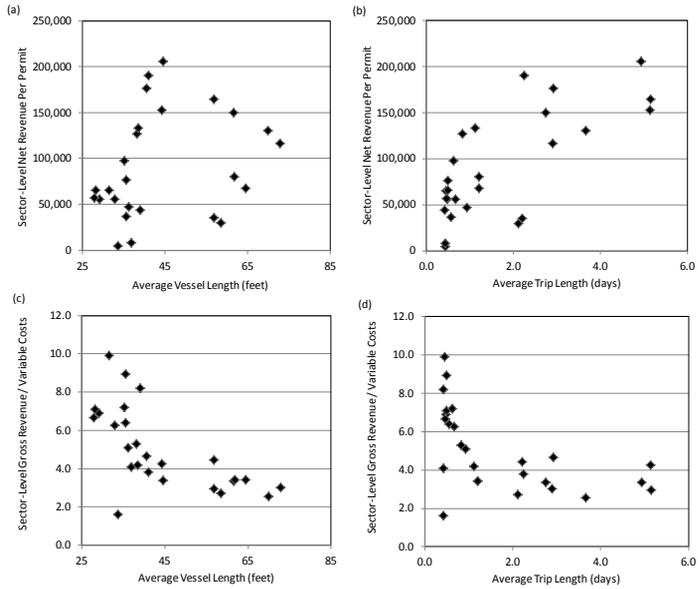


Figure 3. Sector-level Average Financial Performance Relative to Vessel and Operational Characteristics

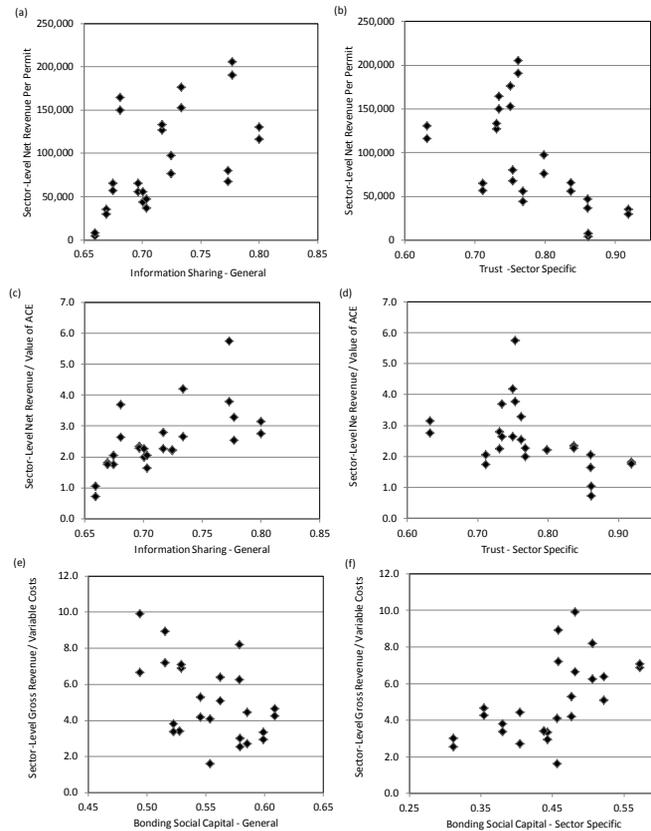


Figure 4. Sector-level Average Financial Performance vs. Social Capital Measures

Table 7
Correlation between Vessel Characteristics and Performance Indicators
at the Sector Level

Performance Measure	Average Vessel Length	Average Trip Length	# Homeport States	# Vessels Per Owner
Gross revenue/trip costs	-0.65***	-0.55***	-0.60***	0.54***
Net revenue/value of ACE	0.51***	0.30	0.46**	0.00
Net revenue/permit	0.27	0.73***	0.72***	0.32
Net revenue/active vessel	0.09	0.74***	0.61***	0.47**
Net revenue/owner	0.09	0.68***	0.59***	0.45**

* p-value ≤ 0.10 , ** p-value ≤ 0.05 , *** p-value ≤ 0.01 .

Discussion and Conclusions

Survey results suggest that most fishermen place significant value on their self-defined fishing communities and possess substantial social capital as measured in a variety of ways. Notwithstanding their reputations as rugged individualists who compete with each other for a limited resource, the survey suggests a relatively high level of trust and information sharing among New England fishermen. It appears that sectors with relatively smaller vessels on average (*e.g.*, vessels comprised of small trawlers and gillnetters that generally fish shorter trips and closer to port) tend to have higher levels of bonding social capital within their sectors (*e.g.*, strong ties to fellow sector members). However, the sectors with smaller vessels have relatively lower scores for the general bonding measure and information sharing measures which focus on relationships beyond the sector. The reverse is true for sectors with larger vessels that take longer trips and have more geographically dispersed membership.

