PRIVATE LAND DEER COOPERATIVES HARVEST AND SATISFACTION ANALYSIS IN SOUTHERN LOWER MICHIGAN

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Fisheries and Wildlife – Master of Science

2013

ABSTRACT

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Private land deer cooperatives are a growing phenomenon in Southern Michigan. In these areas, deer densities are high and focused management on reducing deer numbers is needed. Deer cooperatives consist of landowners managing the deer herd together. Landowners retain the rights to their properties but band together to talk about harvest and habitat management practices. This study evaluates the influence members within a deer cooperative have on individual doe harvest behavior, as well as considers changes in satisfaction among deer cooperatives. Social networking analysis and general satisfaction measurements were used to better understand deer cooperatives in southern Michigan.

ACKNOWLEDGEMENTS

I would like to give a special thanks to my patient, loving, and ever-supportive husband, James Mitterling. I could not have done this without him.

I also want to thank all of the cooperative leaders for their assistance with data collection, providing contact information of members, sending in pictures last minute, and their constant support and encouragement. In particular I would like to thank to Tony Smith, Case DeYoung, Jim Strader, Jake Ehlinger, Doug Weeks, Kirk Nartker, Dave Curtis, and Leo Geller for the personal investment they made in our lives.

The Department of Natural Resources, Wildlife Division, has been a support since day one. Thank you for bringing me into the Wildlife family. Thank you Kelly Siciliano Carter for enlightening me to Human Dimensions; Doug Reeves for being such an encouragement; and Brian Frawley for being accessible and willing to share data.

Thank you to Michigan Chapter of Quality Deer Management Association for their financial contributions and for taking an interest in this project. Thank you Michael Goyne for all of your support and encouragement.

Thank you to my committee who has been with me through some life challenges. I am especially thankful for my advisor, Dr. Daniel Kramer, for giving me the opportunity to work on such a fascinating project. I also want to thank Dr. Shawn Riley and Dr. Kenneth Frank for serving on my committee and taking the time to help me understand the complexities this project presented.

Finally, I thank Dr. Brent Rudolph for all of his contributions. Many times Brent helped keep me sane in the chaos of life, school, and work – I am extremely grateful.

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THESIS INTRODUCTION

In Southern Michigan, deer densities often exceed population goals because food abundance is high, winter conditions are mild, many natural predators have been nearly eliminated, and mortality rates are low aside from hunting and deer/vehicle collisions (Michigan Statewide Deer Management Plan). The capacity of recreational hunting to function as a tool for deer population control is in part restricted by the limited demand that individual hunters have to harvest deer (Brown et al., 2000). Less than half of all Southern Michigan deer hunters are successful, and most successful hunters (64%) harvest only a single deer, with slightly fewer antlerless deer taken relative to antlered deer (Frawley, 2012). Wildlife managers often wish to reduce deer densities to minimize the impacts of abundant deer populations, but this requires harvest of a sufficient number of female deer, often exceeding hunter demand (Brown et al., 2000; Côté et al., 2004; Giles & Findlay, 2004; Lischka et al., 2008). However, anecdotal observations suggest hunters are beginning to join together in private cooperatives in an effort to coordinate deer population and management efforts based on commonly held objectives. These objectives often include harvest practices that may coincide with wildlife managers' objectives to reduce deer densities.

Because of the close proximity of their members, local knowledge, and common purpose, cooperatives should be able to establish effective community based natural resources regimes (Brosius et al., 1998). What makes these groups different than hunt clubs, or even deer camps, is that they consist of private landowners who aid in the management process in their area yet maintain full individual rights to their land as private landowners. While the cooperatives contain property that is "co-managed," the

management goals for cooperatives are designed for the whole group but voluntarily implemented by individuals on their own properties.

Cooperatives are able to pool observations and harvest data to gain collective insight regarding deer at a scale more likely to approach that of a population or subpopulation at a local level, rather than observations regarding individual deer making use of individual properties. By joining, members gain some functional advantages of larger landownership for the group as a whole that will extend efforts to a larger scale than each landowner could otherwise achieve and implement specific management guidelines (Developing Successful QDMA Deer Management Cooperatives brochure).

The problem consists of decreasing hunters while deer densities are high in many areas of Southern Michigan. It seems that deer cooperatives may pose a possible solution as they join together as co-managers of their local deer herds.

