Determining and Utilizing Communication Networks in Marine Fisheries: A Management Tool

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ABSTRACT

The discovery of important lines of communication, and centrally located communication network people in marine fishery communities, is a relatively simple task. This paper demonstrates a protocol for such a discovery, as an alternative to usual, and sometimes costly, survey research, through a series of case studies conducted in the king mackerel and shrimp fisheries in the South Atlantic region of the United States. A snowball sampling technique is utilized to determine network graph centralization, and various types of centrality. Social characteristics of centrally located network people are also presented, in order to press forward toward a determination of an even less expensive and time consuming measure for the identification of central network figures in the absence of time and funds needed to execute the snowball technique. There are shortcomings associated with the exclusive use of the social characteristics protocol, and these are pointed out. Once communication networks are established, managers have at their disposal an important means of two-way communication with both commercial and recreational fishermen, and through which exchanges of data and preferences can occur on a dependable, regular basis. As such, it is hypothesized that some of the key management difficulties which currently exist, such as maintaining a trusting relationship with fishermen, determining fishermen preferences, compliance with regulations, and determining changing fishing patterns, can be overcome more effectively.

INTRODUCTION

With the development of the concept "upward aggregation of responsibility and authority" in fisheries management, Maiolo and Orbach (1982) examine the growing "...involvement of people and entities increasingly farther removed from the fishery resources, fishing activity and fishing communities themselves...." This is especially true with regard to decisionmaking affecting the allocation of marine resources. The most revealing example of this is the Magnuson Fishery Conservation and Management Act (MFCMA). Justification for the extension of national jurisdiction over marine resources, in addition to conservation, was based on the desire to manage the distribution of benefits which derive from the exploitation of such resources. Clearly, technological development affecting harvesting, processing and distribution; the related increased fluidity (*e.g.*, multiple species fishing); and the geographical mobility of fishermen (Johnson and Orbach, in manuscript) "...forces the management process beyond local political boundaries, therefore, beyond the pale of local

authority or control, and into the larger management arena (Maiolo and Orbach, 1982).

An important aspect of this shift of control from local to regional or national groups involves adaptive responses on the part of fishermen, themselves. Fishermen's adaptations involve not only the process of adopting new physical materials, objects and organizational technologies into their occupations and life-styles, but also the process of learning to work within the newly created political and administrative system, and having to deal with the constraints (and, we would add here, opportunities) imposed by the upward aggregation of management regimes (Maiolo and Orbach, 1982). To this, we would add that a similar process must occur at the management level itself, if newly developed policies are to be judged as effective and equitable by those affected by the policies. In this vein, Polinac and Littlefield (1983) note that "Perceptions of rules as 'bad' or 'unfair' can have negative sociocultural consequences." They go on to cite evidence of noncompliance with fishery regulations as an important consequence. Note, too, that Wilson (1983) found a similar pattern among clam fishermen. In this case, patterned deviance, ignored by law enforcement officials with local community ties, resulted, when confidence in the basis for regulations (and the regulators!) was low.

Clearly, the nature and frequency of the communication among the various players in the newly developed management system will play a key role in both the perceptions and the reality (they are not always the same, as we know) of the dynamics and outcomes of policy decisions. This problem area was recognized from the outset in the development of the MFCMA, as evidenced by its structure, to wit: the creation of regional councils, composed of representatives of various other management bodies, different user groups, and consumer groups; and the statutory mandates to have Scientific and Statistical Committees, and advisory groups involving various interest groups. Despite the enabling legislation, in reality, the newly created system has several impediments to the facilitation of communication between managers and their constituents. For example, Gale and Miller (1985) have noted,

> ...communication in the fishery system tends to be disjointed and incomplete. For example, nonfishing constituencies have remained peripheral to the decisionmaking process. Communication among major constituencies is unequal in both type and amount. Councils are bombarded with evidence and testimony from fishing interest, yet these groups and their representatives rarely interact with scientific and technical personnel.

The absence of effective management/constituency communication has been countered, in some cases, by the emergence of fishermen organizations

(Pollnac and Littlefield, 1983). Nevertheless, even in those cases, communication problems exist insofar as such examples were "not to the liking of managers (233)." Probably, too, such an arrangement whereby fishermen have to force their way into the process isn't to their liking either!

In fairness to the management groups, historically, councils have had rather limited frameworks at their disposal to choose participants for the various roles defined under the MFCMA. The result has been selections which, regardless of intent, have been open to criticism in the nature of political cronyism, homogeneity of philosophy (to the exclusion of competitive ideas, *e.g.*, the controversy over the balance of recreational and commercial interests), and diversity of skills, such as, for example, the number of social scientists on a technical committee, or on the council staff.

In 1985, under a continuing technical assistance contract between East Carolina University and the South Atlantic Fishery Management Council in Charleston, S.C., which is charged with the responsibility of managing fisheries in the Southeastern portion of the FCZ, ECU social scientists were asked to address the problem of identifying communication networks in the king mackerel fishery in the Southeast, and search for an alternative to the usual large scale survey technique, which was viewed as too costly and time consuming. Further, we were asked to examine protocols associated with identifying specific opinion leaders and centrally located players, and to provide the council with a list of people who could enhance a two-way communication process between the fishery and the council. Utilizing such information, the intention of the council was to appoint representatives of the industry on key advisory committees. The research group decided to take the opportunity farther by establishing a number of different protocols for identifying central figures which council staff, or other researchers, could utilize in other fisheries.

