Breaking Stereotypes Through Network Analysis of the Chesapeake Oyster Community

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Abstract

Given the stories of Oyster Wars, competition for resources, and the large number of people involved in managing the oysters of the Chesapeake Bay, one might expect a fractured social network. Some management mandates require multiple stakeholder groups at the table, but these very rarely also mandate collaboration between the different types of oyster work going on: wild harvest, aquaculture, sanctuaries, and restoration. 140 people were surveyed via snowball sampling to document the social network of the Chesapeake oyster community. The survey questions used to construct the links between people in the network focused on the transfer of valued advice. Results show that the oyster community is well-connected across jurisdictional divides, type of oyster worked with, opinions of management, and across most career sectors. This shows that, despite persistent stereotypes to the contrary, members of the oyster community reach out for advice to a diverse cohort of colleagues.

Keywords: social network analysis, Chesapeake, oyster management

1. Introduction

When talking about the history of Chesapeake Bay oysters, many refer to the iconic Oyster Wars during the 1940's and 1950's in which watermen and law enforcement took up arms against one another (Wennersten 2007). As a direct result of this gunfire on the Potomac, the Maryland and Virginia Potomac River Compact of 1958 established the Potomac River Fisheries Commission to calm the conflict and mitigate jurisdictional differences between Maryland and Virginia. This era, still fresh in the minds of many involved in the fishery, creates the common perception that the Chesapeake oyster community is sharply divided.

Recent changes to the oyster world in the Chesapeake also contribute to this perception, as rapid aquaculture development in Virginia but not Maryland means the oyster industry in each state now looks very different (Hudson and Murray 2016). These new farm leaders are well-organized and connected with each other through industry groups such as the East Coast Shellfish Grower's Association, Shellfish Growers of Virginia, and the Virginia Seafood Council but perceived as sometimes at odds with scientists and managers (Leach et al. 2014). Meanwhile, the wild harvest industry centered in Maryland maintains the reputation of watermen as fiercely independent, and powerfully organized through the Maryland Watermen's Association (Keiner 2009).

The restoration community is another sector actively placing oysters in the Bay in hopes of increasing their population, and in turn, the ecosystem services they provide (Luckenbach et al. 2005). There are many groups, from those like Friends of the Rappahannock with just a handful of members working on a single project, to the much larger nonprofits like the Chesapeake Bay Foundation; each has a different culture and operating practices. However, as a whole, the restoration community has been accused of not talking to scientists to inform their reef construction (Kennedy et al. 2011; Mann & Powell 2007). They may also compete with industry for bottom leases and whether the fruits of their labor should be open for harvest.

The characterization of each of these sectors of the oyster community are based on historic relations and caricatures of a very diverse community that fundamentally shares the basic goal of having more oysters in the Bay (NCBO 2016). However, perceptions remain and stereotypes are sometimes grounded in elements of truth. Social network analysis can help determine which of these perceived divides are actually present within the oyster community. In addition, one can consider the oyster community and the natural resources on which it relies a socioecological system; network analysis can also uncover whether the people involved are helpful, hurtful, or architects of the ecosystem in question (Janssen et al. 2006). Such a network analysis is a tool to 1) identify bridging organizations that connect key stakeholder groups and 2) suggest helpful organizational structure by identifying network arrangements associated with positive environmental outcomes (Rathwell & Peterson 2012).

A social network analysis was performed to help quantitatively measure the connectedness and divisiveness of people who work on oysters in the Chesapeake Bay. Before discussing methods and results, the literature serves as a reminder of why stronger connectedness might be an advantage to the community, and review the oysters, people, and institutions involved in the 'oyster community'.

