ASSESSING PARTNERSHIP DEVELOPMENT UNDER THE MICHIGAN DEPARTMENT
OF NATURAL RESOURCE'S HABITAT GRANTS PROGRAMS USING SOCIAL
NETWORK ANALYSIS

By

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ABSTRACT

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In recent years state wildlife agencies have begun to realize the need to build collaborations and partnerships among their constituents in order to further their conservation goals. This has been done through a variety of avenues including grant programs such as the Michigan Department of Natural Resources' (MI DNR) wildlife habitat grant programs, which continue to provide funds to government, profit and non-profit organizations to develop land for wildlife habitat. Regarding grant programs facilitating partnerships, there has been no systematic assessment of whether this is a successful method to do so. The goal of this research was to evaluate the effectiveness of the MI DNR grant programs in building relationships. In this work, a social network analysis was conducted to assess the nature of partnerships among grant receiving and non-grant receiving conservation organizations. A selection model approach was used to determine what characteristics were driving the partnerships of this network. The outcome variable being modeled was support received from a partner. The results delivered visualizations of the network and insight into why these organizations were selecting one another as partners. Major driving forces in partnership selection were found to be grants, the scale of management, having received prior support and distance between organizations. This valuable information will serve as a platform to better understand the networks surrounding wildlife conservation and allow the MI DNR to address any shortcomings and gaps within the partnership network.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Background Information

With an ever-growing interest in conservation issues and reduced federal and state budgets for natural resource management, agency managers believe partnerships are an increasingly necessary tool to achieve their goals (Rocha & Jacobson, 1998; Bender, 2004). The emergence of untraditional alliances between public agencies and private organizations in recent decades has allowed for more efficient and effective strategies to address conservation concerns (Robertshaw et al., 1993). Not only can partnerships have a positive impact on the resources being managed, they are also considered an advanced form of public participation thus increasing citizen engagement in the participatory process of management (Arnstein, 2011). As outlined in Arnstein's ladder of participation, partnerships should allow for the citizens involved to have some level of input into the management process in order to ensure the success and longevity of the relationships. These partnerships must also exhibit more direct involvement and commitment from partners to on-the-groundwork rather than merely being a cooperative or contractual agreement (Trauger et al., 1995).

The rise of partnerships can also be a result from an increasing recognition of a need to address human dimensions of fish and wildlife management. Human dimensions are described as the processes of incorporating stakeholders' perceptions on management issues in the decision-making process (Decker & Enck, 1996; Decker et al., 2012). Partnerships with stakeholders enables them to have this direct involvement. For agencies to make good use of partnerships, agency personnel must first realize the network of organizations that they are working with. Understanding these networks reveals insight into how these systems operate and where the resources are flowing (Provan et al., 2005).

Social networks can be viewed as a way to develop social capital. In social capital theory, networks are key to the success of an actor in obtaining resources (Burt, 1992; Lin, 2002; Wellman & Frank, 2001). This theory can be helpful in understanding some of the drivers of partnership development within a network. Constructing and analyzing the network of a community can show not only which actors interact with one another, but also the strength of those interactions, driving forces behind them and the flow of information between stakeholders. Social network analysis (SNA) is used to understand these networks and can allow managers to facilitate meaningful partnerships among stakeholders based on resource needs within the community. For wildlife agencies, gaining insight into the network of their stakeholder organizations that are partnering with one another is beneficial to understanding if the current network structure is even conducive to participation and how best to involve them in the participatory process (Holman, 2008). Important "knowledge brokers" to be involved in participatory management can also be identified with SNA and can help bridge the gaps between divided segments of the network (Reed et al., 2009). On the side of conservation organizations, this valuable knowledge can provide them access to external resources by becoming more involved with other network members thus leading to an increase of their social capital and in turn their ability to manage resources effectively (Barnes et al., 2013).

Social Network Analysis was first conceptualized in the 1930s using sociometry, a technique to represent individuals and the relationships shared between them (Moreno, 1934). In recent decades, there has been a burst of interest in using SNA in a variety of social science contexts including natural resource management (Crona & Bodin, 2006; Borgatti et al., 2009; Turner et al., 2014). In SNA, actors and their ties with one another are mapped into a network using nodes and edges. The nodes, or actors, represent the individuals or organizations involved

in the community. These interactions of nodes in a network are represented by the ties, or edges, which can represent relationships or communication between actors (Borgatti & Foster, 2003). Relationships are as equally important as the actors themselves since each actor's relationships define them within the network (Hanneman & Riddle, 2005). Several metrics describing the structure of social networks are often analyzed. One of the most measured aspects of a network is *centrality*, which identifies the most influential members of the network. Types of centrality include: degree centrality, the number of ties to each node; betweenness centrality: the number of times a node acts as a bridge between two other nodes; and closeness centrality, the average distance to all other nodes.

Two fundamental models are used in SNA to investigate the network behind the structural aspects: the influence model and the selection model (Frank, 2011). The influence model expresses how the beliefs or actions of an actor can be affected by those with whom they interact. Selection models, on the other hand, aim at understanding how actors choose with whom to interact. For example, Frank et al. (2011) describes how people provide help to those with whom they have developed an emotional attachment or those of a certain status with regards to natural resource use. There are different network mechanisms in selection models that can drive connections such as transactional costs, aspects that may inhibit an interaction (proximity); information seeking, where the goal is to gain new knowledge; or homophily, where actors' similarities attract them.

Applications of SNA in the natural resource disciplines have increased steadily in recent years (Bodin et al., 2006; McAllister et al., 2008; Moore et al., 2015). SNA can be a useful tool in natural resource management to identify stakeholders, address conflicts, and ensure a diverse representation (Prell et al., 2009). Moreover, SNA can be especially important when seeking to

understand the behaviors of stakeholders. While there have been several studies on influence in social networks for natural resource management (Stevens et al., 2015; Barnes et al., 2016; Kramer et al., 2016), fewer have focused on what drives selection.

With public participation becoming increasingly embedded in natural resource management, the need to understand the stakeholders involved also increases. Over the years there have been many efforts across conservation agencies to encourage partnerships through incentives or grant programs (e.g. National Fish Habitat Conservation Through Partnerships Act, The Regional Conservation Partnership Program, and many state/federal wildlife action plans) but these have not always been targeted towards specific types of partnerships nor have they been sufficiently evaluated to determine effectiveness in partnership building (Bidwell & Ryan, 2006). Thus far, there has been research linking state wildlife agencies (SWA) to their stakeholders in order to increase public participation (Chase et al., 2004; Johnson et al., 1993; Lord, 2006) and research on partnerships among agency stakeholders (Bidwell, 2006) but little that has taken both into consideration. In this research I examined the influence that SWA have on conservation organizations through means of grant funding and how the knowledge produced from this research could be used to facilitate better participation and increase resource flows.

Habitat Grant Programs

The MI DNR awards various grants for purposes of improving and increasing the quantity and quality of wildlife habitat in Michigan and foster lasting partnerships with conservation organizations (Michigan Department of Natural Resources, Wildlife Division, 2017b). This study focuses on three main wildlife grant programs which consist of government, profit and non-profit organizations, and individuals. Those are: the Wildlife Habitat Grant Program

4

(WHGP), the Deer Habitat Improvement Partnership Initiative (DHIPI), and the Northern Lower

Peninsula Deer Habitat Improvement Grant Program (Deer PLAN) (Figure 1).

