Social Network Analyses of Trap Certificate Transfers in the Florida Lobster Fishery: An Exploratory Analysis

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ABSTRACT

In 1992, the Florida spiny lobster trap certificate program (TCP) was created to reduce the number of traps and maximize efficiency of the fishery. As with many other rights-based management programs, participants in the fishery are allowed to transfer (i.e., buy and sell) allocations to other participants, which is expected to result in consolidation and optimal performance of firms. However, the spiny lobster TCP is functioning in a diverse fishery. It is heterogeneous in firm size and function, with participants holding a broad number of traps and accommodating various markets. Additionally, participants are located across a relatively wide geographic range including the Miami area and the Florida Keys. The fishery is also comprised of two distinct ethnic groups, Anglo and Hispanic, which may result in cultural and language barriers among participants. Lastly, two commercial fishermen's associations are active in the study area. This paper is an exploratory examination of how these factors influence the certificate transfer market. Transfer data from 1992 - 2008 are analyzed as social networks to examine relationships between sellers and buyers. Each example of an annual network analysis depicts that year's certificate transfers. Results can help the fishermen's associations and fishery managers better understand how markets for fishing rights work in order to improve the transfer process and ultimately the efficiency of the fishery.

KEY WORDS: Spiny lobster, Florida, tradable fishing rights, social network analysis

Los Análisis de Red Sociales del Certificado de Cesta se Trasladan en la Pesquería de Langosta de Florida

En 1992, el programa de certificado de nasa para pescar langosta espinosa de Florida (TCP) fue creado para reducir el número de trampas y maximizar la eficacia de la pesquería. Como con muchos otros programas de dirección a base de derechos, a participantes en la pesquería les permiten trasladarse (es decir, comprar y venderse) asignaciones a otros participantes, que es esperado causar la consolidación y la interpretación óptima de negocios. Sin embargo, la programa funciona en una pesquería diversa. Es heterogéneo en tamaño firme y función, con participantes que sostienen un amplio número de nasas y acomodan varios mercados. Además, los participantes son localizados a través de una relativamente amplia variedad geográfica incluso el área de Miami y las Llaves de Florida. La pesquería también consiste de dos grupos étnicos distintos, Americano e hispano, que puede resultar en cultural y barreras de los idiomas entre participantes. Finalmente, las asociaciones de los dos pescadores comerciales son activas en el área de estudio. Este papel es un examen exploratorio de como estos factores influyen en el mercado de transferencia de certificado. Los datos de transferencia de 1992 - 2008 son analizados como redes sociales para examinar relaciones entre vendedores y compradores. Cada ejemplo de un análisis de red anual representa las transferencias de certificado de aquel año. Los resultados pueden ayudar a las asociaciones de los pescadores y los gerentes de pesquería mejor entienden como los mercados para derechos de pesca trabajan a fin de mejorar el proceso de transferencia y por último la eficacia de la pesquería.

PALABRAS CLAVES: Langosta espinosa, Florida, derechos transferibles de pesca, análisis de red social

Les Analyses de Réseau Sociales de Transferís de Certificat de Piege dans la Pêcherie de Homard de Floride

En 1992, le programme de certificat de piège de pêcherie de homard épineux (TCP) a été créé pour réduire le nombre de pièges et maximiser l'efficacité de la pêcherie de Floride. Comme avec beaucoup d'autres programmes d'administration à base de droits, on permet aux participants à la pêcherie de changer (c'est-à-dire, acheter et vendre) les allocations à d'autres participants, qui est attendu s'ensuivre dans la consolidation et la performance optimale de sociétés. Pourtant, le homard épineux TCP fonctionne dans une pêcherie diverse. C'est hétérogène dans la grandeur ferme et la fonction, avec les participants tenant un large nombre de pièges et d'approvisionnement marchés différents. Supplémentairement, les résidences de participants et les terres de pêche couvrent 100 miles de Miami sud à Key West. La pêcherie est composée aussi de deux groupes ethniques distincts, Anglo et Hispano-Américain, qui peut s'ensuivre dans culturel et les barrières de langue parmi les participants. Enfin, les associations de deux pêcheurs commerciaux sont actives dans la région d'étude. Ce papier a l'intention d'examiner comment ces facteurs influencent le réseau de transfert de certificat. Les données de transfert de 1992-2007 sont analysées comme les réseaux sociaux pour examiner des rapports entre les vendeurs et les acheteurs. Chaque analyse de réseau annuelle représente les transferts de certificat de cette année et une analyse longitudinale représente des changements et des processus dans le réseau transactionnel depuis le commencement du TCP. Avec les analyses de réseau, les rôles de facteurs socio-culturels, spatiaux et affiliative sur les transferts de certificat sont examinés.