The project first concentrated on North Carolina king mackerel fishermen. Subsequent funding was made available to continue the research in South Carolina, Georgia, and Florida. Then, funding was made available in late 1987 for similar research in the shrimp fishery. This paper reports on the findings, the research protocols, and the management implications.

METHODS

As noted previously, the research was undertaken initially in North Carolina, and focused on communication networks in the king mackerel fishery. That fishery was chosen because of the salient problems at the time, namely, overharvesting in the Gulf waters, the potential for overharvesting in the South Atlantic waters, debates surrounding the biology of the stock(s), *e.g.*, whether one or more separate stocks existed, and competition between commercial and recreational fishermen (SAFMC/GMFMC, Fishery Management Plan and

Amendement Plans, 1983 and 1985,1987).

Two reports resulted from our initial research (Johnson and Maiolo, 1986; Maiolo and Johnson, 1987). It was then decided to continue the study to include South Carolina, Georgia and Florida (Maiolo and Johnson, 1987). Concern about the status of the shrimp fishery in the Southeast, in conjunction with a desire to update a previously published profile on that fishery prompted the council to request a replication of the network study for the shrimp fishery in North and South Carolina, and then in Georgia and Florida.

How the respondents were chosen. Determination of the networks.

Opinion leader research has a distinguished history in the social sciences (*e.g.* Hovland *et al.*, 1953; Roberts, 1977; Lauman and Pappi, 1977; and Burt, 1983; also, Maiolo (1965), for an extensive listing and discussion of classic research dealing with attitude and opinion change). Social network analysis has been of particular value as an analytical approach (*e.g.* Barnes, 1972; Burt, 1983). Systems of relationships among people are seen to have a number of structural characteristics, such as graph centrality and density. Also, persons within a system are structurally positioned in that they vary in the extent to which they are the focus of relations with others. Thus, it is assumed that a person who is central has high amounts of power, prestige, access to information, brokerage capacity, and so on. As such, centrally located people can be very useful in the exchange of information, and the capacity to influence the actions of others, as in the case of fishery regulations.

We approached each fishery from the standpoint of domains and sectors. For example, we view the mackerel fishery in North Carolina as having the two primary domains of recreational and commercial. Any further subdivisions within this designation are referred to as sectors within each industrial domain. The recreational domain includes charter/headboat and "pure" recreational sectors. The commercial domain includes harvesting and dealer sectors.

In attempting to capture the network of fishing participants, we employed a snowball sampling technique similar to those discussed by Goodman (1961) and Erickson (1979). The procedure involves the random selection of an initial set of respondents (in our case, by domains and sectors). Each respondent would then be asked to identify k other people in which they engage in communication (*e.g.*, who are the people who you most frequently discuss matters concerning mackerel [shrimp] regulations?). The people named in the first wave, who were not interviewed in the initial sample, would then be asked to name k other people with whom they share the specified communication relationship. This would then be repeated for a number of stages or waves as determined by the research design for a specific problem, *e.g.*, until a high degree of network closure is reached.

Much consideration was given to the decision regarding the fixed number

(k) of individuals to be named in each additional stage. Although others have used this sampling procedure without a fixed number of choices, Goodman (1961) provides some statistics for making inferences about a sample when the number of choices are fixed. Based on the successful implementation of our initial work, we set k equal to three. There are, of course, advantages and disadvantages to this procedure. However, a fixed k of three choices alleviates a high degree of bias that would be introduced because of individual variations with respect to the relevant specified network relations. In a procedure with an unspecified k, some respondents would be inclined to provide a large number of choices (or small number) that would display a high degree of variance with respect to strength of network ties. By reducing the number of choices to three we hoped to reduce the amount of variance with respect to these sociometric strengths (*e.g.* Erickson, 1979; Johnson *et al.*, in manuscript; for a discussion of this and other factors related to snowball sampling). In pretests of this procedure we experimented with a combination of unlimited and fixed choices. We finally chose a procedure which asked informants to name three individuals with whom they "talked to most often about the mackerel fishery." This procedure was viewed as an aid to decrease the bias which might be introduced by informant variance.

In addition to gathering data on proposed names of central people, selected attributes of each individual in the samples were compiled. These included occupation, age, level of education, domain and sector of the industry predominately involved in, and so on. We added some variables as we learned from previous field work, and as we shifted from the mackerel to the shrimp fishery. In the former, we included respondents from both the commercial and recreational domains, and regardless of the location of fishing and size of vessel. In the latter, we restricted the research to the commercial domain, and vessels of 45' in length or greater. This would capture mainly FCZ vessels, and was conducted in such a manner in order to keep the respondent size to a level commensurate with budget constraints.

The purpose of this portion of the research was twofold. First, the attributes could be compared to measures of centrality within a communication network in order to discover patterns of association. So, for example, it may be the case that major dealers are the most central links in the network in a particular sector. These findings may then be applied in other similar contexts without having to employ any extensive snowball sampling. For example, in the absence of the possibility of obtaining specific network information and the names of central people, information about the characteristics of centrally located people would be useful to managers faced with the problem of selection of advisories. Often, managers are faced with severe time and budget constraints. Our objective was to provide them with a useful selection tool under such conditions. The danger, of course, is that this protocol might be utilized as a priority procedure, instead

of an alternative. As we discuss the results of using this procedure, we caution the reader to view the results as very tentative.