1.1 Motivations to work together

There are many reasons for different groups within the Chesapeake watershed to work better together, but for oysters (and fisheries in general), one of the main drivers is the mandate to implement ecosystem-based fisheries management. In short, this means managers must consider the many ecosystem services that oysters provide, such as food, habitat, water filtering, and cultural appreciation (Chesapeake Bay Fisheries Ecosystem Advisory Panel 2006) as well as the many factors that may determine their health and survival, such as reef structure, water temperature, dissolved oxygen, and salinity (Baggett et al. 2015). Ecosystem-based fisheries management, like a growing number of successful fisheries management strategies worldwide, requires a stakeholder-driven approach involving collaboration and participation to help determine which of these many factors should be prioritized (McLeod & Leslie 2009). It also requires specialists on each of these areas to work together, the effects of which we expect to see in the social network.

Outside of the push for ecosystem-based fisheries management, the culture of science and management is changing such that collaboration with industry and each other is known as a requirement for positive environmental outcomes (Chapin et al. 2011). This starts with the basics of sharing data, and acquiring better data through these collaborations (Johnson 2011), and extends into building more trusting relationships through regular communication and ongoing efforts to build and maintain trust (Freitag 2015). Trust comes from both formal partnerships but especially informal communication that allows relationships to develop over time (Levin & Cross 2004). Trust therefore both emerges from collaborations and enables future collaboration, and encourages researchers to look specifically at the informal connections in the network to help explain the dynamics within.

1.2 The Oyster Community

Oysters in the Chesapeake serve many different ecosystem roles and are often placed there specifically to achieve a suite of ecosystem service outcomes. One can think of the oysters in the Bay as a complex system comprising aquaculture oysters, oyster reefs open for wild harvest, sites in the process of restoration, and sanctuary reefs. Like the diversity of oyster types, there is a wide variety of people and institutions involved in their management both formally and informally.

Most directly, the Virginia Marine Resources Commission (VMRC), Maryland Department of Natural Resources (DNR), and Potomac River Fisheries Commission (PRFC) implement and enforce rules surrounding oysters through a variety of staff members that issue bottom leases, monitor fishing activity, plan restoration and replenishment activities, and perform scientific studies. While PRFC has a staff of five who work on all topics, DNR and VMRC have many branches to work on each set of needs separately. Layered on top of these state agencies, federal agencies provide science support and restoration support (NOAA and Army Corps, respectively). In addition, there are many community groups and nonprofits, from neighborhood associations to large Bay-wide environmental non-governmental organizations, which initiate their own projects and campaigns including activities such as citizen science, restoration efforts, and oyster gardening. Finally, industry groups not only lobby to the advantage of their businesses but fund scientific studies and provide a professional network for sharing skills and local ecological knowledge.

Different management and stakeholder groups are occasionally required to collaborate and work together toward shared goals. Maryland's Oyster Advisory Commission and Virginia's Blue Ribbon Panel on Oysters both serve as formal structures with representatives from across the oyster community to make recommendations to state legislatures and agency managers. Each state also has an Interagency Workgroup tasked with planning and coordinating large-scale restoration projects. Finally, the bigger agencies require staff to collaborate on projects; while this collaboration may not reach across the entire agency, combined with physical proximity, there is reason to suggest that agency staff are familiar with each other's work. Across the oyster community, these mandated collaborations bring together the different sectors and people who work with different types of oysters to work on common questions, something this analysis explores more in-depth.

The oyster community, therefore, could be characterized either by perceived divisions, known collaborations, or a combination of both. We use network analysis to identify how well connected the oyster community is across the entire watershed. Such a network analysis may help identify areas in which further collaborations or trust-building activities would be helpful. Alternatively, it may lay to rest stories of oyster wars with a more collaborative picture of how the oyster community interacts in modern times.

2. Methods

The network structure of the oyster community was measured through an online survey (Qualtrics) with the option to phone in answers instead. The oyster community was defined through a snowball sampling approach starting with established Virginia Sea Grant partners, ending the snowball when referrals were either not new or worked and lived entirely outside the Chesapeake region. Invitations were first emailed to respondents, with a reminder after a week. Follow-up phone calls two weeks after the first invitation were made, with a message left for those who did not answer. A field visit to a skipjack restoration in Deal Island, Maryland, was made to follow up with some watermen who were known to not answer their phone and did not have email so that they could take the survey in person.