Figure 1. Geographical extent of WHGP, DHIPI, and Deer PLAN grant recipients across Michigan
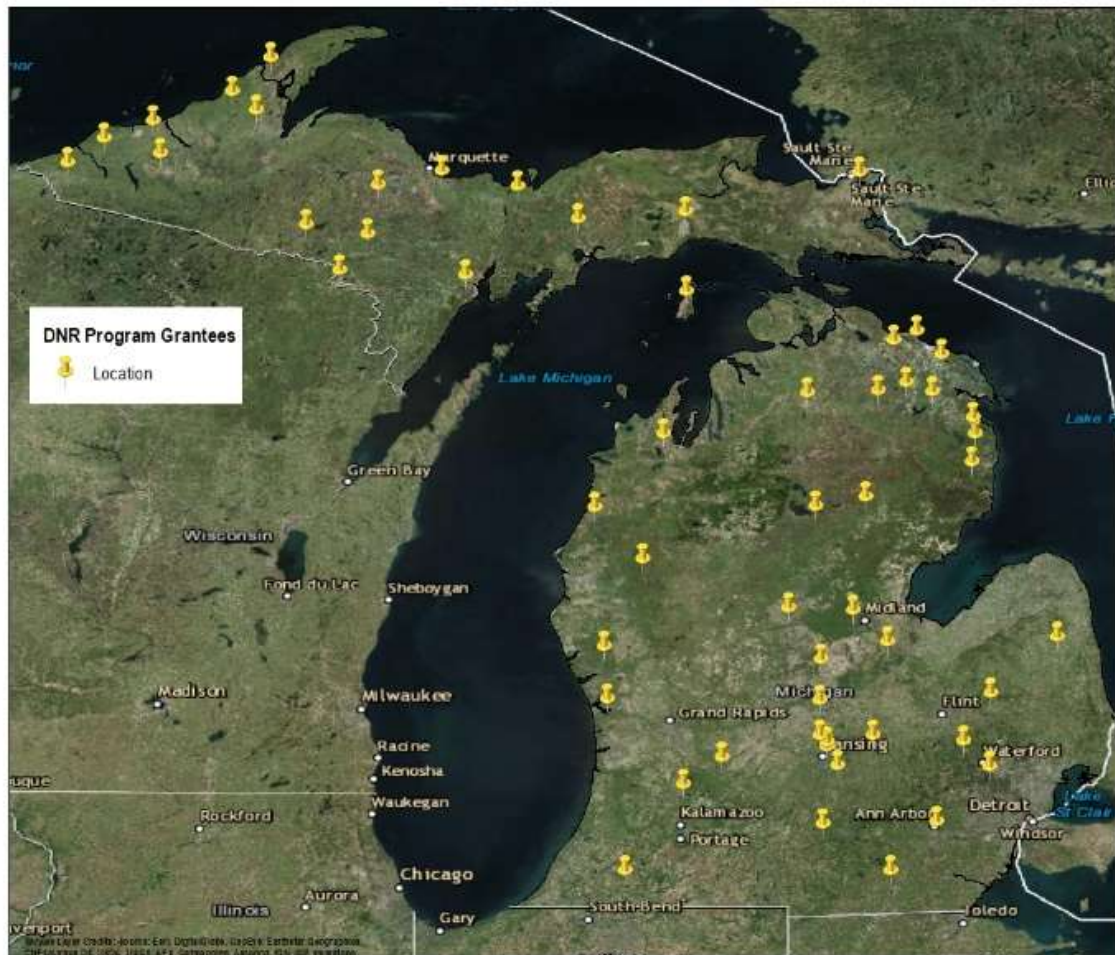
The points represent an approximate location of the grantees as the centroids of zip code areas matching

the database from the US Census (https://www.census.gov/geo/maps-data/data/cbf/cbf_zcta.html). This

map was developed using ESRI's ArcGIS v10.5.

The statewide WHGP, established in 2013, is the largest of the three grant programs with

the most funds allocated each year and is funded in part by hunting and fishing licenses

(Michigan Department of Natural Resources, Wildlife Division, 2017b). The priorities developed

for the WHGP include increasing opportunities for recreational wildlife use and maintaining and increasing habitat for waterfowl, upland bird species, small game, and big game. The other two grant programs have similar intentions but differ in the region of the state in which they are administered. The DHIPI is the granting program for the upper peninsula of Michigan, and the Deer PLAN is the granting program in the Northern portion of the lower peninsula of Michigan (Michigan Department of Natural Resources, Wildlife Division ,2017c and Michigan Department of Natural Resources, Wildlife Division, 2017a). The goal of both plans is to improve and increase habitat specifically for deer on privately owned lands. Public Act 106 of 1971 dedicated $1.50 of every hunting and fishing license sold to deer habitat improvement and created the Deer Range Improvement Program fund (DRIP). The act has provided the funds for these programs since they began in 2009. The parallels between these three programs' goals in habitat development for game species and their funding schemes are what warranted their inclusion in this study over other MI DNR grants.

Significance of the Research

The WHGP, DHIPI and Deer PLAN programs aim to assist the MI DNR in 1) developing and improving habitat for wildlife, and 2) partnership development. The first objective targets Goal 2 (manage habitat for sustainable wildlife populations and wildlife-based recreation) of the MI DNR strategic plan and is already within the evaluative scope of the various grant administrators (Michigan Department of Natural Resources, Wildlife Division, 2016). However, there has been no systematic assessment of the equally important second objective. The goal of this research was to evaluate the effectiveness of the MI DNR grant programs in building relationships. This research addressed Goal 5 in the MI DNR's Guiding Principles and Strategies to improve and maintain public communication, strong relationships, and partnerships but more

specifically to measure and evaluate the success of existing partnerships (Michigan Department of Natural Resources, Wildlife Division, 2016).

Social Network Analyses, among grantee organizations and among all conservation organizations in Michigan, determined whether and how the grant programs were strengthening partnerships. I hypothesized that partnership building within this network of conservation organizations was explained by characteristics of the organizations involved and was facilitated by the grant programs. Therefore, the results of this project should enable the MI DNR to improve the administrative and strategic efficacy of these and potential future grant programs to create partnerships through eligibility requirements and application criteria, clarification and prioritization of program goals, and the identification of grant characteristics associated with partnerships.

METHODS

Semi-Structured Interviews

Phone interviews were conducted from December 2017 to February 2018 to gain qualitative information on the partnerships formed between grant-receiving organizations. All grant recipients over the last four years were identified by the MI DNR grant administrators. Although there were a few individuals who applied for the WHGP and the Deer PLAN, they were the minority of applicants and an even smaller number of them received a grant. In this study, I focused on surveying only the organizations involved in the network. Once the relevant grantees were identified, a group of 20 organizations who received a grant were randomly selected. Of the 20 selected, 16 phone interviews were successfully conducted. The remaining four grantees did not respond to the interview request. The grantees were asked questions aimed at understanding their experience with the grant and their partnerships for habitat management (Appendix A). This included asking about how and why they applied, the nature of their relationships with partnering organizations, and if/how the grant had affected their organization.

Survey Methods

In addition to surveying grant recipients, other Michigan-based conservation organizations that had not received or applied to the grant programs, but had potential to do so, were also identified. In order to determine the boundary of inclusion for organizations as a potential grantee, I used a definitional focused search for organizations, which implemented some restrictions based on specific characteristics (Laumann et al.,1989; Prell, 2012). I sought to find organizations that were similar to the organizations that received the grants in order to identify matches among these "like-organizations" and the grantees. The means by which I

collected these additional organization names included through the semi-structured interview process, searching grantee webpages and discussing potential applicants with MI DNR staff (Frank, personal communication, Nov. 22, 2017). These additional organizations allowed me to compare and identify differences with the grant-receiving organizations.

The survey was distributed on June 25th, 2018 to 206 conservation organizations via a weblink sent to the organizations' emails on file with the MI DNR grant coordinators and was available to complete until October 16th 2018. Because there were three types of respondents: successful applicants, unsuccessful applicants, and non-applicants, each type was sent a different survey version to allow for unique data needs and requests. Each of the three surveys consisted of roughly 30 questions regarding of the organization's 1) attributes and demographics, 2) grant status, 3) relationships with partnering organizations, 4) perceptions of the MI DNR and 4) leveraged resources as a result of the grant (Appendix B). All organizations who were sent the survey were put into a roster from which respondents could choose their partners for habitat projects (Butts, 2008). To understand how these organizations were partnering for habitat management and based on the results of the phone interviews, I asked respondents to identify the type of support they received from each partner. Data are more reliable when survey respondents are asked who they feel supports them rather than asking the organizations who they provide support to (Frank et al., 2004). There were four types of support included —shared equipment, funding, volunteer, and knowledge. The three different survey versions were largely the same but one major distinction was that information was collected on partnership support received prior to receiving the grant in the successful applicant version, but not in the unsuccessful applicant and non-applicant versions. The survey was developed according to the Tailored Design Method to

help identify and reduce the four main sources of survey error: coverage, sampling, nonresponse and measurement (Dillman et al., 2009).