Second, we were interested in producing a matrix of transition probabilities. This matrix will allow us to make structural inferences about the flow of information between groups in a domain/sector delineated on the basis of known attributes. Transition probabilities are defined as the ratio of choices within a delineated group to choices made outside the same group. We are interested, for example, in identifying a group within an industry or fishery domain/sector that has the highest ratio of outside ties. Once a group is identified that has many ties outside their own group, it may be most efficient to channel information through them. In addition, we would be able to investigate the existence of status levels within and between sectors and the characteristics of the flow of information between and among such statuses (*e.g.*, information may only flow from low status to high status).

Data Gathering

The initial data gathering in North Carolina in the king mackerel fishery utilized both telephone interviewing, and interviewing fishermen at their homes and work places (*e.g.*, docks). We found no difference in quality, and no difference in the number of refusals. We did have problems with some fishermen not having telephones or listed numbers. We designed the out of state studies to involve only telephone interviewing, because of cost. Had we attempted to do on site interviewing, the costs would have been so high, even with trained, local people, that the research could not have been undertaken.

Refusal rates and rates of no contacts remained at an acceptable level (less than five percent) until we encountered problems in Florida during the data gathering phase of the shrimp research. Fishermen were found to be so excised over the Turtle Excluder Device (TED) issue (*e.g.* Fee, 1987), and were so angry with both the South Atlantic and Gulf Councils, that many refused to participate.

Project interviewers were trained for several hours in the delivery of the interview instrument, and then monitored by the senior staff. The most frequent problem encountered was eliciting names (nominations). This became an increasing problem as we entered the Florida study dealing with the shrimp fishery. Interviewers were trained to prompt the respondents, and explain the need for the names, but not to press beyond that point.

FINDINGS

Mapping the Network: The King Mackerel Fishery in North Carolina

A sociomatrix was constructed based on interviews with 238 fishermen. This 238 X 238 binary matrix was subjected to a structural equivalence algorithm similar to those discussed by Burt (1983) and Johnson (1986). The resulting Euclidean Distance Matrix was then subjected to a clustering

procedure in order to identify sets of structurally equivalent actors (status/role sets). The clustering analysis was used to help construct the sociogram in Figure 1.

Table 1 identifies individuals having primary importance (*e.g.*, centrality) in the network. In addition, the ratio of outside ties to the total number of ties is given for each. The manner in which these data can be used is largely determined by any number of different questions. These questions may relate to theoretical notions concerning centrality or prestige, the degree to which a person has wide ranging social ties, network density, inter-clique communication, or some other idea concerning communication behavior. As an example of one of the many ways this information can be used, we will briefly explore the utility of centrality and the ratio of "outside" ties to the total number of ties for each of the individuals in Table 1.

Centrality has three basic conceptual and graph theoretic definitions (Freeman *et al.*, 1979). The first of these concepts is based on the number or degree of ties a person has within a system of people and is labelled point centrality. Related to this is relative point centrality, which adjusts for the size of the network. The second is point betweenness which determines the extent to which a person is located between other actors in a network. The third is based on the centralization of the entire network, and reflects the degree to which the network is dominated by a single point. These three forms of centrality have implications with respect to control, independence and the amount of activity within a network. [Graph centralization and relative betweenness could not be calculated for the North Carolina network. The size of the sociomatrix was found to be too large for the computer program.]

If we are interested in central persons who maintain a large number of ties with individuals who are not from the same domain or sector of the industry, we can measure this by simply counting the number of ties to people not of the same domain or sector and then dividing that number by the total number of ties.

Table 1. North Carolina fisherman identified as having primary importance in the communication network and the ratio of ties outside their sector to their total number of ties.

Recreational	Ratio	Charter/Headboat	Ratio	Commercial	Ratio
174	0.14	008	0.10	098	0.22
176	0	012	0.33	121	0
		031	0.13		
		032	0.11		
		108	0.86		
		147	0.40		

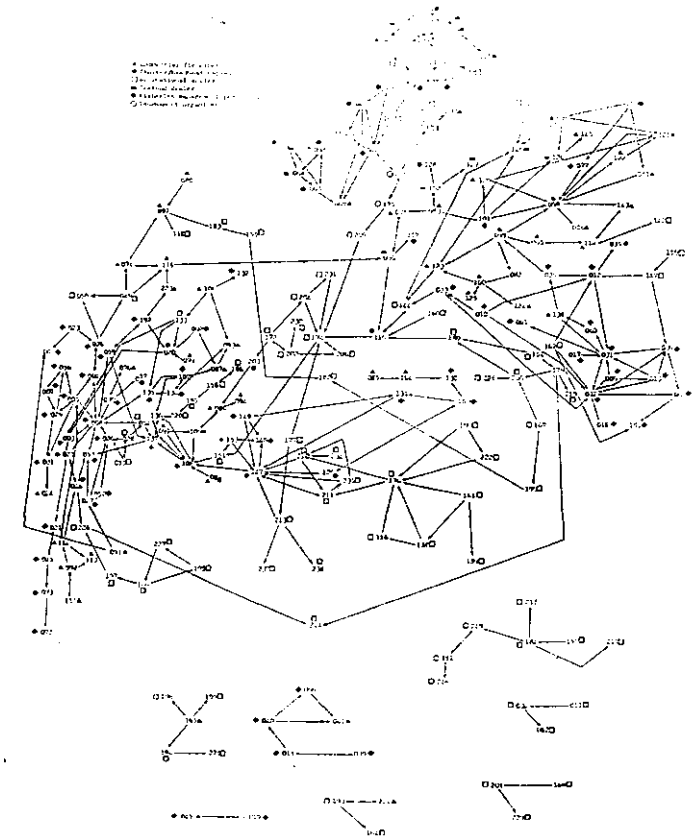

Figure 1. Network of the King Mackerel Fishery in North Carolina. (triangle = commercial fisherman, diamond = charter/headboat captain, square = recreational angler, filled rectangle = seafood dealer, filled circle = fisheries management personnel, circle = tournament organizer.)