While most network studies base their network structure on communication frequency, this analysis focuses specifically on communications about oysters and did not know the extent of the network prior to writing the survey, so we used a valued information approach instead. This eliminated communications about linked fisheries like blue crabs, communications best characterized as "over a

pint of beer", and other frequent but not valuable communication. Therefore, two questions from the survey formed the network structure:

1) Who are they people (up to 5) that you rely on most when you make decisions about oysters in the Bay?
2) Please rank, from 1 to 5 with 5 being 'must have', the value of the information provided by [people from previous question]

The survey instrument also collected information on the attributes of each respondent: education, kinds of participation in the oyster community, and attitudes toward oyster management and marine science (on a scale of 1-5). Network analysis was performed in UCINET and displayed with Netdraw (Borgatti et al. 2002).

Semi-formal interviews with ten key informants helped interpret the network map and give insight on dynamism within the network. These discussions were based on preliminary results in the form of printouts of the best advice pathways (figure 1), the full network, and the network with one key communicator removed (a change that had occurred since the survey); all nodes were color coded by sector. Each interview took about an hour. Key informants were identified across all sectors and from within both the core and periphery of the network.

3. Results and Discussion

The survey yielded 140 respondents, for a 75% response rate (considered very high but incomplete). The remaining 25% were from all of the oyster-related sectors (management, industry, academia, nonprofit), but contained more wild harvest watermen than would be expected in the overall population of potential respondents. Because the survey was snowball sampled and reached saturation, the missing respondents were unlikely to change the network boundaries, which is the main concern for nonresponse bias. Estimating potential effects on the network structure from nonresponse using interactions over the survey invitation, only one respondent, a prominent aquaculturist, would likely have changed their network status (Znidarsic et al 2012). He may have been a key communicator with high degree centrality (the number of ties to other people) and betweenness (the number of times this person acts as a bridge between other people in the network) had his incoming advice been included.

[insert figure 1 here]

Despite the hypothesis that the oyster community would have gaps between clusters of people (based on historic conflict and rumors from the community), the network is fairly well-connected. Including all connections, the density of the network is 3.829 and including only connections based on advice valued as a 4 or 5 out of 5 the density of the network is 0.035. The density is the proportion of all potential ties, and generally, densities above 3 are considered dense or well-connected. The network was almost entirely in one cluster, with three tiny separate clusters consisting almost entirely of wild-harvest watermen that did not respond. These would likely have been connected to the main cluster had everyone participated.

Looking within the main network body to see what controlled how people are arranged, sector (divided into industry, government, academia, and nonprofits, as self-identified in the survey) was the only factor in which any cliques occurred (cliques are relatively isolated subgroups within a larger network) Analysis of groupings by state, locality, type of oyster worked with, opinions of science, and opinions of

management (as collected in the survey) did not yield any clusters or cliques. The biggest sector cliques are portrayed in figure 1: the Virginia aquaculturists and Maryland wild harvesters (the biggest segment of industry in each state, depicted as black circles). According to extension agents from each state, this makes sense – they trust each other most and only reach out when absolutely necessary, usually to a designated industry liaison.

The average opinion of the current management regime for oysters was a 2.7 out of 5. The average response to how important science should be in management was 4.5 out of 5. In combination, these data may suggest that including more science in management might increase the favorability of management. While different types of stakeholders utilize different knowledge bases in order to assess risk and related management needs (D'Anna 2015), science may provide a shared language of trusted information on which to base decisions (Freitag 2014). In addition, the fact that neither of these factors created clusters in the network shows that people are asking advice from others who have sometimes opposing opinions of management; in other words, they respect each other across disagreement.