Of the 206 surveys distributed, I received 113 responses for an overall response rate of 55%, although 21 of the surveys were removed due to missing data resulting in a sample size of 92. By respondent type, 42 of 50 successful applicants responded (84%); 10 of 25 unsuccessful applicants responded (40%); and 40 of 131 non-applicants responded (31%).

Structural Analysis

I analyzed the network of organizations from a structural perspective as well. This analysis allowed me to identify the organizations that play an important role in resource flow and who might act as brokers: those who can help bridge gaps and bond connections within this network (Bodin et al., 2006). One of the most measured aspects of a network is *centrality*, which identifies the most influential members of the network. In a highly centralized network, there are fewer actors that have more connections than other actors (Bodin et al., 2006). There are a three main types of centrality: degree centrality, betweenness centrality and closeness centrality. Degree centrality is indicated by the number of connections to each node. High degree centrality scores imply that those actors have increased access to the amount of information and resources available in the network (Hanneman & Riddle, 2005). Along with calculated overall degree centrality, it can be calculated as in-degree (number of links going to the node) or out-degree (number of links going from the node). In this case, I focused on in-degree centrality since I was interested in the selection process. Betweenness centrality is the number of times an actor lies along the shortest path between two pairs of actors, normalized by the highest betweenness possible (Borgatti et al., 2009). Betweenness indicates the potential power in the position of that actor to disrupt, facilitate or distort information flow. Closeness centrality is the average path

length between one actor and all other actors in the network. Shorter path lengths allow for easier transfer of information between actors (Borgatti, 2005).

Another metric that can be measured is network density. Density is described as the proportion of potential connections to actual connections in the network. A density score of one indicates that all possible connections occurred and a score of 0 indicates that the actors in the network are completely disconnected from one another (Wasserman & Faust, 1994).

The three centrality measures and density each bring relevant, unique information that is important for understanding the stakeholder dynamics involved in this network. All four metrics were calculated for each of the organizations that participated in the survey. Visualizations and calculations of these metrics were done using the *igraph* package in the R software (R Core Team, 2018; Csardi & Nepusz, 2006).

Selection Model for Support

Using the data collected on organization partnerships, I modeled the effects of various covariates on the likelihood of receiving support. I used each of the four different support types identified: shared equipment, funding, volunteers, and knowledge as dependent variables (*Support: 0=no, 1=yes)*, as well as overall support, indicating whether any support was received, regardless of the types.

Given that I collected different information from each of the three respondent types, two separate selection models were developed. The first pertained only to successful applicants from whom information was collected on partnership support received prior to receiving the grant. The framework for model 1 is:

$$log\left[\frac{p(supportii')}{1-p(supportii')}\right] = \beta_0 + \beta_{i'} + \beta_1 distance_{ii'} + \beta_2 prior\ support_{ii'} +$$

$$\beta_3 different\ organization\ type_{ii'}$$

$$\beta_{i'} = \gamma_{00} + \gamma_{01}^{i'} scale_i, + \gamma_{02}^{i'} fund\ amount_i, + \mu_{i'}$$

where $log\left[\frac{p(supportii')}{1-p(supportii')}\right]$ represented *support* at time two (after receiving the MI DNR grant)

and can be interpreted as the probability that organization *i'* (i.e. the receiver) will provide

resources to organization *i* (i.e. the sender) (Frank, 2011).

Model 1 covariates included distance of the organizations to one another, support

received prior to receiving the MI DNR grant, organization type, the scale of management, and

the amount of funds received. *Distance* was measured in meters as the exact straight-line

distance between organizations. Research suggests organizations working in the same region will

be more likely to become partners. Shorter geographical distance between organizations allows

for more in person interactions which facilitates richer exchanges and stronger relationship

(Torre & Gilly, 2000). *Prior support* received indicated if support was received prior to receiving

the grant, such that prior support equaled one when received and zero when not received.

Investigating *prior support* helps to determine the nature of the relationship before a certain

event (Frank & Fahrbach, 1999). *Different organization type* equaled one when paired

organizations were of the different type and zero when they were same. Various types of

organizations (non-profit, government, local community-based, etc.) have their own competitive

advantages. For example, where governments can provide more financial resources, nonprofits

tend to work closer with the local communities and thus can provide more social supports

(Brinkerhoff, 2002). It may be more beneficial for an organization to partner with those offering

different advantages, which typically would come from a different organizational type (Brown & Korten, 1991).

The first three covariates: *distance, prior support,* and *different organization type* were all pairwise, meaning the values were based on individual pairs of organizations. The last two covariates were modeled as receiver-level effects, meaning that they were considered for individual organizations rather than dependent on a pair. *Scale* referred to the geographical scale at which these organizations manage land at. It was collected as a categorical variable with local, regional, statewide, and multi-state being the options. Although little research exists for this type of variable, it was included in the analyses as a way to help account for the effects of higher status levels vs local status levels (Berkes, 2002). The final variable for this model was *fund amount*. This variable was measured using the exact dollar amount each organization received divided by $1000. With the interest in evaluating the grant programs, I thought adding a variable to this first model that accounted for the amount of funds would allow for better understanding of that effects.

The second model included all three respondent types, which excludes the prior support variable since I only had one time point for the unsuccessful applicants and non-applicants. The framework for model 2 is:

$$log\left[\frac{p(support_{ii'})}{1-p(support_{ii'})}\right] = \beta_0 + \beta_{i'} + \beta_1 distance_{ii'} + \beta_3 different\ organization\ type_{ii'}$$

$$\beta_{i'} = \gamma_{00} + \gamma_{01}^{i'}organization\ age_i + \gamma_{02}^{i'}scale_i + \gamma_{03}^{i'}fund\ amount_{i'} + \mu_{i'}$$

where $log\left[\frac{p(support_{ii'})}{1-p(support_{ii'})}\right]$ represented support at time one and can be interpreted as the probability that the organization *i'* will provide resources to the organization *i* (Frank, 2011).

Similar to model 1, model 2 also included the covariates *distance*, *different organization type, scale,* and *fund amount* but additionally included the age of the organization. The *organization age* variable was measured using the exact year the organization became officially established. It was included more as a control variable to account for variations in the longevity of the organizations. Like *scale* and *fund amount*, *age* was also analyzed as a receiver-level effect in model 2. *Fund amount* was similar to that described above for model 2, however it also included zeros for those organizations that did not receive a grant at all. In this way, the variable represented whether receiving a grant and the amount of the grant influenced being selected as a partner.

There are several frameworks of selection models that can be used for analyzing social networks (Carrington et al., 2005). One of the more widely used models is the exponential random graph model (ERGM) (Lusher et al., 2013). This method utilizes the presence (or absences) of relationships as a means to explain new, emerging relationships. ERGMs emphasize network structures (e.g. reciprocated ties and relationship triangles) while also accounting for individual attributes (Robins et al., 2007). Another suite of network models that are commonly used are latent space models (LSMs). Differently from ERGMs, emerging relationships between actors in LSMs are dependent on the space between their social positions in the network (i.e. their latent space), which is measured in terms of Euclidean space (Hoff et al., 2002). The additive and multiplicative effects model (AME) is a more recently developed framework for social network analysis. These models also use latent space to account for emerging relationships but different from LSMs & ERGMs, AMEs allow one to account for pair-wise interactions as well as sender-specific and receiver-specific factors (Minhas et al., 2019; Snijders, 2011). AMEs are built on a generalized linear modeling framework and accounts for several network

14

dependencies including heterogeneity, reciprocity, transitivity and stochastic equivalence (Hoff, 2015). Accounting for such dependencies is limited in ERGMs and LSMs. With its ease to implement, straightforward interpretation of results, and flexibility of use, the AME model was the most appropriate choice for my analysis. These are logit models where the coefficients are presented as log odds ratios and can be converted to odds ratios for interpretation. I used the R software, version 3.6.0, for statistical analysis of this data (R Core Team, 2018) and the R package *AMEN* to analyze the AME selection models (Hoff, 2015).