Some of our measures of social capital appear to be related to economic performance, but in complex ways; we are reluctant to interpret correlation as causality. We cannot rule out the possibility that sector characteristics, such as average vessel size, trip length, and geographic spread of operations are the primary drivers of our economic performance measures and also of the social capital measures. However, our results suggest that the utility of different types of social capital may depend on one's type of fishing operation which, in turn, determines the appropriate performance objective. For example, sectors that have relatively larger vessels, take longer trips, and fish large expanses of ocean may be more dependent on sharing information about where to find fish and may benefit from a relatively large network of information sources. Since sectors with larger vessels tend to have larger fixed costs, they need to generate a higher absolute level of net revenues to cover these costs, and this may be a better performance metric than a cost-effectiveness measure. While these vessels may be less cost effective than some smaller vessels, they generate profits by landing a high volume of catch.

For sectors with smaller vessels and shorter average trip length operating over a more confined area, it may be that cost effectiveness rather than absolute net revenues is a better measure of performance, since these vessels have smaller fixed costs to cover. Weather conditions can prohibit some of these smaller vessels from participation in the ground fishery year-round. Another restricting factor is availability of fish near the ports, which is affected by both fish movement and area closures. The owners, who are more likely to also operate their own vessels, may generate income from other fisheries, such as lobster or shrimp, or wage labor making them less dependent on the absolute profit generated from the groundfish fishery and more concerned with getting a good return for

the time and the trip-related expenses they allocate to each fishery. These vessels may also be more concerned with optimizing their overall returns on both groundfish and non-groundfish trips by switching activities based on relative profitability.

The fact that these small boat sectors tend to have higher levels of within-sector bonding social capital may be partly a consequence of their geographic proximity and/or shared ethnic background. However these close ties may also facilitate coordination of activities within the sector in ways that contribute to economic performance, including cost saving but also increased revenue. For example the Port Clyde sector developed a marketing cooperative and a 'community supported fishery' (CSF) modeled after community supported agriculture programs (CSA's) where CSF members purchase a share of the catch prior to the beginning of a season. Similar to Port Clyde, New Hampshire sector members are in the process of starting a sector-wide marketing cooperative called Granite State Fish to sell their catch directly to local consumers. Most of the New Hampshire sector members have agreed to be part of this cooperative. These marketing efforts require a high degree of cooperation to ensure quality is maintained and market commitments are met.

A key determinant of economic viability for all fishermen fishing under sectors is access to sufficient ACE to support fishing operations. Small boat sectors arguably face a higher risk of both permit and ACE consolidation to larger, more capitalized sectors and vessels which may serve to reinforce the need for and development of bonding social capital in these smaller sectors. For example, the New Hampshire sectors started their own permit bank via a private loan made directly to the sector. Only New Hampshire permits were purchased from members, all of whom preferred to keep their permit in New Hampshire. The remaining sector members agreed to not only share the ACE associated with those permits, but also the cost and the risk associated with the loan repayments.

The analysis presented here evaluates the relationship between social capital and performance based on only two years of sector operations for most of these sectors. The role of social capital may become clearer over time and after a follow-up survey. We will then have more information to evaluate performance, sectors will have had more time to learn to capitalize on their social capital, and we will have more information about development of social capital over time. We may be able to improve upon our measures of social capital if we can more clearly understand how different types of social capital contribute to performance. It would also be useful to consider other performance objectives, such as stability and longevity of sectors, measures of satisfaction and well-being of those operating under sectors, and compliance rates. It may be that social capital has a more important role to play in these outcomes than it does in pure economic performance.

Our analysis focused on a cross-sectional comparison of sectors and their performance, but as we note, it can be difficult to untangle the effects of social capital from other factors that affect relative performance. An alternative would be to compare absolute or relative changes in performance over time; *e.g.*, pre and post-sector implementation. However, this may also be tricky since a number of factors that might affect performance will have changed and may have affected sectors differently. For example, reductions in the Gulf of Maine cod total allowable catch (TAC) would more heavily impact sectors with smaller vessels based in the Western Gulf of Maine. Simulation techniques that compare actual outcomes to counterfactual outcomes (had conditions or fishing behavior differed) may be useful for identifying how specific factors affect performance (Scheld, Anderson, and Uchida 2012).