3.1 Key communicators

The oyster community contains a handful of key communicators that increase the density of the network overall and connect people from different sectors. Using betweenness values, there are four people serving more significantly in this kind of role (values over 100) than others, one of whom has a high enough value he may have moved from a key communicator to an information gatekeeper role. Most of these four, as well as those with moderate (values above 30) betweenness also serve as boundary spanners, connecting segments of different sectors to each other (Johnson 2011). In addition to these boundary spanners, several other people exhibited high in-degree centrality (with values over 5, indicating more people looked to them for advice than they turned to). These people were from government and academia and serve a public role as part of their career.

While there may be room for more collaboration within the oyster community, the perception that the community is fractured turns out to be mostly false. The one group within the community that tends to talk to itself is industry, but they maintain important ties to boundary spanners in order to keep themselves connected to the larger network. These results are also surprising given that while some collaboration is mandated by regional policy, several of the key informants pointed out that conversations about different types of oysters (aquaculture, sanctuary, restored, open to harvest) tend to happen in separate venues. This suggests that the connectivity comes largely from informal connections. Important key communicators and boundary spanners are holding the network together not only through job responsibilities but through their force of personality and reputation as well.

3.2 Force of personality versus professional role

People in the oyster community with high betweenness were described by the key informants as both effectively fulfilling the duties of their profession and having the personality to facilitate many sometimes challenging conversations across a wide variety of colleagues. At a more fundamental level, some survey respondents asked which hat they should be wearing as they answered the questions – a professional one, maintaining their sector's official positions, or a personal one, introducing more nuance. Upon further clarification and due to the fact that the survey was anonymous, the network that resulted likely depicts more of that personal network than one would detect in public forums. The network pictured in figure 1, therefore, is a blend of connections because of personality and

professional role. It is therefore unlikely that filling professional roles with different people would yield the same arrangement of advice pathways or density of communication.

While each person's connections result from a blend of professional responsibilities and personal relationships, managers were more likely to serve the role as key communicator, probably at least partly due to the fact that they are supposed to interact with many stakeholders as part of their job responsibilities. Many of these managers, with a few others who have similarly engaged formal professional roles, form much of the core of the network. Several leaders of stakeholder groups, like the Oyster Advisory Commission in Maryland, attributed their connectivity to the relationships formed through their leadership role in participatory processes. In short, some people have responsibility for being able to see and orchestrate the whole oyster community to take advantage of the social network's advantages (Bodin and Crona 2009).

There are two main ways that people are mandated to interact with others: as part of their organization or through collaborative workgroups. The first connects people within a single organization, and this connection could benefit from further analysis as just because two people work together does not mean they are required to provide advice to one another. For example, connections between the policy and science branches of state agencies were described by key informants as an area for future improvement. The collaborative workgroups – Maryland's Oyster Advisory Commission, Virginia's Blue Ribbon Oyster Panel, the Sustainable Fisheries Goal Implementation Team, and each state's Interagency Workgroup on Oyster Restoration – require regular discussion and collaborative decision-making. While individuals may not regularly seek each other's advice outside of workgroup meetings, they can serve as a means to begin professional relationships and a forum in which to seek advice. Both forms of connection are depicted in bold in figure 2.

[insert figure 2]

The role of these mandated collaborations will show up stronger in this network analysis than if we had asked just about communication frequency, as collaborative workgroups carve out dedicated time devoted entirely to oysters, and people may wait to use these forums to seek advice. For example, by tradition, the December meeting of the Sustainable Fisheries Goal Implementation Team is dedicated to oyster restoration, so many members of the oyster community go out of their way to show up at this meeting and managers consider it their main time to get informed about oyster concerns that will require decisions in the coming year.