Table 1. Descriptive statistics of variables included analysis

	Mean	Std. Dev.	Min	Max
Model 1 (N=1,764 pairs)				
Outcome Variables				
Overall Support	0.06	-	0	1
Shared Equipment Support	0.02	-	0	1
Funding Support	0.02	-	0	1
Knowledge Support	0.05	-	0	1
Volunteer Support	0.03	-	0	1
Covariates				
Prior Support - Overall	0.06	-	0	1
- Shared Equipment	0.01	-	0	1
- Funding	0.02	-	0	1
- Knowledge	0.04	-	0	1
-Volunteer	0.03	-	0	1
Distance (meters)	314.78	192.30	1.38	1031.22
Different Organization Type	0.33	-	0	1
Scale	1.81	-	1	4
Fund Amount (in $1,000 increments)	40.77	45.84	2.48	174.44
Model 2 (N=8,464 pairs)				
Outcome Variables				
Overall Support	0.04	-	0	1
Shared Equipment Support	0.01	-	0	1
Funding Support	0.02	-	0	1
Knowledge Support	0.03	-	0	1
Volunteer Support	0.01	-	0	1
Covariates				
Distance (meters)	302.27	195.08	0.05	1431.40
Different Organization Type	0.30	-	0	1
Scale	2.03	-	1	4
Fund Amount (in $1,000 increments)	18.61	36.72	0	174.44
Age	59.45	27.34	2	115

RESULTS

Semi-Structured Interviews

The main decision to apply was needs based since many of these organizations are grant funded and have no steady revenue. For several of the grantees, habitat development is part of their mission, making this grant even more appropriate. When asked how receiving the grant affected their organization, most interviewees responded that the grant allowed them to develop long-term habitat in areas of need. Also mentioned was that the grants helped to foster partnerships/relationships and encourage volunteers to get involved. A few of the grantees indicated that relationship building with the MI DNR was one of the most successful outcomes of their projects.

Table 2 is a list of the types of organizations mentioned as being top partners and the number of interviewees that mentioned each type. The row in red indicates the number of organizations that are recipients of a MI DNR habitat grant, for each type. Aside from gaining information on who the grantees are partnering with, I also learned how they partner with these organizations. As mentioned above, receiving some form of support (i.e. shared equipment, funding, volunteers, or knowledge) came across in most of the interviews as why the grantees formed partnerships.

Table 2. Organization types mentioned in survey

Government	Non-profit	Sportsmen's Club	Conservation Districts	Other
6	15	1	1	3
0	6	1	1	0

*The numbers shaded in red = grantees.

Structural Analysis

Figure 2 provides a geographical distribution of the network, showing the relative location of each organization and the general structure. The density of the network was 0.046. This measure, being on a scale of zero to one, was very low indicating that the network is disconnected. Although there were several organizations involved in the network (92) many were peripheral and only had one or two connections. The values for the mean connections in the different support types (range: 0.01-0.06) in table 1 above provided further evidence for the low density of the network. The average in-degree centrality score was four ties with a range of 0-43 (Figure 3). Organization 67, a governmental organization, had the most ties in the network. The organization with the second highest in-degree centrality score (org. 42) wa also governmental, followed 3rd and 4th by non-profit organizations (org. 86 and org. 28). The average betweenness centrality score was 0.016 (Figure 4), indicating that this network had few organizations that provide a bridge among different sections of the network. The organizations with the three highest betweenness scores were all non-profit organizations (org. 74, org. 69, and org. 62). The average closeness centrality score was 0.049 (Figure 5), indicating that this was a disconnected network. With a range of 0.01-0.06, most organizations shared a very similar score and no actors stood out from the rest as high scorers.