MOTS CLÉS: Homard, certificat de piège, analyses de réseau sociales, transferts

INTRODUCTION

Tradable fishing rights are increasingly used in fisheries management. Establishment of a rights-based fisheries management program assumes the expected maximized economic efficiency of the fishery will be reached through the trading of shares, and can only be achieved via a well-functioning trading market. Economic theory dictates that in order to achieve maximized efficiency, the certificates---essentially, the right to fish---will move from the less efficient fishermen to the more efficient fishermen, and the market should reflect this (Grafton 1996, Hanna and Munasinghe 1995, Squires *et al*. 1995). Not as common in the literature are studies on the effects of social factors and social ties on a tradable permit market and in the decision-making of market participants, and the reasons why a market may not function as expected.

In 1992, the Florida spiny lobster trap certificate program was created through the South Atlantic and Gulf of Mexico Fishery Management Councils in coordination with (what is now) the Florida Fish and Wildlife Conservation Commission. The intent of the program is to reduce the number of traps and maximize efficiency of the fishery (Larkin and Milon 2000, Shivlani *et al*. 2004). As with many other rights-based management programs, participants in the fishery are allowed to transfer (i.e., buy and sell) shares to other participants and newcomers to the fishery.

As with most fisheries, the spiny lobster fishermen in south Florida are not a homogenous group. Participants are distributed throughout the coasts and are deeply rooted in a social and cultural system, with both Anglo and Hispanic groups. Some fishermen are members of one or both of the two fishermen's associations active in the study area. These social factors and established social ties may affect how certificate trades occur.

This paper uses social network analysis to explore the role of spatial and sociocultural characteristics of the fishery affect the certificate market. First, the context of the spiny lobster fishery and the trap certificate market are presented followed by an introduction to social network analysis and its application for this research. Four examples from the results of these analyses are presented. The paper concludes with implications of using social network analysis to examine these types of markets for management and fishermen's associations, and further research questions generated by the exploratory study.

OVERVIEW OF THE SPINY LOBSTER TRAP CERTIFICATE PROGRAM AND THE FISHERY

The Florida spiny lobster fishery is one of the most economically important commercial fisheries in Florida, and over 90% of the lobster landings are reported from the Florida Keys and around Miami (Data source: Florida Wildlife Conservation Commission). The target species is *Panulirus argus*. Lobster are caught commercially using mostly traps, but there are some commercial divers in the study area.

The trap certificate program for the Florida spiny lobster fishery was established in 1992 through the South Atlantic and Gulf Fisheries Management Councils and the Florida Department of Environmental Protection, and is legislated through Florida Statute 370.142(1). The Florida Wildlife Conservation Commission currently manages the program, including the initial allocation and certificate transfers, monitoring, and enforcement.

The program is meant to address a variety of issues, including reducing the number of traps in order to stabilize the fishery, increasing yield per trap, increasing industry rents, reducing crowding and damage to bottom habitat, and maintaining or increasing overall catch levels (Milon *et al*. 1999). The fishery saw the number of traps increase from approximately 100,000 to over 900,000 from 1960-1990, while landings remained stable between 5 - 8 million pounds per season (Milon *et al*. 1999). There was concern for both the stock and the efficiency of the fishery, including issues with crowding and conflict and pollution from traps and debris (Milon *et al*. 1999).

A reduction in traps began with the establishment of the program, first with active reductions of 10% and later with both active and passive reductions in the effort level (i.e., number of traps) held by each individual. Legal trap use is controlled under the program by requiring each trap to have an affixed tag that is imprinted with a unique certificate number. Owners need to purchase new tags each year for the traps they want to use at which point the certificates become "active." At this time there are about 460,000 active certificates (Figure 1). There have been no reductions since 2005, but in February 2009 the Florida Wildlife Conservation Commission approved a passive reduction of 10% on all non-family transfers until the number of certificates reaches 400,000.