This ratio of outside ties to the total number is presented in Table 1 for each of the central people (similar in nature to the transition probabilities discussed earlier). Figure 1 is the visual representation of the network derived form the data. As is quite evident, persons from the charter/headboat sector tend to dominate the network in terms of centrality and diversity of ties.

An interesting feature of the structure of this network is the fact that each of the central people is directly linked to one or more other central figures. In the cases where there is not direct links (actors 174, 176, and 008), other central figures are no more than three links away. Thus, the central people within this network are generally well connected.

This has implications in terms of the flow and nature of information. Respondent 108, for example, is somewhat between 147 and 008. Number 008 has a larger number of ties, but most are with people from within his own sector of the industry. We would expect him, for example, to have a high degree of access to information concerning problems within the charter/headboat sector. Number 108, on the other hand, has 86% of his ties with individuals outside his sector and has a direct link to 147 another central actor within the sector of the industry. We would hypothesize that 108 would have a higher degree of access to a wider range of kinds of information (at least information crossing sector boundaries).

Similar analysis can be performed on other respondents listed in Table 1. In addition, a whole range of other theoretical concepts can be applied to these data. What is important to recognize is that these types of methodological and theoretical approaches provide basic guidelines for interpreting the data.

Data were collected representing the "guesses" or intuitions" of various state and federal marine resource managers about who (fishing participants) they thought were important from the three sectors of the commercial and recreational domains. More specifically, a sample of mid to top level individuals responsible for the management of various marine resources from the North Carolina Division of Marine Fisheries (NCDMF), the South Atlantic Fishery Management Council (SAFMC), and the North Carolina Marine Fishery commission were asked to provide one or more names from each of the domains and sectors who they thought would be important in the North Carolina king mackerel fishing communication network. These "guesses" constituted resource managers' perceptions concerning who is important, at least from the standpoint of the flow of information. This portion of the research was performed to assess the adequacy and utility of the network approach.

In addition, the SAFMC's newsletter mailing list was obtained to test

1. The degree to which active (*e.g.*, central) participants in the communication network were included on the list
2. The extent to which people sampled in the study were listed.

Finally, the actual North Carolina membership of the SAFMC's king mackerel advisory panel was obtained.

A Comparison of Methods

Table 1 contains fishermen who have been identified as important from both the relational and positional analysis of the network data. This importance is determined on the bias of in-degree centrality, betweenness, diversity in types of relations, and structural uniqueness. The basis for this selection is evident from an examination of Figure 1.

Table 2 contains the responses of resource managers concerning their "intuitions" about who is important, and also includes names from mailing lists and the advisory panel membership list. In comparing the two tables, there appears to be little overlap. One exception is sport fishermen 174. The tie between 174 and 138, then Director of the NCDMF, and currently Executive Director of the SAFMC, clearly exposes 174 to a wide range of management personnel. In addition, 174 has become known within the state as a spokesman for sportfishing interests. Among fishermen of other sectors, however, there is overlap in only one of the sectors, and if the SAFMC mailing list and advisory panel participants are also considered, this discordance becomes even more

Table 2. Resource Manager's "intuitions" about importance of participants in the NC King Mackerel fishery.

	Division of Marine Fisheries (N=4)	SAFMC (N=1)	NC Marine Fish Commission (N=1)	SAFMC Mailing List (N=58)	SAFMC King Mackerel Advisory Panel (N=10)
Recreational	174*				
	226 (2)	VP Raleigh	174*	174*	-
	2 not listed**				
Charter/Headboat	192 (2)	013	226	129	-
	020, 031			134	-
Commercial	078 (3)	146	226	078	221
	061			146	146
	221			221	

* Central person from the recreational sportfishing sector.
** This also includes 105 names that were elicited but not interviewed.

glaring.

An Alternative Protocol

Mapping network relations with the use of snowball techniques is effective, and while less costly and time consuming than general surveys, still costly and time consuming nonetheless, even with the use of telephone interviewing. Without telephone interviewing, the costs are very high (up to $75 per sample point, for long distance interviewing). We began to look for an even less costly, roughly equivalent alternative to the network mapping protocol, in order to provide agencies and organizations with at least another option, depending on need, and available time and funding, as noted above.

We have noted, too, that we gathered selected socio-demographic information. Similar to studies on innovation and diffusion (Kim and Palmore, n.d.), number of nominations (dependent variable) was correlated with age, education, years fished, and so on. Such analysis was conducted in the hope of identifying socio-demographic characteristics which might predict varying degrees of centrality.

A comparison of means on some of the variables between the commercial and recreational domains are presented in Table 3. Statistical significance was found in regard to two variables, *viz.*, age and education. However, these are not felt to be meaningful for making decision. What is important, we feel, is that the variables listed in the table give clues as to the profiles of network participants in a way to be useful for selecting advisories, in the absence of specific network information. Taking into account the standard deviations, most of the network members fall between the ages of 32 and 54; have some high school to some graduate college training, and belong to at least one fishermen's organization. The s.d. for years lived in the community rendered the variable unimportant—16.95 and 15.57). These variables indicate grounding in the fishery in terms of experience, to some extent, through age (as a proxy variable); formal education and attendant calculating behavior, including the choice to belong to a special interest group. We do not have mackerel specific comparisons on other fishermen, but the data are not different from findings we have on general fishermen populations, except for educational level, which is higher in this study than we have seen in others (*e.g.* Maiolo, Williams *et al.*, 1985; Maiolo, Kearns *et al.*, 1985; Kearns *et al.*, 1986. Also, Johnson, *et al.*, 1986).