Figure 2. Geographical distribution of the network

Legend: N.A. Tribes, Government, For-Profits, Non-Profits, Sportsmen's Clubs, Con. Districts
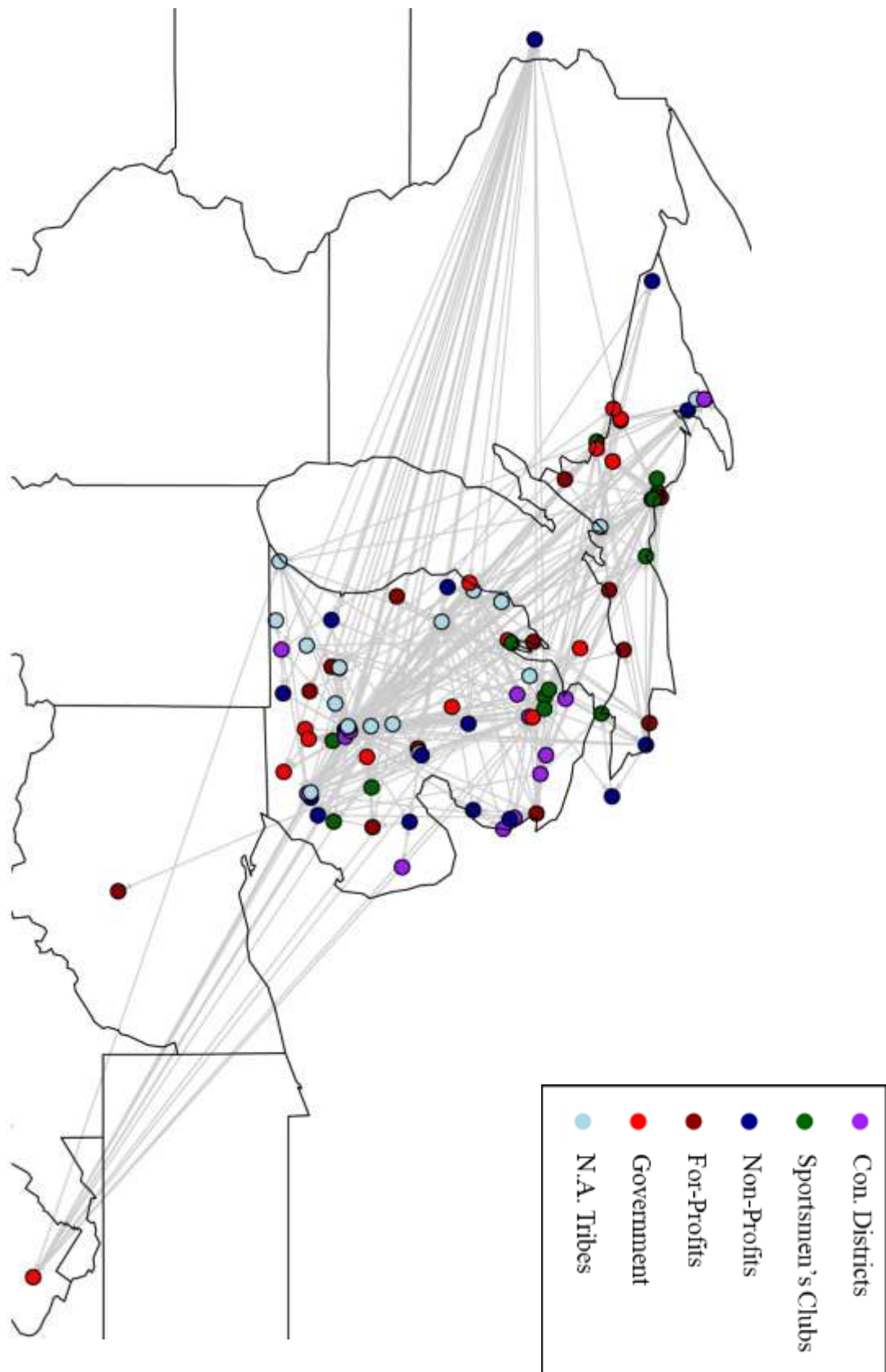
Figure 3. Indegree centrality
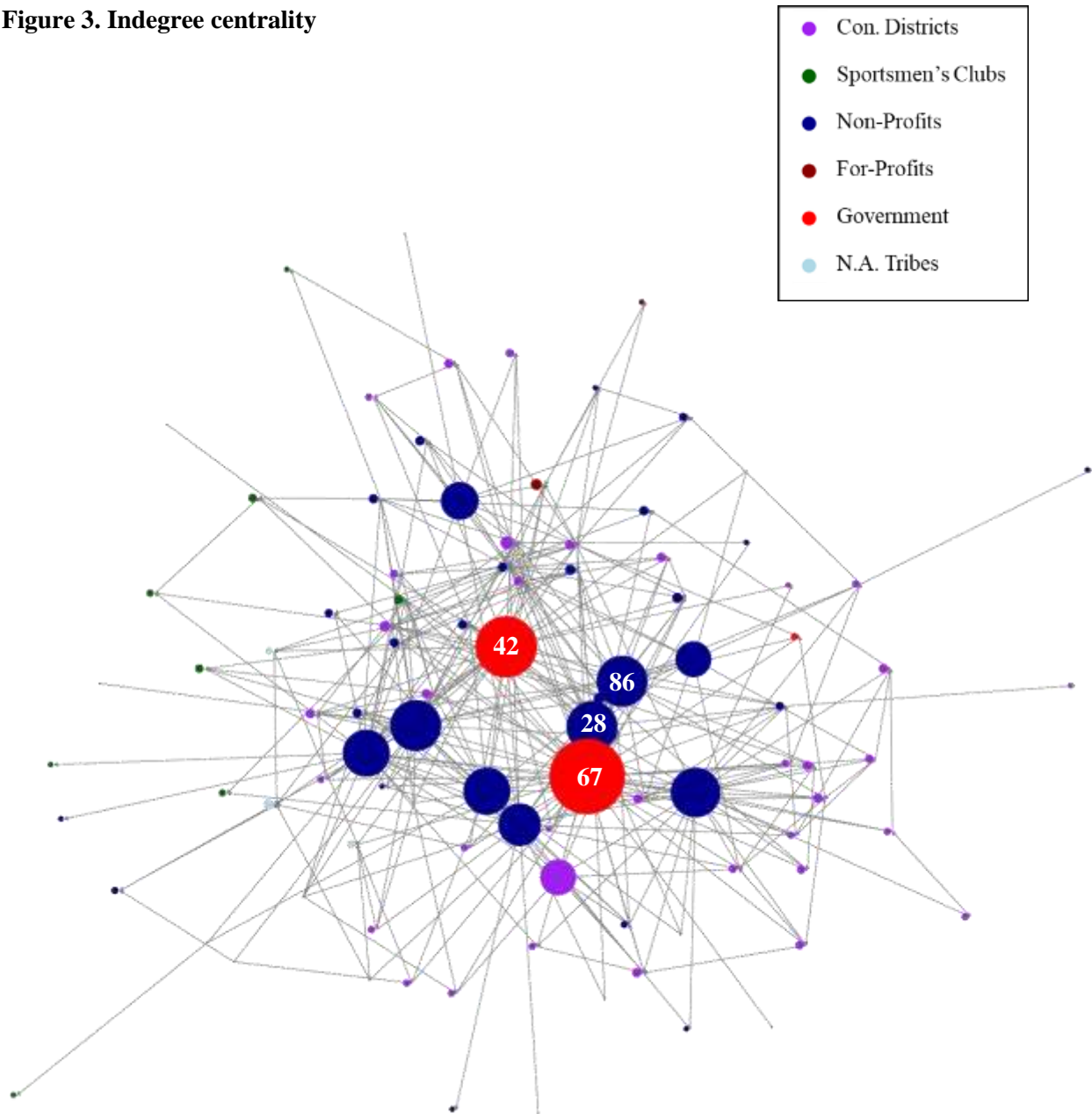
Figure 3 depicts the results of in-degree centrality of the nodes of the network. The larger the size of the node, the higher the in-degree centrality score that organization received. The colors correspond to the various organization types indicated in the legend above.
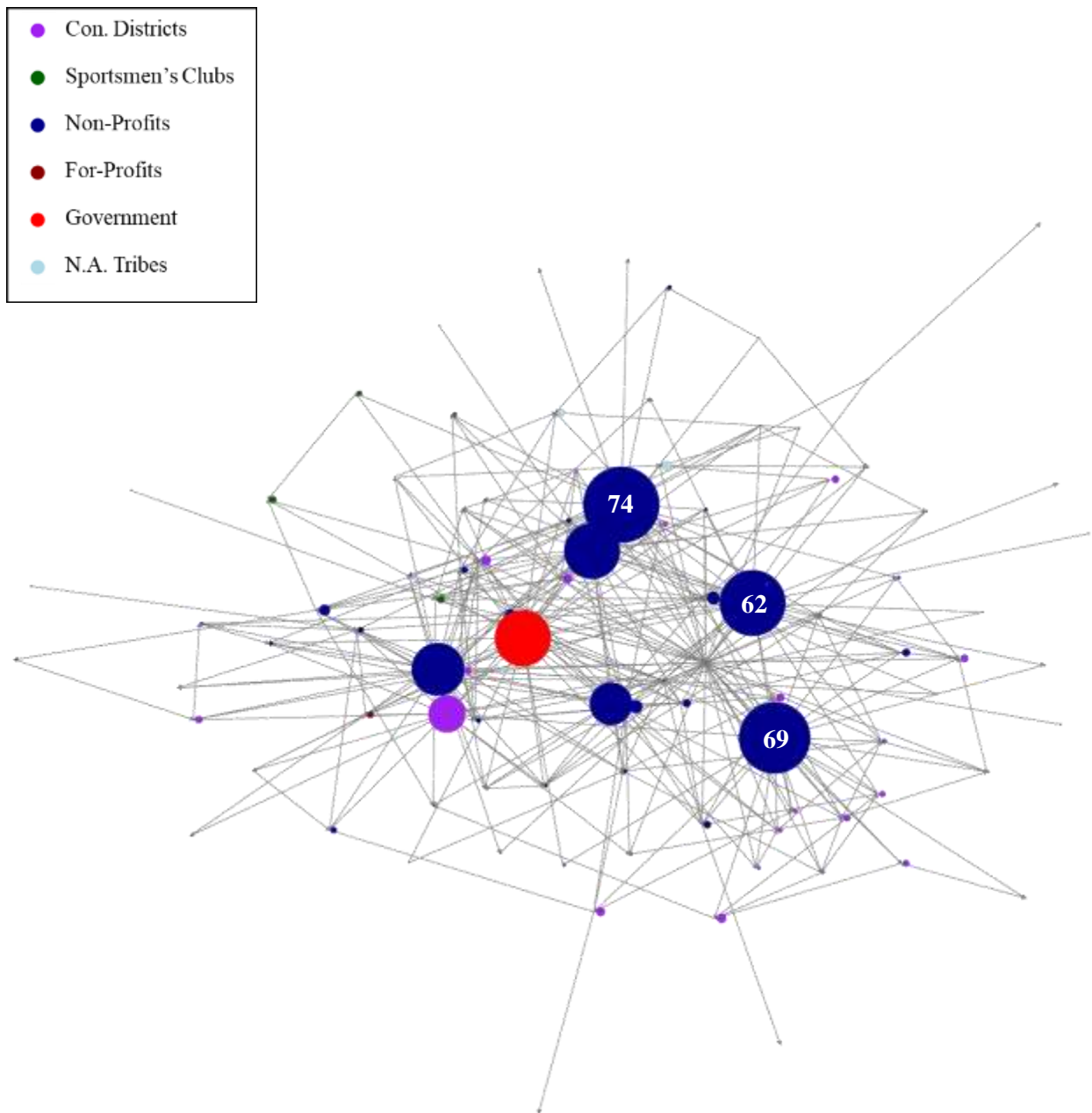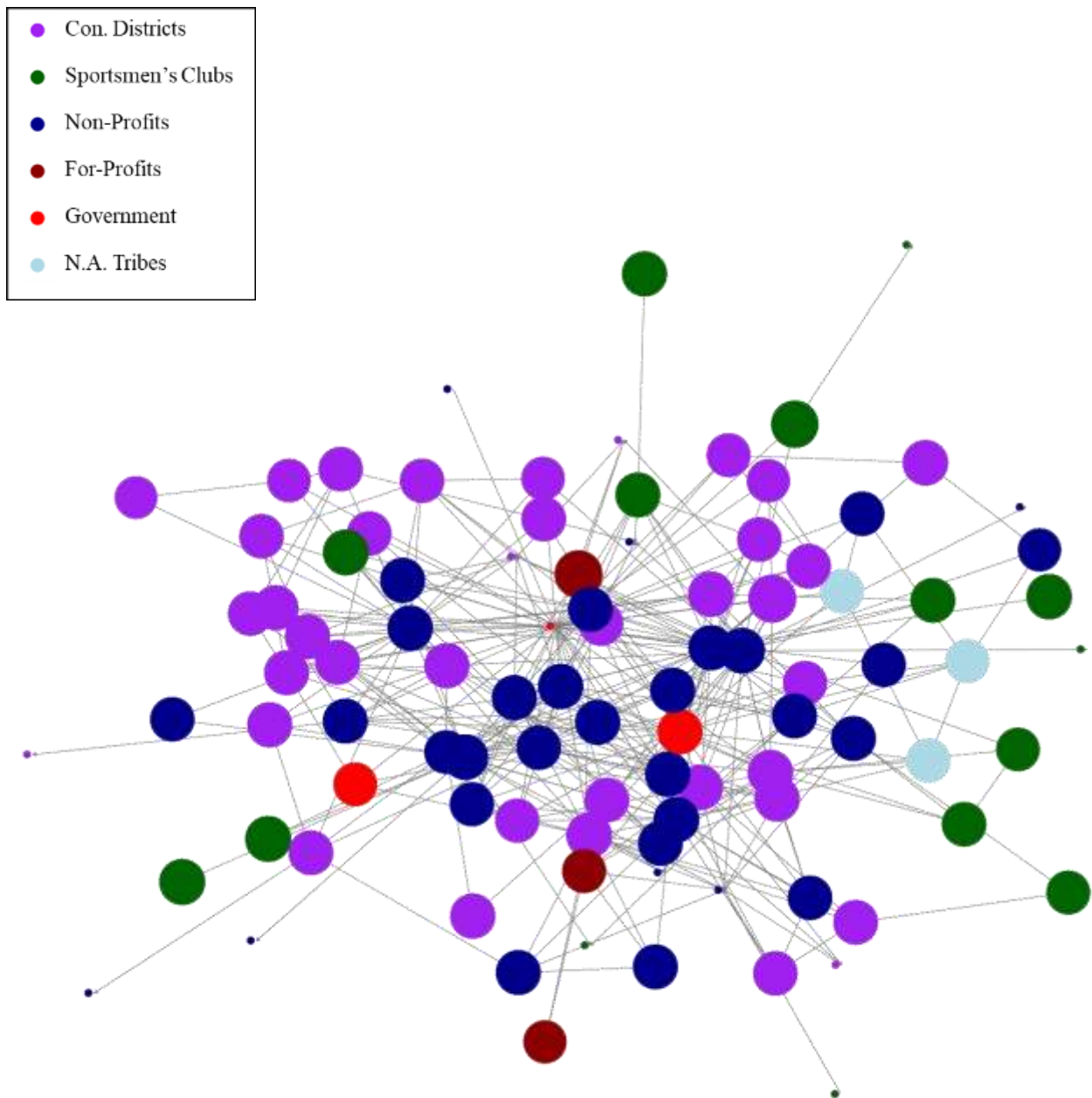
Figure 4. Betweenness centrality