3.3 The strength of weak ties

The network of highly-valued advice depicts one long chain containing members of several sectors all working in and around St. Mary's, Maryland (the upper right corner in figure 2). The chain is bookended by nonprofit employees who key informants report work hard to keep the rural St. Mary's community connected to the rest of the region. With this chain, and other many-step connections buried deeper in the network, certain people or organizations serve as a conduit of trusted information because of the partnerships or friendships they have, and key informants report that nonprofits often serve this role.

When asked about this long chain, key informants responded with surprise that there weren't more as apparent as the St. Mary's chain, as they all had personal experience with these long chains of information transfer in other contexts. They were sometimes described as gossip, with accuracy

decreasing in each step of information transfer. This is not surprising, as others have noted the importance of trust in utilizing the strength of weak ties (Levin & Cross 2004). However, they are quite important in this situation because the frequency of giving advice is low, so the long chains keep the conversation moving (Granovetter 1983), especially when not everyone feels they need advice and actively seeks it out.

3.4 Mandated interactions

The mandated collaborations depicted in figure 2 are summarized in table 1. Each of these forums differs in structure, frequency, size, and scope of responsibility, but each was referenced several times by key informants as providing important guidance for the Chesapeake region in managing oysters as well as a good opportunity to discuss issues across sectors. In addition, they act in concert with one another, with regular updates from each other regularly on meeting agendas.

[insert Table 1]

Mandates of participation, while not always effective (Cooke & Kothari 2001), do offer the chance to form new relationships or elevate leaders of such processes within the community and beyond. For example, the leader of Maryland's Oyster Advisory Commission also sits on several Virginia Marine Resource Commission committees and members of Virginia's Blue Ribbon Oyster Panel have been asked to serve as external advisors to participatory management in New Jersey.

In addition to these current collaborations, almost everyone in the network had a college degree (those that didn't were the older members of the wild harvest fleet). With a growing expectation of a college education across all sectors, this is another opportunity to both directly form trusted relationships and form a common knowledge base to work from in the future (Raymond et al. 2010). A diversity of universities is represented by the respondents, but there were large groups of alumni from William and Mary and St. Mary's College of Maryland, explaining some of the connections to academia from other sectors, as some of the academics have large cohorts of former students still active in the Chesapeake oyster community. Another way divisions may be present but not visible in the network is in looking at connections by the type of knowledge contained in the advice offered (experiential/local, scholarly/scientific, etc.). Our hypothesis is that each connection embodies just one form of knowledge, which boundary spanners may integrate (Johnson 2011); otherwise knowledges aren't integrated, as this is something very difficult to achieve (Nadasdy 1999).

Increased interaction overall is both possible and might strengthen the informal ties over time. For example, academics aren't as well-connected as they should be across sectors, given they largely come from state universities with formal advisory roles. Some of these academic key informants reported desire for a venue to do that advising. Stronger diverse partnerships can also help achieve joint goals, like gaining support in the legislature or grant money – according to key informants, this happens currently, but only when the initiative is struggling with only one stakeholder base. Finally, documenting this network is the first time anyone has considered all the members of the oyster community in the Chesapeake simultaneously, and participants appreciated a visual of all the different people taking actions on oysters. They expressed desire to have a forum to talk about the whole community and establish a shared vision for everyone to see how their work fits in. The desired outcome of such a forum would be to prevent turf wars of people attempting to work on the same thing, prevent competition over grant money, and allow leveraging of resources for economy of scale.

3.5 Snapshot in time

This network analysis, created from a single survey, represents only a snapshot in time. In the intervening months since the survey was completed, several people have retired, taken other positions, or were fired. While the firings were unusual, the other dynamics of the network are a constant force. Many of the key informants talked about changes since the removal of number 70, whose leadership style was noted as a "consultative ethic", requiring input from many people before making decisions. The institutional culture of the agency he led is reported to be different as a result of his departure, with the science and policy branches in particular feeling a separation.