Table 4 displays correlations between selected variables in each of the domains and the number of times nominated during the conduct of the research (using the snowball sample). In the commercial domain, three variables attracted our interest. The number of periodicals refers to the subscriptions to magazines and newsletters to which fishermen subscribe. This is an indication of an interest in fishing technology and other issues, such as management. Second in value is

Table 3. Comparison of Means on Selected Variables: Recreational vs. Commercial Domains. (NC Mackerel Study).

Variable	Recreational	Commercial	Level of Statistical Significance
Age	43.27	40.21	.028
Years Lived In Community	22.62	18.30	.076
Years of Education	14.02	13.06	.015
Number of Fishermen Organizations joined	1.50	1.35	.252

Table 4. Correlations of Selected Variables with number of Time Nominated. (NC Mackerel Study).

Commercial Domain (N=66): Variable	Correlation Value
Age	-.026
Years Lived in Community	.110
Years of Education	.202
Number of Organizations	.156
Number of Periodicals	.401
Yearly Exvessel Sales	.109
Recreational Domain (N=172)	
Age	.123
Years Lived in Community	.064
Years of Education	-.105
Number of Organizations	.121
Number of Periodicals subscribed to	.097
Years Run Charter/Headboat	.239
Fish in FCZ	.166
Percent Income from King Mackerel	.416

years of education, followed by number of fishing organizations to which the respondents belong, their years lived in the community, and the amount of yearly exvessel sales of fish.

In the recreational domain, the charter/headboat captains showed their presence with years of such experience exhibiting the highest coefficient. Years of education was negative in sign primarily due to the presence of the large number of charter/headboat captains (n = 72), and their strong presence in the network. When the recreational domain was split into sectors, the negative correlation held up for charter/headboat captains. The "pure" recreationals and

the "other" category (*e.g.*, tournament directors and governmental agency people) were positive in sign but not significant. Other variables of note for further analysis were the percentage of recreational fishing which occurred in the Fishery Conservation Zone (FCZ), and age.

The most notable correlation in the recreational domain, of course, is that between the percent of total income derived from the sale of king mackerel and number of times nominated. Much of this is explained by the presence of the charter/headboat captains who gain supplemental income from the sale of kingfish, but not all of it. Some is attributable to the "pure" recreational fishermen who sell kingfish.

Table 5 displays results of Stepwise Regression routines for both domains combined (recreational and commercial). The number of organizations belonged to and age, in combination, creates a Multiple R of .16004 with a significance level of .0474. This may be a case with statistical but, perhaps, not meaningful level of significance since, in spite of the .0474 level, only .02561 percent of the variation is explained. The finding does provide a lead for further analysis, however.

When the domains were separated, some viable findings for council application are indicated (Table 6). Commercial fishermen who are centrally located, as measured by number of nominations, tend to be the most widely read, the more highly educated, belong to more organizations, have the larger boats and most ex-vessel sales, and tend to be more grounded in the community than their less centrally located counterparts. Also, insofar as the purpose of the study, in the first place, was to identify people with whom council could communicate, the "periodicals read" variable should be good news to managers who would want to select key people who would read materials sent to them for comment. Twenty-five percent of the variance is explained, and we believe that the data can be utilized to more effectively select advisors in the absence of specific network information, including the identities of central figures. Selection could be made on the basis of profiles where candidates match up on the socio-demographic variables examined here.

Table 7 displays the stepwise regression results in the recreational domain. Note that percent income from sales of king mackerel was entered first. The second variable entered was frequency of effort (for kings, in the FCZ) and then years as charter/headboat captains, indicating a separate effect of nonprofessional recreational fishing, which apparently translates itself into network location. The number of organizations belonged to apparently produces an effect for non-charter headboat captains insofar as it adds some value, but the zero order correlation between organizational membership and the charter/headboat variable was found to be -.042.

When the domain was split to compare "pure" recreationals with the Charter/Headboat sector, the picture changes somewhat. For non-charter people

Table 5. Stepwise Regression on Selected Variables, Commercial and Recreational Domains Combined. Dependent Variables in Number of Times Nominated. * (NC Mackerel Study).

Step	Variables	Multiple R	R2	Level of Significance
1	No. of Organizations	.11989	.01437	.0648
2	Plus Age	.16004	.02561	.0474
3	Plus years in Community	.16720	.02795	.0840
4	Plus years of Education	.16764	.02810	.1544

* A second regression which included number of fishing related periodicals read added .05 to the R, raising the R2 to .04733.

Table 6. Stepwise Regression on Selected Variables. Commercial Domain. Dependent Variable is Number of Times Nominated. (NC Mackerel Study)

Step	Variables	Multiple R	R2	Level of Significance
1	Periodicals read	.40079	.16063	.0009
2	Years of Education	.43587	.18999	.0013
3	Yearly ExVessel Sales	.44957	.20211	.0028
4	Number of Organizations	.47810	.22858	.0029
5	Boat Length	.48873	.23886	.0005
6	Years in Community	.50012*	.25012	.0075

* Other variable shown to add little to the R include percent King Mackerel catch sold, percent of King Mackerel sold to total sales, number years commercial fishermen, and age.

in the recreational domain, experience as a fishermen, tournament participation and reading habits seem to be good predictors. Income from sales of king mackerel appears to be behavior emanating from the first two variables mentioned (Table 8).