Figure 4 illustrates the results of betweenness centrality of the nodes in the network. The larger the size of the node, the higher the betweenness centrality score that organization received. The colors correspond to the various organization types indicated in the legend above.

Figure 5. Closeness centrality

Figure 5 illustrates the results of closeness centrality of the nodes in the network. The larger the size of the node, the higher the closeness centrality score that organization received. The colors correspond to the various organization types indicated in the legend above.

Selection Models'

Results for model 1 and model 2 were reported in unstandardized coefficients (log odds ratios) and standardized coefficients (standard deviations). By looking at the standardized coefficients, comparisons can be made among the covariates since they have been normalized (Menard, 2011). In model 1, the *prior support* a grantee organization received was statistically significant ($p \leq 0.001$) and positive for all support types as well as overall support (Table 3). This suggests that an organization's prior support was correlated with their current partnerships. Among the different support types, the effect of *prior support* on the likelihood of selection varies. For example, with overall support, the odds of receiving support were 98.3 ($e^{4.588}$) times higher when having received prior support vs not. Compared that to funding support where the odds of receiving support were 13.7 ($e^{2.618}$) times higher.

Table 3. Model 1 results of selection model by support type (N=1,764 pairs)

	Shared Equipment Support		Funding Support		Knowledge Support		Volunteer Support		Overall Support	
	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs
Scale	0.376 * (0.166)	2.272	0.222 (0.167)	1.326	0.296 (0.183)	1.614	0.426* (0.190)	2.241	0.129 (0.233)	0.551
Fund Amount	0.006* (0.003)	2.15	0.006* (0.003)	2.311	0.008** (0.003)	2.563	0.004 (0.003)	1.513	0.008* (0.004)	2.379
Prior Support	3.169*** (0.611)	5.186	2.618*** (0.334)	7.839	4.848*** (0.578)	8.387	3.110*** (0383)	8.125	4.588*** (0.417)	11.007
Distance	-0.002*** (0.001)	-4.963	-0.002*** (0.001)	-4.169	-0.002** (0.001)	-2.52	-0.002*** (0.001)	-4.023	-0.001 (0.001)	-1.575
Different Org Type	-0.142 (0.163)	-0.869	-0.178 (0.164)	-1.083	-0.429* (0.212)	-2.024	-0.020 (0.176)	-0.112	-0.380 (0.241)	-1.578
Intercept	-2.333 (0.365)	-	-2.182 (0.359)	-	-2.946 (0.435)	-	-2.594 (0.406)	-	-3.092 (0.518)	-

*p < 0.05; **p < 0.01; ***p < 0.001

The other covariates were statistically significant for some of the support types but not all. *Distance* was found to be statistically significant in all support types except for overall support and the effect was negative which indicates that larger geographic distance between organizations decreased the likelihood of partnerships. *Different organization type* was only found to be statistically significant for knowledge support and on average had a much smaller effect on partnership selection than the other covariates. Looking at volunteer support, the effect of d*ifferent organization type* (-0.112) was more than 13 times smaller than the next most effective covariate, *fund amount* (1.513). *Scale* was found to be statistically significant and positive for shared equipment support and volunteer support. Analyzing the variable further for volunteer support, it showed that an organization is 1.5 times more likely to be selected as a partner with every increase in scale level. The last variable in Model 1 to review was *fund amount*. This variable was statistically significant and positive for all support types accept volunteer support. When significant, the effect of the variable on the outcome was very similar.

In model 2, my main variable of interest, the *fund amount* received, was statistically significant ($p \leq 0.05$ or $p \leq 0.01$) in all models except for shared equipment support. This finding not only suggests that organizations that received a grant had higher probability of being selected but that the more money those organizations received also increased their probability of being selected as a partner. Along with the effect of the grants*, distance* was also statistically significant with a negative effect in every support type ($p \leq 0.001$). This indicated that the further away organizations were from one another, the less likely they were to partner. The effect size was about the same for all support types, for every meter increase in *distance*, the odds of receiving support decreased by one ($e^{-0.002}$). Although this seems small, I was working with a small unit (meters) relative to the overall distances. Another important covariate to note in these

results was *scale*. This covariate was statistically significant and positive for all support types but

shared equipment support. This covariate also had the second highest standard coefficient

meaning it was the second most influential covariate on the outcome. D*ifferent organization type*

was also included in this model and was only found to be statistically significant (p ≤ 0.05) for

overall support. The final covariate included was the *organization age*. This variable had a

positive effect and was statistically significant for funding support and knowledge support. The

effect size was relatively the same for the different support types. With every one year increase

in age, the odds of being selected as a partner was one times higher.

Table 4. Model 2 results of selection model by support type (N=8,464 pairs)

	Shared Equipment Support		Funding Support		Knowledge Support		Volunteer Support		Overall Support	
	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs	Unstd coeffs (SE)	Std. coeffs
Organization Age	0.005 (0.004)	1.41	0.008* (0.003)	2.385	0.006* (0.003)	2.186	0.002 (0.003)	0.614	0.005 (0.003)	1.803
Scale	0.131 (0.080)	1.643	0.339*** (0.073)	4.662	0.225*** (0.063)	3.568	0.165** (0.061)	2.693	0.248*** (0.059)	4.199
Fund Amount	0.003 (0.002)	1.389	0.005* (0.002)	2.331	0.005** (0.002)	3.039	0.005** (0.002)	3.057	0.005** (0.002)	3.164
Different Org Type	0.110 (0.142)	0.773	-0.085 (0.106)	-0.797	-0.159 (0.084)	-1.904	-0.068 (0.115)	-0.593	-0.192* (0.078)	-2.48
Distance	-0.002*** (0.000)	-4.313	-0.002*** (0.000)	-6.523	-0.002*** (0.000)	-9.412	-0.002*** (0.000)	-6.187	-0.002*** (0.000)	-9.778
Intercept	-3.398 (0.341)	-	-3.516 (0.327)		-2.640 (0.261)		-2.789 (0.262)		-2.457 (0.245)	-

*p < 0.05; **p < 0.01; ***p < 0.001

DISCUSSION

Our findings from the structural analysis indicated a disconnected network of conservation organizations, given a low-density score, few actors with high in-degree centrality and low closeness centrality scores. However, information gained from this study can be of value to agency managers. Identifying the organizations that were selected the most (high in-degree centrality) as important partners showed who might be the most influential in the network moving forward while highlighting the actors that may need more assistance with making connections. Organizations with high betweenness centrality were important because of their ability to act as brokers along main communications paths in the network, allowing them to facilitate the flow of information (Tang et al., 2010). With this knowledge, interventions might be implemented to better allocate resources to organizations that are less connected to the network, thus increasing their social capital and facilitating cooperation among organizations (Pretty, 2003).