Interviews asked key informants about number 70's departure, any resulting changes they observed, and what attributes they would like to see in the person filling the position. Key informants recognized that 70's consultative ethic created a dense network structure that could probably not be replaced by anyone else in the agency currently, or by an external person without significant investment in their social network. But because number 70 made their relationships transparent and open, whoever does step into that role can begin to model or replicate some of his successes if they are a trusted member of the community. In addition, key informants saw that it may take multiple people to re-cultivate the connectedness in his area of the network, but that it may not fundamentally alter the density of the network, as opposed to some others near retirement age.

These other well-connected individuals, for example number 32, credited their position in the network to past experiences, having spent time in their career in a number of the different sectors (e.g. a nonprofit employee starting an oyster farm or an industry employee taking a government position). They reported being able to take their connections with them, and building a stronger reputation and trust in their new role because of their diverse background. In many ways, then, some of the changes in the system will not change the network structure that much because "people have long memories" and continue to seek advice from trusted friends, regardless of their official role.

Of course, changes over time are not always positive. Personalities or events can also burn bridges or make it difficult to maintain relationships. For example, the people replacing the employees who were fired may be more careful in how they form and use their relationships. Public debate over restoration in Maryland, for instance, sets up many of the people in this network on sides whether they are for or against a large restoration project. They may be at least temporarily unable to reach across that conflict for advice on other oyster matters. In addition, as the public policy debate shifts over time, certain aspects of this advice will become more or less important – and it's worth looking at the full network then, knowing the value reported may at least partially lie in the content most prevalent at the time.

4. Conclusions

The snapshot of the oyster community captured by a network analysis highlights the importance of informal connections often formed through long careers and calls to attention some considerations in managing that community in the future. One such consideration is in filling oyster-related careers and the importance of evaluating potential candidates not just on what they know but how they might be able to leverage their network. In some cases, formalizing interactions as a new responsibility of the job if they were particularly highly valued may be called for (Seibert et al. 2001).

This snapshot look at the community was a chance to negate some stereotypes about the people who work with oysters. It offered a moment of reflection to recognize aspects of the oyster community that work well in bringing people together towards shared goals. It also suggests that the oyster community has learned and adapted since the era of the Oyster Wars to become a more collaborative network. Efforts to push the community in this direction should be recognized as successful and continued into the future as this collaborative culture has repeatedly proven to be more effective at meeting conservation goals (Crona and Hubacek 2010).

One of the biggest conclusions of measuring the network is how unexpectedly well-connected the oyster community is already. The overall density comes from informal connections layered on top of those required by mandated collaborations. This kind of rich social network has repeatedly proven advantageous in resource management contexts, especially in setting a foundation for successful participatory or co-management. While particular characteristics of network structure (cohesiveness, cliques, centralization) may harm or help management, established pathways of communication that are both formal and informal are important foundations (Bodin and Crona 2009). Comparing network structure both over time and in different contexts is an important emerging research arena.

These collaborations, importantly, have the potential to kindle long-term relationships that people will maintain throughout their careers, so rather than being seen as a means to meet the needs of a single project or avenue of policy advice, they should be seen as an investment in future innovation (Kania & Kramer 2011) – as one key informant pointed out, "people have long memories". In addition, large meetings across the whole community could be utilized to formulate a collective vision and help people best find their role in the broad community, recognizing that people know and trust one another but rarely get the chance to set aside the political conflict of the moment and discuss all types of oysters simultaneously. The question then becomes how to promote these collective actions to meet a shared vision over the long term.