The trap certificate program has yet to demonstrate a substantial increase in efficiency for the trap sector of the fishery. Based on previous bioeconomic models, an optimal and sustainable number of traps has yet to be reached, and the benefits of a reduced number of traps would not be evident until at the number is lowered to around 300,000 traps (Larkin and Milon 2000, Milon *et al*. 1999). Participants in the lobster trap fishery also report that the catch-per-unit-effort has not improved since the establishment of the program (Shivlani *et al*. 2004).

Additional effects on the fishermen and fishing communities have been noted in socioeconomic studies following establishment of the program. A study conducted three years after the start of the program noted some changes in the fishery. Shivlani and Milon (2000) reported that the traditional system of working up to captain status, a type of apprenticeship system that is particularly important in knowledge development of the next generation of fishermen, had been eliminated due to the availability and additional capital required to purchase trap certificates.

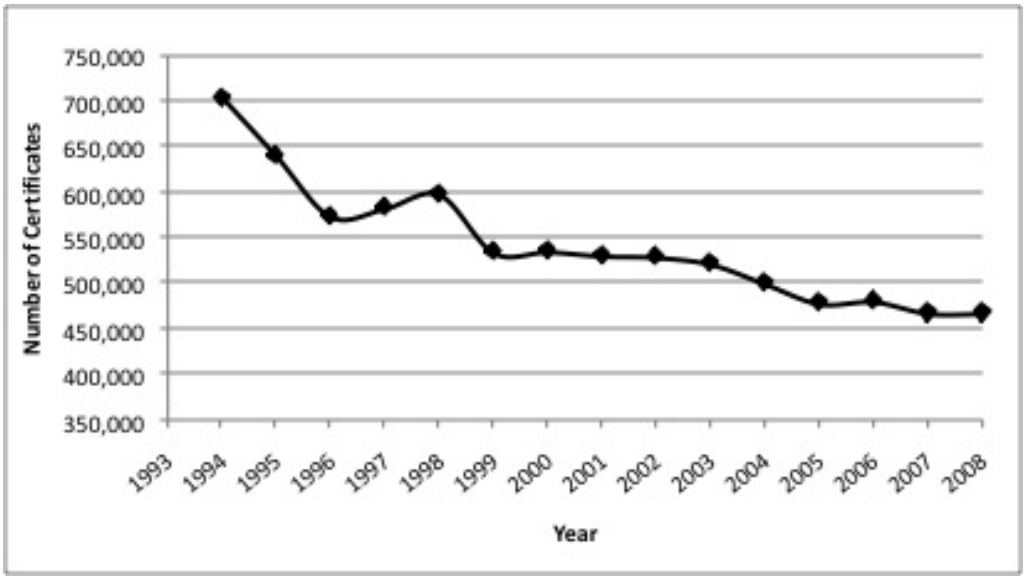

Figure 1. Number of active certificates over the course of the trap certificate program. (Data source: Florida Wildlife Conservation Commission).

Additionally, the fishermen were worried about outsiders buying certificates with the intent of selling them instead of actually fishing. These and other factors, such as losing members of the industry to other fishing sectors, gentrification of the Florida Keys, and loss of cooperative social networks, contributed to what the surveyed fishermen noted as "a changing landscape" in the fishery and the loss of presence of commercial fishing in some areas of the Keys (Shivlani and Milon 2000).

SOCIAL NETWORK ANALYSIS

Social network analysis uses information about how people are connected. These relationships can be based on whom you know, to whom you are related, with whom you collaborate on projects or work, or with whom you are involved in an exchange; anything that ties two people together can be used in social network analysis. The trap certificate market represents an exchange network.

This information creates an adjacency, or people-by-people, matrix. Figure 2 shows an example of a matrix representing four participants in a market. A "1" indicates the presence of a tie between those two people, and a "0" indicates the absence of a tie, where a "tie" is any defined link between any two people. These data are entered into social network analysis software. The relations between people form a structure, and this can tell us something about a social system or a community. For this project, social network analysis is used as an exploratory tool to examine the trap certificate market.