One interesting covariate from the models that helps explain the flow of resources the structure of the network is depicting is *scale*. In model 1, this covariate was only statistically significant for shared equipment and volunteer support, both of which are physical resources, and indicated that the larger the scale of an organization the more likely they were to be selected as a partner. *Scale* was meant to distinguish between institutional status levels of the organizations, so this finding could be interpreted that the flow of physical resources through the grant receiving network was driven by the high-level organizations whereas nonphysical resources were less tied to the status of the organization. Since these organizations received funds from the MI DNR, it could be that they are less likely to seek additional high-level organizations for that resource. Differently than model 1, model 2 shows *scale* being statistically

significant for all support types but shared equipment. Since model 2 shifted to include non-grant receiving organizations, the wider significance of *scale* could indicate that without MI DNR funds organizations seek more high-level organizations for necessary physical and nonphysical resources (Edwards, 2001).

This study's main aim was to investigate the effects grants had on partnership selection among survey respondents for all support types. The AME selection model indicated that a relationship existed between the MI DNR grants and being selected as a partner. Although little research exists that directly links an actor's network with receiving grant funding, social capital theory can be used to explain this relationship. In some interpretations of social capital theory, networks are key to the success of an actor in obtaining necessary resources (Burt, 1992; Lin, 2002; Wellman & Frank, 2001). The stronger the social network of an organization the more likely they are to succeed in procurement of resources (in this case grants) that otherwise would be unavailable to them (Bourdieu & Richardson, 1986; Burt, 1992; Lin, 2002). This theory has been previously used to explain factors that contribute to making a nonprofit organization successful (Hager et al., 2004). The authors argued that successful organizations tended to create a more developed network and tie themselves to centers of power which led to such organizations being viewed as legitimate and increases their access to resources. In this study, those organization that received a grant had a stronger network and the more grant funds they received increased their network as well.

The *distance* covariate is statistically highly significant with a negative effect in both model 1 and model 2 for almost all support types. This finding indicates that the further organizations are to one another the less likely they are to partner. This effect is in line with much of the literature on geographic distance among partnerships (Bouba-Olga et al., 2012).

Where human resources are involved (i.e. volunteer and shared equipment support), being geographically close to one another has been found to facilitate those types resource flows (Vedovello, 1997). These findings suggest that these conservation organizations tend to work locally or regionally and partner with one another in the same way.

Although these findings for the prior support, scale, grants and distance covariates provided a strong case for what drives partnership selection in this network, this study showed some limitations that would need to be addressed in future research on this topic. The data collected in this study was not truly longitudinal, meaning network actors were not surveyed at two or more different time points to determine if some event (e.g. receiving a grant) had a true effect on the organizations' networks (Carrington et al., 2005). Although analyzing longitudinal data has its own caveats, it allows for more reliable interpretations of the results than the "recall" method used in this study. An additional covariate that could have been collected to determine the strength of these relationships was reciprocity, i.e. a mutual exchange support (Wasserman & Faust, 1994). Given time constraints and a lack of knowledge on the full extent of the network, it was difficult to take reciprocity into consideration.

CONCLUSIONS

As state wildlife managers look to new ways to achieve their conservation goals, partnerships with private organizations such as cooperatives and non-profit organizations have become vital to the success of such agencies (Trauger et al., 1995; Wigley & Sweeney, 1993). Partnerships can result in an increase in public participation from stakeholders which has been shown to be beneficial to wildlife agencies to ensure their management techniques are relevant and build trust with citizens (Decker et al., 2015). To facilitate these relationships among conservation organizations, the MI DNR has implemented partnership development as a goal of their habitat grant programs. However, this has not been a requirement for obtaining a grant. In this study, I presented evidence that grants were a driving force in partnership selection among the surveyed conservation organizations, along with distance to one another, having received prior support, and the scale at which the organization manages resources.

These findings were in line with my hypothesis and hold significance in shaping the future of these grant programs and conservation policy. By understanding the social networks of their stakeholders and partners, state wildlife managers and policy makers can be in a better position to engage citizens for decision making for conservation (Prell et al., 2009). Understanding what drives partnerships selection among conservation organizations provides a unique opportunity for managers to intervene and incentivize networks that will maximize the potential for success in resource management and conservation. High-level organizations were sought out for partnerships within this network and are somewhat common among the grant receiving organization pool, so a strategic on the part of the MI DNR to help facilitate these connections could be to implement certain requirements for partnering between different scaled organizations or organization types. This would ensure that the funds the MI DNR award go to

those high-level organizations that typically have a reputation for good management practices while still including and assisting the smaller scale organizations in the management process. Future research could capture the changes in the network using our preliminary work and reevaluate the drivers for selection should a similar intervention be implemented.

APPENDICES

APPENDIX A: *Interview Protocol*

Interview Protocol Form

Project: Evaluating the Habitat Grant Program

Date _____

Time _____

Grantee being interviewed _____

Release of information? _____

Notes to interviewee: Thank you for your participation. I believe your input will be valuable to this research and in helping grow all of our professional practice.

Confidentiality of responses is guaranteed

Approximate length of interview: 10 minutes

Purpose of research:
This research will focus on evaluating the effectiveness of the DNR grant programs and aims to improve the process to allow the program to run successfully. The following questions were formulated to gain useful information that can be used to help guide the development future surveys for this project.

1. How did you come to learn about the Habitat Grant Program? What made you decide to apply?

2. Who are the organizations and/or individuals with whom you regularly work? What kind of organizations are they and what kind of work do they do?

3. Do you work with other organizations or individuals when carrying out the tasks to complete your project? How do you work with them? What are their names?

4. Since receiving the grant, have you sought out additional resources to help carry out your habitat project? What resources? (Financial, Volunteer, Shared Equipment, etc.)

5. Does any information on the work you do for your project get publicized? If so, through what outlets? (Newsletters, social media, website posts, etc.)

6. What effects, if any, has the grant had on your organization; operationally, values, etc?

7. What do you feel was the most successful outcome of the grant process or work?

DNR Habitat Grant Programs Survey

Dear Participant, you are invited to contribute to a research project being conducted for a Master's thesis project of a MSU student in the Department of Fisheries and Wildlife. The results of the study will be used by the Michigan Department of Natural Resources to inform the management of their habitat grants. You should feel free to ask the researchers any questions you may have. **Study Title**: Using Social Network Analysis to Measure and Assess Relationship Building and Partnerships under the Michigan DNR's Habitat Grants Programs **Researcher and Title**: Sarah Burton (Graduate Student) & Daniel Kramer (Professor) **Department and Institution**: Department of Fisheries and Wildlife, Michigan State University **Address and Contact Information**: Rm 13 Natural Resource Building, East Lansing, MI 48824; burtons7@msu.edu or dbk@msu.edu; 517-614-6965 This study aims to understand how Michigan's Department of Natural Resources Habitat Grant Programs may foster successful partnerships with and perceptions of the DNR. We are asking your organization and others to answer some questions about the type and extent of their interactions with other organizations for habitat management projects. From this study, we hope to understand the success of these grant programs in building successful direct and indirect relationships with the MDNR. Participating in this survey will take about **20 minutes** of your time, depending on your answers. You must be at least 18 years old to participate in this research. This survey is completely voluntary and you may choose to end the survey at any point. By continuing with the survey, you indicate your voluntary agreement. Confidentiality will be kept and information obtained in this survey will only be shared with the research team.