This study relies on information provided directly by sector members that took part in our baseline survey, but information from key informants, particularly sector managers, may also be important in understanding the relative success of different sectors and the role social capital plays in sectors. Sector managers are key sources of information about the history of each sector (how members came together) and the interactions between sector members. In-depth interviews and a review of information supplied by sector managers to the New England Fishery Management Council (NEFMC) suggest that the

relationship among sector members provides an essential foundation for successful operations (NEFMC 2010). Interviews also suggested that membership may begin to shift based on the first year of experience and improved knowledge of the regulations involved.

Interviews with sector managers also highlight their role in the development of linking social capital between sectors and fisheries managers. The sector manager is the direct link between the sectors and the regulatory body (NMFS), non-profit and non-governmental organizations and universities, and between sectors. One benefit in fostering these links is the ability to gain access to new value-added opportunities (like grants and research projects) and to participate in the information and decision-making framework of new policies and regulations. An important component of this is the good personal and working relations developed between sector managers and sector leaders and the officials who work at the regulatory offices making and enforcing policy and regulations. These relations may be important to enable the regulatory process to incorporate new knowledge and experience to improve the management system over time.

While our focus in this study was on the role of social capital in determining the relative performance of different sectors operating within a single fishery, it is clear that social capital can play an important role in determining overall fishery performance. This is particularly true for co-management systems that rely on cooperation between fishermen and between fishermen and regulators rather than strict top-down regulation (Ostrom 2009; Gutierrez, Hilborn, and Defeo 2011). The quality and types of social capital in a fishery may be important factors in deciding how to structure a fishery management system and the associated compliance system (*e.g.*, affecting the extent to which fishery participants can be expected to comply with regulations voluntarily and self-police). Systems based on cooperatives as opposed to individual quotas may, in some cases, have advantages over individual quota systems both in terms of improved performance and reduced compliance costs (Holland and Wiersma 2010), but these systems may be more dependent on social capital as well. Fishery management measures are often divisive and seen as a zero sum game, which can undermine social capital. But co-management systems and cooperative research programs can help build social capital by engaging fishermen with each other and with fishery scientists and managers. Fostering (and not undermining) social capital should be a consideration in evaluating management actions and other programs.

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Appendix: Correlations between Social Capital Measures, Economic Performance Measures, and Sector Characteristics for Individual Years

Table A1

Correlations between Social Capital Measures and Economic Performance Measures for 2010 and 2011

Sector Characteristics	Bonding (general)	Bridging (general)	Linking (general)	Information Sharing (general)	Bonding (sector specific)	Trust (sector specific)
2010						
Gross revenue/trip costs	-0.46	-0.09	-0.29	-0.25	0.54*	0.00
Net revenue/value of ACE	0.25	0.00	0.15	0.63**	-0.50*	-0.60**
Net revenue/permit	0.20	-0.10	0.17	0.54**	-0.56**	-0.59**
Net revenue/active vessel	0.18	-0.20	0.23	0.33	-0.42	-0.34
Net revenue/owner	0.13	-0.18	0.15	0.47*	-0.48*	-0.51*
2011						
Gross revenue/trip costs	-0.52*	0.06	-0.11	-0.32	0.71***	0.15
Net revenue/value of ACE	-0.08	0.29	0.30	0.63**	-0.19	-0.35
Net revenue/permit	0.13	0.02	0.28	0.60**	-0.51*	-0.60**
Net revenue/active vessel	0.26	-0.21	0.12	0.33	-0.42	-0.36
Net revenue/owner	0.07	-0.07	0.28	0.53*	-0.45	-0.51*

* p-value \leq 0.10, ** p-value \leq 0.05, *** p-value \leq 0.01.

Table A2

Correlations of Sector Characteristics and Economic Performance Measures for 2010 and 2011

Performance Measure	Average Vessel Length	Average Trip Length	# Homeport States	# Vessels Per Owner
2010				
Gross revenue/trip costs	-0.56**	-0.57**	-0.61**	0.52*
Net revenue/value of ACE	0.50*	0.69***	0.58**	0.27
Net revenue/permit	0.24	0.70***	0.74***	0.40
Net revenue/active vessel	0.10	0.64**	0.74***	0.52*
Net revenue/owner	0.06	0.61**	0.65**	0.48*
2011				
Gross revenue/trip costs	-0.86***	-0.63**	-0.64**	0.56**
Net revenue/value of ACE	0.51*	0.16	0.34	-0.29
Net revenue/permit	0.31	0.81***	0.70***	0.25
Net revenue/active vessel	0.07	0.82***	0.48*	0.46
Net revenue/owner	0.13	0.77***	0.53*	0.45

* p-value \leq 0.10, ** p-value \leq 0.05, *** p-value \leq 0.01.

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