Figure 2. Example adjacency matrix for a network of four individuals

	Participants			
Participants	Joe	Bob	Ann	Lynn
Joe	1	1	1	1
Bob	1	1	0	0
Ann	1	0	1	1
Lynn	1	0	1	1

Fishery data were provided by the Florida Wildlife Conservation Commission. These data include information on all transfers from 1993 - 2008 (seller, buyer, addresses, number sold, price, fees, etc). Every transaction would be represented by one tie in the network, and the buyer and seller would be the nodes. The data were entered into an adjacency matrix using UCINet, a social network analysis software package (Borgatti 2002).

Then visualizations of the networks were generated NetDraw, a tool in UCINet. Visualizations use algorithms to calculate distances and placement of the nodes, and are a useful way to present information about the networks.

Attributes for each individual were added to the data. These included location based on the fishermen's residential address, which were coded as: Miami Area, Upper Keys, Middle Keys, Lower Keys, Key West, and Outside (for those residing outside the study area). These distinctions are commonly used in south Florida in reference to the different places. An attribute of Latino or non-Latino was also added for each person based on last name.

The social network analysis software was used to calculate a measure of "betweenness" for each node.

Betweenness is a measure of centrality that is calculated by the number of shortest paths between all other nodes that the node is on. In other words, high measures of betweenness means that these individuals control the flow of certificates by having the most ability to cut off flow between two other individuals.

RESULTS

Overall Certificate Market

This is a visualization using every transaction (n = 2,217; Figure 3). Every node (dot) represents a fisherman and every line represents a tie between them, indicating that these two individuals have traded with one another at least once. Immediately you can see that this is a very complex and active market. More importantly, you can see that there are nodes are not in just pairs, or even in small groups, but very much connected to one another. This would suggest that the fishermen who have participated in the market have bought and sold many times over. They are constantly adjusting the number of certificates that they own. Because this is a large network, it is difficult to work with the visualization. So, the transactions have been separated by season.

Figure 3. Visual representation of all certificate transfers from 1993 to 2008. Data source: Florida Wildlife Conservation Commission.

First Season (1993 - 1994)

This is the first season with the trap certificate program (Figure 4). Color-codes for area are not available for print, and square nodes indicate Latino, circles indicate non-Latino. The size indicates betweenness, a network metric calculated from the social network analysis that was previously discussed.

The nodes with the highest measures of betweenness are the three large square nodes and the black square indicated by the dotted-line circle in Figure 4A. The transfer data indicate that these are three Latino fishermen living in the Miami area and one Latino living outside the study area. One interesting thing about this network is the strand of nodes coming from that central group, as indicated by the dotted-line circle in Figure 4B. Especially starting with the white square node, the chain is buyer-seller-buyer-seller, etc. This represents the movement of a certificate through 11 fishermen during only one season. This is a very active and "recycling" market.