You are being sent this survey because your organization has received one or more of the following Michigan Department of Natural Resources grants:

Wildlife Habitat Grant Program (WHGP)
Deer Habitat Improvement Partnership Initiative (DHIPI)
Northern Lower Peninsula Deer Private Land Assistance Network (NLP Deer PLAN)

Q1 What organization are you representing?

_____

Q2 What year(s) did your organization receive the grant(s)? Please separate years by commas.

_____

The following series of questions will provide the necessary information to evaluate the partnerships developed between organizations. You will be asked to select up to 10 of your top partners that you regularly work with on habitat management projects. Here, a partner is defined as an organization that you receive support from in order to further your organization's habitat work. This support can be in the form of volunteers, funding, shared equipment or knowledge/expertise. The list of organizations have been broken down into 6 different types. A brief description/example of the types are below:

Conservation Districts: A local government entity that carries out natural resource management programs. In Michigan they are developed at the county levels.

Sportsmen's Clubs/Co-Ops: These are local organizations or collectives of individuals who have a passion for hunting, fishing and/or wildlife conservation. Example- Hiawatha Sportsman's Club, Tower Road Area QDM Cooperative, Canada Creek Ranch.

Non-Profit Organizations: An organization dedicated to conserving natural resources and/or wildlife habitat; most having official non-profit status. Example: Ducks Unlimited, Great Lakes Commission, Chippewa Nature Center.

Federal/State Agencies: A recognized government entity that operates at a federal or state level.

For-Profit Organizations: A company that conducts conservation activities for a profit, sometimes in a consulting role. Example: Green Timber Consulting, Upper Michigan Land Management and Wildlife Services, Boyne Outfitters.

Miscellaneous: This grouping includes tribes, universities, and allows for entry of other organizations not mentioned in the above categories, such as local municipalities.

Q3Below is the list of organization types, as described above. Please indicate the types of organizations your organization regularly partners with. Check all that apply.
☐ Conservation Districts (1)
☐ Sportsmen's Clubs/Co-Ops (2)
☐ Non-Profit Organizations (3)
☐ Federal/State Agencies (4)
☐ For-Profit Organizations (5)
☐ Miscellaneous (6)
☐ My organization doesn't have any partners. (7)

Q4 Please indicate the Conservation Districts you regularly work with from the list below.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of Conservation Districts

Q5 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations **since** your organization's most recent grant. The last 2 questions are asking to identify support received from organizations **prior**/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q6. Please indicate the sportsmen's clubs/co-ops you regularly work with from the list below. If not

included in the list, you will have the opportunity to add organizations in the following section.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of Sportsmen's clubs/co-ops

Q7 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations since your organization's most recent grant. The last 2 questions are asking to identify support received from organizations prior/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q8 Please indicate the Non-Profit Organizations you regularly work with from the list below. If not included in the list, you will have the opportunity to add organizations in the following section.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of Non-Profit Organizations

Q9 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations since your organization's most recent grant. The last 2 questions are asking to identify support received from organizations prior/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q10 Please indicate the Federal/State Agencies you regularly work with from the list below. If not included in the list, you will have the opportunity to add organizations in the following section.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of Federal/State Agencies

Q11 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations since your organization's most recent grant. The last 2 questions are asking to identify support received from organizations prior/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q12 Please indicate the for-profit organizations you regularly work with from the list below. If not included in the list, you will have the opportunity to add organizations in the following section.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of For-Profit Organizations

Q13 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations since your organization's most recent grant. The last 2 questions are asking to identify support received from organizations prior/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q14 Please indicate the organizations you regularly work with from the list below. If not included in the list, you will have the opportunity to add organizations in the following section.

Select all that apply. To select multiple, hold CTRL while clicking the organizations.
Omitted List of Miscellaneous Organizations

Q15 Please fill out the corresponding columns for each organization indicated, or write in additional organizations.

These questions are asking about your organization's relationships in terms of the most recent grant cycle your organization was involved in. The first 3 questions are asking to identify support received from organizations since your organization's most recent grant. The last 2 questions are asking to identify support received from organizations prior/before your organization's most recent grant.

What type of support have they provided **since** your organization received their most recent grant?	How many projects have you worked on together **since** your organization received their most recent grant?	What is the gender of the main person you contact at this organization?	What type of support have they provided **prior** to your organization receiving their most recent grant?	How many projects have you worked on together **prior** to your organization receiving their most recent grant?
Vol / Fund / S. Equip / Know			Vol / Fund / S. Equip / Know	

Q16 Why did your organization apply for the MI DNR grant?

_____

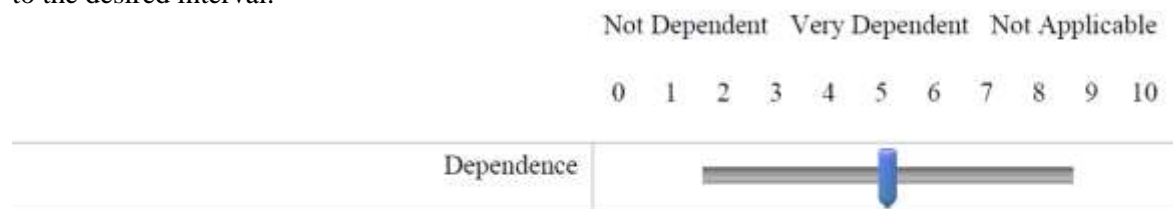Q17 Does your organization partner with the MI DNR for other projects, unrelated to the habitat grants?

○ Yes, please explain what projects. (1)

_____

○ No (2)

Q18 How dependent on grants is your organization for habitat development? Click on the circle and drag to the desired interval.

	Not Dependent	Very Dependent	Not Applicable
	0 1 2 3 4 5 6 7 8 9 10		
Dependence			

Q19 Please indicate on the scale below what percent of your organization's funding comes from the Michigan Department of Natural Resources- Wildlife Division.

		Not Applicable	
	0 10 20 30 40 50 60 70 80 90 100		
Percent of Funding			

Q20 Please indicate the agreement your organization shares with the following statements.

	Strongly Disagree	Strongly Agree	Not Applicable
	0 1 2 3 4 5 6 7 8 9 10		
Enhancing and improving the quality and quantity of game species habitat is important to my organization.			
My organization works to enhance, restore and conserve the State's wildlife resources, natural communities, and ecosystems.			
The work my organization's does is ultimately for the benefit of Michigan's citizens and future generations.			

Q21 Please indicate your agreement with the statements below in regard to whether the Michigan DNR has had an effect on the following aspects of your organization:

	Strongly Disagree					Strongly Agree					Not Applicable
	0	1	2	3	4	5	6	7	8	9	10
... ability to achieve habitat goals.											
... your organization's knowledge of the MI DNR.											
... feeling your organization can rely on the MI DNR as a partner for future projects.											
... your organization's trust in the DNR to make appropriate management decisions.											

Q22 On a scale of 1-10, how likely would you be to recommend the DNR- Wildlife Division as a partner?

	Unlikely					Highly Likely					Not Applicable
	0	1	2	3	4	5	6	7	8	9	10
Likelihood											

Q23 What year did your organization establish?
_____

Q24 How many employees does your organization have?
o 0 (5)
o 1-10 (1)
o 11-30 (2)
o 31-50 (3)
o 50+ (4)

Q25 How many members does your organization have?

o 0 (6)
o 1-100 (1)
o 100-1,000 (2)
o 1,000-5,000 (3)
o 5,000-10,000 (4)
o 10,000+ (5)

Q26 At what scale does your organization work at?
o Local (1)
o Regional (2)
o Statewide (3)
o Multi-state (4)

Q27 After receiving the MI DNR grant(s), did your organization seek out additional resources to help complete the work of the grant?
o Yes (1)
o No (2)

Q28 Of the list below, what type of resources did your organization leverage after receiving the DNR habitat grant and in what amounts?

	Amount
Monetary/Additional Funding ($ amount) (1)	
Volunteers (# of people) (2)	
Shared Equipment (# of times used) (3)	

Q29 Please provide any feedback about your organization's experience with the granting process.
_____
_____

Q30 Please provide any additional comments regarding the Michigan Department of Natural Resources-Wildlife Division's habitat grant programs.
_____
_____

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REFERENCES

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