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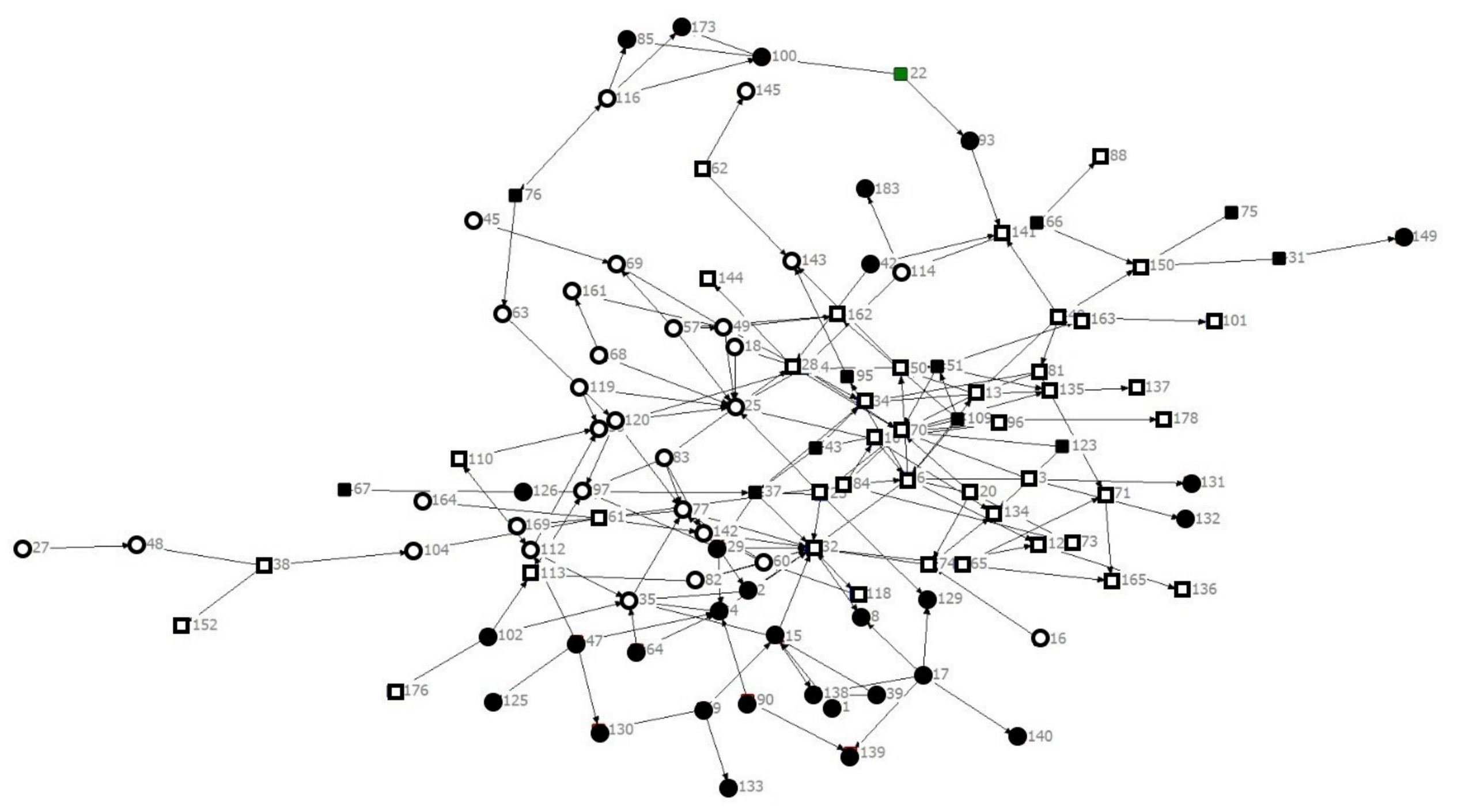
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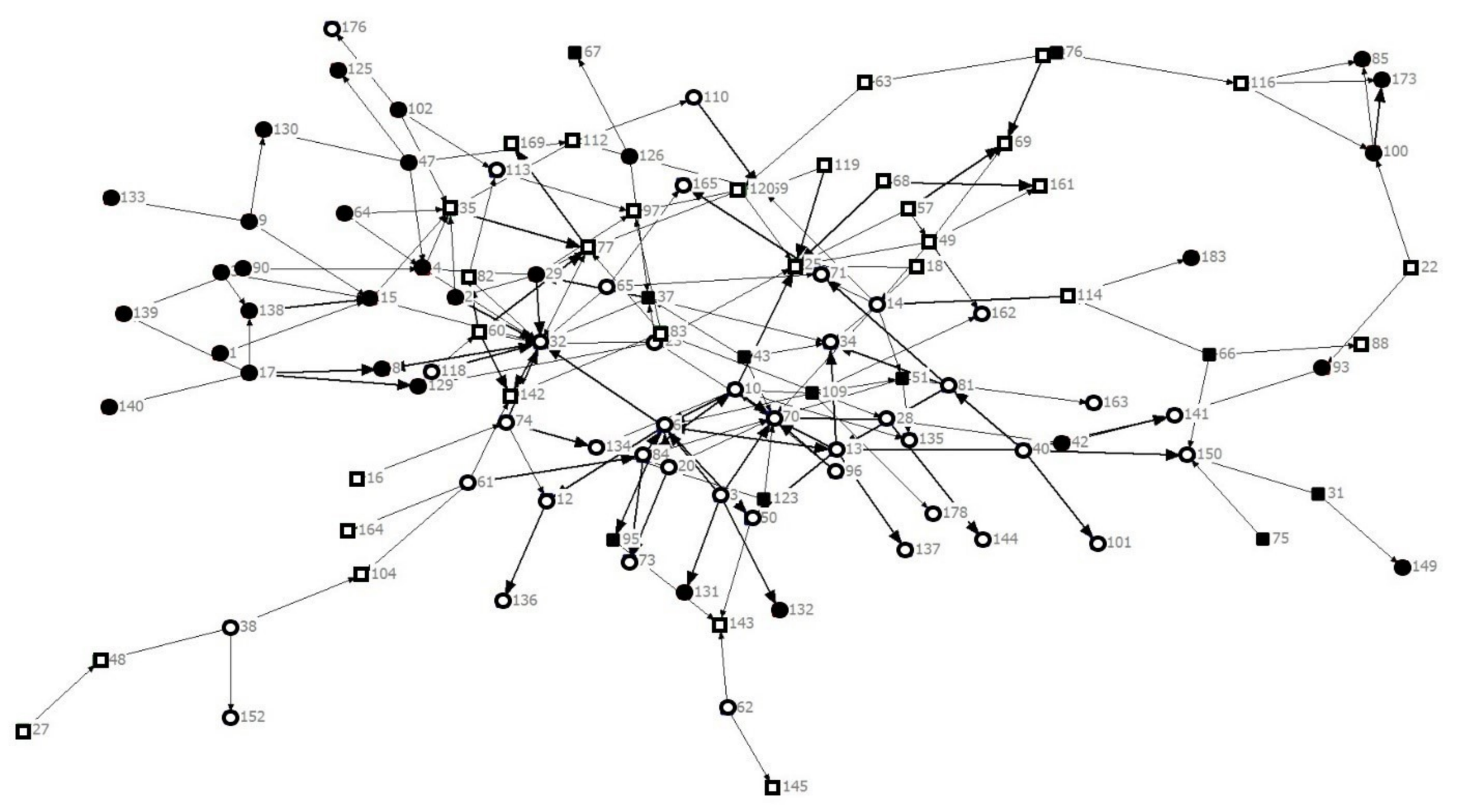
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Group	State	Meeting Frequency	Size
Oyster Advisory Commission	MD	Inconsistent	20 people
Blue Ribbon Oyster Panel	VA	8 times from June 2006 to May 2007	20 people
Interagency Workgroup	MD	quarterly	6 people
Interagency Workgroups	VA	Quarterly for each of three river systems	52 people
Sustainable Fisheries Goal Implementation Team	Watershed-wide	Twice a year, Executive Committee monthly	44 people