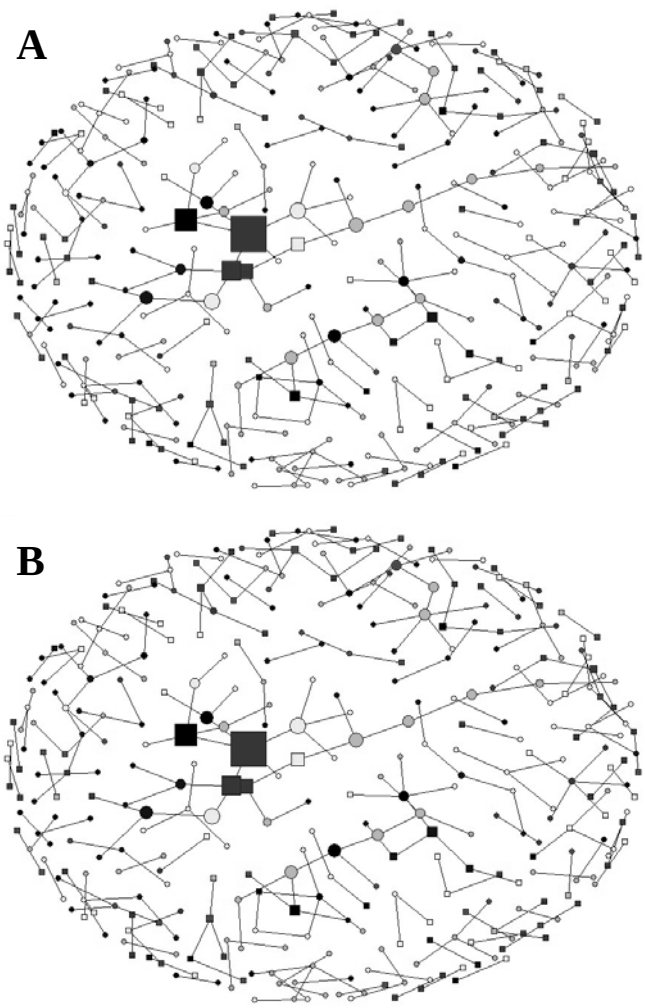

Figure 4. Network of trap certificate transfers in 1993 - 1994.

Third Season (1996 - 1997)

When examining the network generated from transactions during the third season of the program (Figure 5), it is immediately noticeable that it is less dense, since there were fewer transactions during this period. Obviously the things that pop out are the large "stars" in the middle of the visualization. From the transfer data, the large node labeled "1" in Figure 5 represents an individual who participated only as a buyer, and who is from outside of the Keys (north central Florida). He is possibly a retiree or person with a second home in the Keys, which is not uncommon in the spiny lobster fishery.

The large node labeled "2" in Figure 5 is an individual who participated as a buyer and seller several times. The interesting thing about this person is that almost all of his transactions as a buyer involve purchases of seven certificates, but his activity as a seller involves bulk transactions. This season was the third active 10% reduction of the program, which left any fishermen originally allocated ten certificates with only seven. Fishermen with such small operations perhaps considered the benefits of fishing only seven traps were not worth the costs, and chose to exit the fishery. The individual who bought out all of these exiting fishermen and sold in bulk back to new entrants or existing fishermen contributed to the expected consolidation of the fleet.

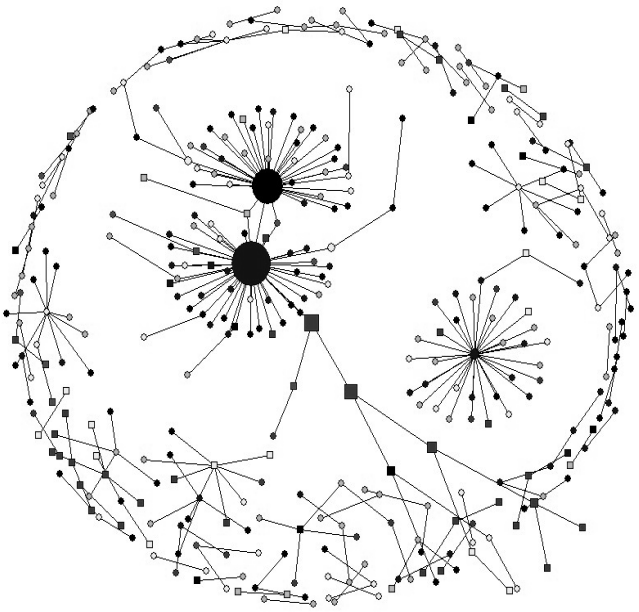

Figure 5. Network of trap certificate transfers in 1996 - 1997 season.

Eighth Season (2000 - 2001)

The 2000 - 2001 season had the lowest number of transactions since the inception of the program, which is evident by the low density of this network (Figure 6). This season also had the lowest landings and the highest average certificate price since 1993.

The nodes on the right have the highest measures of betweenness, but what is most interesting about this network is that there are so many dyads (two nodes, one tie). This is unlike multiple transactions and dense sub-networks in previous examples. The majority of the transactions are one time only, versus the "recycling" or chains indicating continual buying and selling via several fishermen.