For charter/headboat captains, years spent at that job, a counterpart to experience among the "pure" recreations is the best single predictor, followed by the community residence and then the sales variable, and then interestingly, number of organizational memberships. Years of education adds some value but it must be kept in mind that it is a negative insofar as the less educated are more probable to be nominated than the more educated among charter/headboat captains.

Table 7. Stepwise Regression on Selected Variables. Recreational Domain. Dependent Variable is Number of Times Nominated. (NC Mackerel Study)

Step	Variables	Multiple R	R2	Level of Significance
1	Percent Income from King Mackerel Sales	.41576	.17285	.0000
2	Fish in FCZ	.43759	.19148	.0000
3	Years run Charter or Head Boat	.45546	.20744	.0000
4	Number of Organizations	.47254	.2230	.0000
5	Number of Periodicals	.47880	.22925	.0000

Table 8. Stepwise Regression to Compare Recreationals with Charter/Headboat Sample: Dependent Variable is Number of Times Nominated. (NC Mackerel Study).

	Recreationals (Exclusive of Charter/Headboat Captains)			
Step	Variables	Multiple R	R^2	Level of Significance
1	Yrs. as Rec. Fishermen	.22347	.04994	.0332
2	Number of Tournaments Entered	.31410	.09866	.0104
3	Number of Periodicals	.33604	.11292	.0149
4	Percent Income from King Mackerel Sales	.34469*	.11881	.0265

	Charter/Headboat Sector			
Step	Variables	Multiple R	R^2	Level of Significance
1	Yrs. Run Charter Boat	.28451	.08095	.0154
2	Years in Community	.32524	.10578	.0211
3	Percent Income from King Mackerel Sales	.36463	.13295	.0206
4	Number of Organizations	.38389	.14737	.0284
5	Years of Education	.39723	.15779	.0409

*Number of Oranizations belonged to, age and years in the community added virtually nothing to the R.

Mackerel Fishery; Other States

Several new twists were added to the analysis for the remaining three states. The North Carolina research focused on centrality and characteristics of central figures. The data obtained from the three subsequent states were subjected to analysis which introduced relative betweenness and graph centralization. The first locates the actor along paths between clusters within the networks (networks within the overall network). The second allows us to examine the extent to which the network relations are intensely focused on one or more actors, sectors or domains. [Graph centralization and relative betweenness could not be calculated for the North Carolina network. The size of the sociomatrix was found to be too large for the computer program.] Thus, in a case where an actor exhibits a moderate centrality score but high betweenness, while another has a similar centrality but lower betweenness score, if only one could be selected for an advisory panel, the former is the better choice. However, the protocols and data were still not far along enough to attempt to get predictors for those with high betweenness and transitional values, *i.e.*, the ratio of choices within a delineated group to choices made outside the same group sector delineated on the basis of know attributes. Ethnographic, multiple species data are required in order to yield more data on central figures. This meant that our predictor analysis was still limited to analyzing data with number of nominations only.

The South Carolina and Georgia networks displayed high graph centralization for comparatively small networks (.10 and .11 coefficients, with 120 and 75 respondents, respectively). Also management personnel dominated the networks in both states with varying, but consistently high indegree centrality and betweenness scores, indicating both intensity and diversity in their network relations. Only one recreational fisherman, and no commercial fisherman indicated high scores in South Carolina. One charter captain exhibited a high score in Georgia, along with several sportfishermen, but no commercial fishermen.

The Florida network exhibited low graph centralization, with a score near zero. No actors were found to display high indegree centrality, and the network was extremely large (205). Also, the scores showed more distribution across domains than in the other states. Management ties were found to be mostly in the direction of sportfishing interests. Five charter captains demonstrated comparatively high indegree centrality, but low betweenness. Florida demonstrated a larger number of recreational figures who were comparatively high in regard to centrality scores than the other states (10 respondents), but they varied by indegree centrality and betweenness scores, and in the symmetry of relationships. Seven commercial fishermen emerged as central, which is clearly different from the other states, and obviously due to the importance of the

commercial fishery in that state. Three dealer/processors and one marina operator emerged as central, too.

In regard to the predictor analysis, we found inconsistencies in the data but organizational affiliation and subscriptions to fishery periodicals still were borne out as the best way to proceed in regard to identifying central figures (except for commercial fishermen) where years lived in the community stood out as important. [Because of the lack of any specific theory driving this analysis, and because of the crude nature of the resulting estimates, we felt that simple correlations would be sufficient for the remaining analyses of the predictor variables.]

The Shrimp Fishery: North and South Carolina

A total of 382 respondents were interviewed in the two states, 227 in North Carolina before closure was attained, 155 in South Carolina. The respondent with the highest relative indegree centrality in North Carolina was found to be a dealer, and was cited by a wide range of different other respondents, including two central management people (see 1058 in Figure 2). Seven captain/owners were found to have high indegree centrality but exhibited small geodesic distances, *i.e.*, they are all within a couple of edges or links of one another (see 1082, 1112, 1113, 1231, 1120, 1062, and 1106). In addition, they all tend to have similar centrality scores with no one score being higher than the others, and tend to talk almost exclusively with other fishermen, *i.e.*, they have low transition probabilities.

There are a number of other captain/owners with high indegree centrality who are not connected to fishermen in this portion of the network. These include 1019, 1017, 1021, and 1100. Although their relative indegree centrality scores are similar in magnitude to those of the previous group, there is a tendency among these four to have more varied patterns of communication, *i.e.*, relatively higher transition probabilities. We found only one commercial captain who exhibited a high relative indegree centrality score, actor 1033.

Two management personnel were found to have high relative indegree centrality scores (1166 and 1059). But, they tend not to be cited much by commercial captains or captain owners.

The South Carolina shrimp communication network was found to contain twenty actors with relatively high indegree centrality, with six others having a significant degree of relative betweenness, and another three having only high relative betweenness. There is some degree of centralization in the network (graph centralization = .06) due largely to the high centrality of a single respondent (0019). However, this is not as centralized as, for example, the networks in the South Carolina and Georgia king mackerel fisheries (.10 and .11 respectively).

The respondent with the highest relative indegree centrality is 0019 (Figure

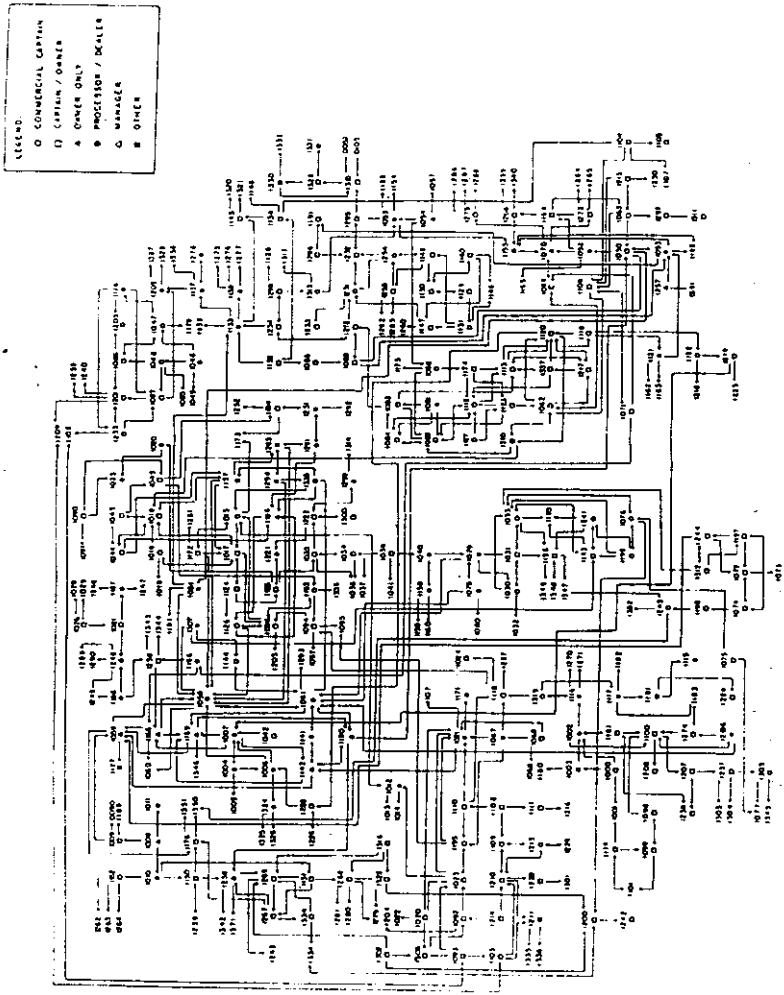

Figure 2. Shrimp fishery network in North Carolina.

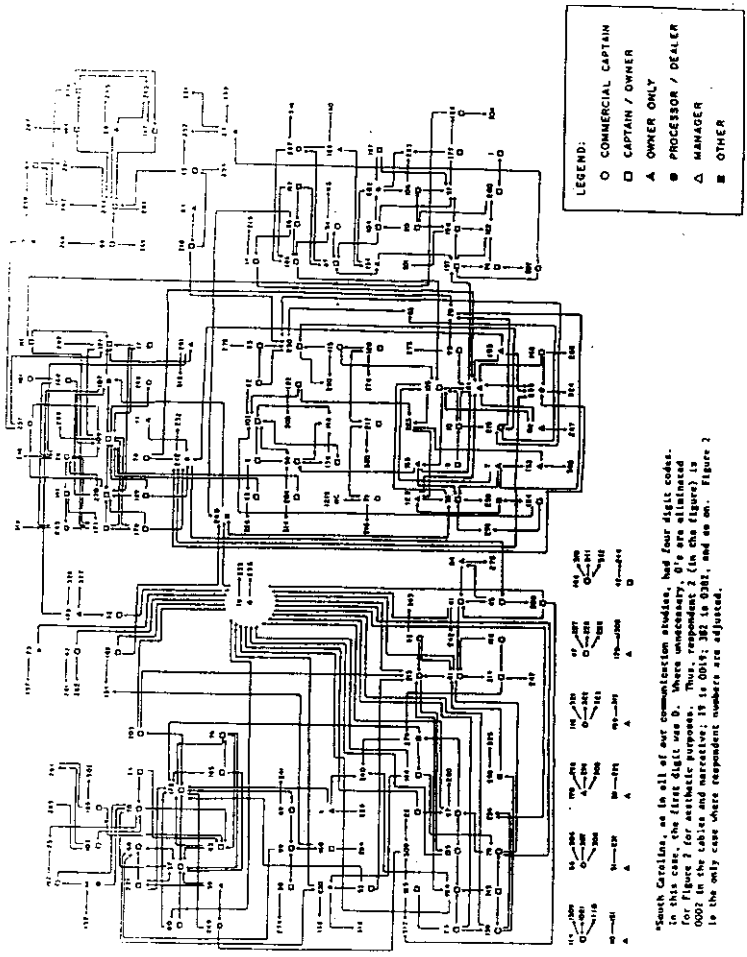

Figure 3. Shrimp fishery network in South Carolina.