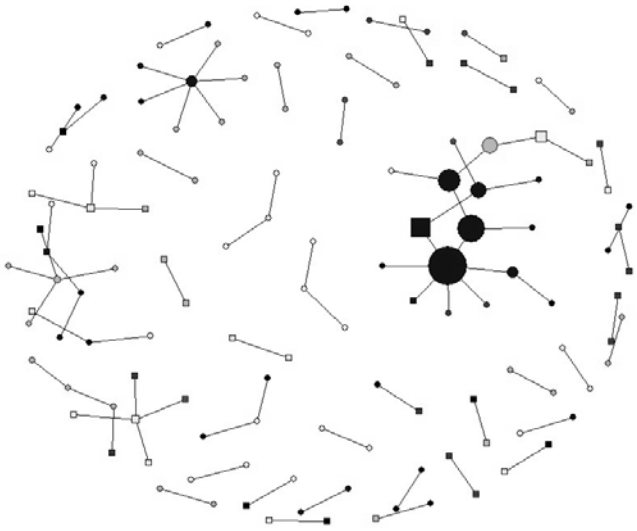

Figure 6. Network of trap certificate transfers in 2000 - 2001 season.

Implications for Management and Further Research

Using social network analysis, managers and industry groups can examine the structure of the network to look for indications of how the program is working. It may also highlight important characteristics, such as the "stars" that jumped out, or problems with trades. With a bird's eye view of the market, managers can look for these problems that may not be evident in records or reports.

The network also indicates that some fishermen have participated multiple times in the certificate market, adjusting their operation sizes. Past studies noted that certain study areas have been subjected to rising costs of living, loss of dock space and fish houses, and urbanization; how have these external factors affected business decisions for the fishermen? Additionally, fluctuations in landings, environmental factors, and additional regulations may influence decisions to exit the fishery or to adjust the number of traps fished.

Further research on the spiny lobster trap certificate market includes collecting information about how fishermen find buyers/sellers, how prices are negotiated, and effects of location, ethnicity, and fishermen's association on certificate prices.

CONCLUSION

As rights-based fisheries management becomes increasingly common in both the U.S. and around the world, it also becomes more important for scientists and managers to gain a better understanding of how the markets created by these programs function. Potentially, the social and cultural system of the fishery can affect the market and the outcomes of the program. It is imperative to understand how fishermen interact, and also how they do

not interact, in order to design a proper system for trades to occur if success of the program is dependent on trades occurring.

Social network analysis is a tool that can be used to examine a market for tradable fishing rights from a unique point of view. The analysis can provide insight to how the market is working and who is trading with whom. With this information, we can strengthen the knowledge base of rights-based fisheries management and improve design of these types of programs.

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LITERATURE CITED

Borgatti, S.P., M.G. Everett, and L.C. Freeman. 2002. Ucinet for Windows: Software for Social network analysis. Analytic Technologies, Harvard, Massachusetts USA: .

Grafton, R. 1996. Individual transferable quotas: Theory and practice. *Reviews in Fish Biology and Fisheries* **6**:5-20.

Hanna, S. and M. Munasinghe (Eds.) 1995. *Property Rights and the Environment: Social and Ecological Issues*. World Bank Publications, Washington, D.C. USA.

Larkin, S.L., and J.W. Milon. 2000. Tradable effort permits: A case study of the Florida spiny lobster trap certificate program. International Institute of Fisheries Economics and Trade Conference, Corvallis, Oregon USA.

Milon, J.W., S.L. Larkin, and N.M. Ehrhardt. 1999. Bioeconomic models of the Florida commercial spiny lobster fishery. Florida Sea Grant, Report Number 117.

Shivlani, M. and J.W. Milon. 2000. Sociocultural effects of a market-based fishery management program in the Florida Keys. *Coastal Management* **28**:133-147.

Shivlani, M., N. Ehrhardt, J. Kirkley, and T. Murray. [2004]. Assessment of the socioeconomic impacts of the spiny lobster trap certificate program, spiny lobster fishery management efforts, and other spiny lobster user groups on individual commercial spiny lobster fishers. The Spiny Lobster Trap Fishery Economics Project. Unpubl. MS.

Squires, D., J. Kirkley, and C.A. Tisdell. 1995. Individual transferable quotas as a management tool. *Reviews in Fisheries Science* **3**:1064-1262.