3). A dealer/processor, 0019 received the majority of his incoming ties from a wide range of different types of respondents. In addition, he is one of only a few bridges between two major subgroupings. Figure 3 shows this person's relative position whereby he is the focus of many relations from the subgroup at the left of the figure while only receiving one citation from a respondent connected to the subgroup to the right in the figure.

Similar to the North Carolina network, most of the people with high relative indegree centrality are captain/owners. These include 0026, 0035, 0037, 0070, 0081, 0087, 0098, 0101, 0105, 0109, 0121, 0137, 0175, 0213, 0244, 0250, and 0270. Additionally, captain/owners 0041 and 0045 have high relative betweenness but not centrality. Of these, 0109, 0175 and, to some degree, 0037 have larger centrality scores in comparison. Respondents 0109 and 0175 maintain central positions in two distinct areas of the network; one in the left corner of Figure 3 (near 0037) and the other in the upper right; 0109 is cited by three other central captains: 0026, 0121, and 0270, indicating his importance. Of these two, however, only 0175 has a relatively high betweenness score, indicating his ties may be reaching into more distant areas of the network. Respondent 0105 is another important captain/owner. He has half ties with respondents other than commercial fishermen and is connected to two central dealers (0181 and 0212). This diversity in types of ties is reflected in his relatively high betweenness score (0.05).

In contrast to the North Carolina network, management did not play a central role in any way. In fact, only one manager was interviewed, and only because he was chosen in the initial sample as a captain.

In regard to personal attributes as predictors, when comparing all respondents in both states in terms of number of times nominated correlated with selected variables utilized in the prior studies, only the number of organizational affiliations was found to be statistically significant. For the shrimp research, we added number of boats owned and number of fisheries management meetings attended. When the data were examined by sector, with states combined, the results were identical. In North Carolina, the relationship held up in all cases where the data could be analyzed the category vessel owner only, who hired a captain different from himself, did not have an n large enough to analyze.

In South Carolina, the sample sizes were too small for analysis in the captains and dealers categories. The significance of the organizational variable was revealed in the captain/owner, and captains/owners with 90% income or more derived from fishing.

Other variables pursued for this analysis were number and sizes of vessels owned, and other indicators of income (*e.g.*, estimated income from shrimping). One produced findings of value. We ran the variable "estimated income" from fishing against nominations and found that in both states, among fishermen

expecting to receive more than 90% income from fishing, such income was found to be significantly related to the number of nominations: N.C. = .387 (n = 88) .001; S.C. = .313 (n = 66) .01.

Conclusions and Implications

Within the mackerel fishery, it is interesting that people located in management positions are important network figures in North and South Carolina, and Georgia, but not in Florida. Parallel to that is the finding that Florida exhibited low graph centralization as compared to South Carolina and Georgia (recall that the technique was introduced after the N.C. portion of the project). And, it is noteworthy that Florida has the largest developed commercial fishery for mackerel, along with the more highly developed and diverse political framework among the Southeastern states.

Thus, we would conclude that small, tight networks prevail in N.C., S.C. and Georgia with a heavy dependence on state management personnel for information (and vice versa). Regional and national management groups would have to rely on those actors to gain input from the fishery, and to communicate important information (*e.g.*, regulations) through those actors. There are some "pure" recreational and charter/headboat fishermen who are sufficiently central to be useful, as well. Indeed, they should not be ignored in the management system.

Florida presents a problem in the selection of advisors to the extent that each domain, and sector within them, should have at least one representative in management advisory groups to ensure network coverage. It is interesting to observe the relationship between the graph centralization (low) and the presence of distinct sub-networks with dominant central figures.

When the project shifted to the more commercially developed shrimp fishery in North and South Carolina, captain/owners and dealer/processors dominated the networks. One can conclude, then, that the degree of development of the fishery affects the shape of the networks, in terms which domains and sectors represented, and to what extent.

In the absence of specific actor information, our data lead one to tentatively conclude that managers could rely on organizational affiliation and subscriptions information to select advisors. That is, let us assume that the managers had to get information about fishermen occupational patterns, attitudes, perceptions, and/or circulate information about impending regulations. Surely the best procedure would be to identify the network using the snowball technique, if key people were to be relied on for the information or reaction (instead of a full scale survey). But, let us also assume there are severe time and/or budget constraints. We would suggest gathering data on as many as possible, focusing on number and types of organizational affiliations, and subscriptions to fishing periodicals. In fact, the SAFMC has begun to do just that and the results look promising at

this point. One fear we have, however, is that such a protocol would be relied upon, entirely, when the importance of the issue(s) warrant(s) taking the time and spending the money to get the information in the most reliable way, namely, with the use of the snowball technique. One should not overlook the fact that our estimates were not stable in every state and across fisheries. To be sure, one of the reasons emanates from variations in statistically manipulatable sample sizes. By the same token, however, we do not have time series data to tell us about the stability of networks over time, and, therefore, about the characteristics of various types of central figures over time. It seems reasonable to hypothesize that the stability of the network is a direct function of the stability of the fishery (*e.g.*, contrast the fluidity of the mackerel fishery, especially the commercial domain, with the constancy of the shrimp fishery). In the meantime, it seems reasonable to suggest that the manager is better off opting for the full scale network protocol in a given fishery, rather than relying on data from another fishery (*e.g.*, social characteristics of central figures), keeping in mind that the snowball technique has enormous benefits for a comparatively small cost.

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