THESIS OBJECTIVES

The purpose of this project was to understand the management practices, social networks, and structures of deer cooperatives in Southern Michigan. The main questions included: 1) How do social networks within deer cooperatives influence individual doe harvest behavior via the social interactions, harvest and habitat management information, and with whom they hunt? ; and 2) Why do changes in satisfaction between current satisfaction levels and those prior to joining a cooperative vary between cooperative members? The specific objectives we addressed were to: 1) describe harvest behaviors of deer cooperative members, 2) evaluate cooperative member by use of social network analysis, 3) estimate deer harvest among deer cooperative members, 4) develop statistical models to understand harvest outcomes and hunter satisfaction.

UNDERSTANDING DOE HARVEST BEHAVIORS IN PRIVATE DEER COOPERATIVES USING SOCIAL NETWORK ANALYSIS

Anna M. Mitterling, Daniel B. Kramer, and Kenneth A. Frank[1]

INTRODUCTION

In Southern Michigan, deer densities often exceed population goals because food abundance is high, winter conditions are mild, large predators have been nearly eliminated, and mortality rates are low aside from hunting and deer/vehicle collisions (Michigan Statewide Deer Management Plan). The capacity of recreational hunting to function as a tool for deer population control is in part restricted by the limited demand that individual hunters have to harvest deer (Brown et al., 2000). Less than half of all Southern Michigan deer hunters are successful, and most successful hunters (64%) harvest only a single deer, with slightly fewer antlerless deer taken relative to antlered deer (Frawley, 2012). Wildlife managers often wish to reduce deer densities to minimize the impacts of abundant deer populations, but this requires harvest of a sufficient number of female deer, often exceeding hunter demand (Brown et al., 2000; Côté et al., 2004; Giles & Findlay, 2004; Lischka et al., 2008). However, anecdotal observations suggest hunters are increasingly forming private land deer cooperatives in an effort to coordinate deer population and management efforts based on commonly held objectives. These objectives often include harvest practices that may coincide with wildlife managers' objectives to reduce deer densities.

Deer cooperatives are different than hunt clubs and deer camps in that they consist of private landowners who aid in deer management in their area, yet maintain full

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individual rights to their land as private landowners. While the cooperatives contain property that is "co-managed," the management goals for cooperatives are designed for the whole group but voluntarily implemented by individuals on their own properties.

Because of the close proximity of their members, local knowledge, and common purpose, cooperatives should be able to establish effective community based natural resources regimes (Brosius et al., 1998). Managing their land cooperatively through shared management goals, cooperatives are able to affect the deer population and habitat on a larger scale with greater influence through voluntarily coordinated efforts. Cooperatives are also able to pool observations and harvest data to gain collective insight regarding deer at a population or sub-population scale, rather than observations regarding individual deer making use of individual properties. By joining, members gain some functional advantages of larger landownership for the group as a whole that will extend efforts to a larger scale than each landowner could otherwise achieve and implement specific management guidelines (Developing Successful QDMA Deer Management Cooperatives brochure).

The purpose of this study was to understand the sharing of information and experiences through social networks within deer cooperatives in Southern Michigan and how those interactions influence doe harvest behavior.

Social capital

Social capital consists of the resources accessed through social relations. The flow of those resources is facilitated through common rules, norms, trust, and sanctions, as well as connectedness within a group (Pretty & Smith, 2004). When social capital is present, individuals in the group will think about their behaviors and ramifications of

their decisions (Pretty & Smith, 2004). Specifically, individual behaviors are embedded in a social context. Some behaviors are condoned by the group based on shared norms and values, while others are not. Therefore, before an individual makes a decision, the individual weighs the social ramifications of that decision including possible social sanctions. These sanctions also assure the individual that other members of the group behave similarly, thus avoiding free-riding (Pretty & Smith, 2004). Therefore, social capital, in some circumstances, becomes a key element in the successful management of natural resources by groups.

There is evidence that high levels of social capital in groups tasked with managing natural resources are associated with sustainable natural resource outcomes (Pretty, 2003). Common interest within a group, such as managing a natural resource, reduces conflict and facilitates communication (Crona & Bodin, 2006). With access to social capital, individuals are more willing to invest in commonly held resources knowing others are investing as well (Pretty & Smith, 2004). Social capital empowers groups to create solutions to problems, while engaging individuals to share results and observations, as well as discussing sanctions (Pretty & Ward, 2001). The openness of discussions can increase trust that may increase the likelihood of successful collective action.

Social capital is embodied in networks of relations among individuals (Anheier & Kendall, 2002). As networks are established and connected over time, social capital is established when influence is intentionally sought (Bourdieu, 1979). In the next section, we discuss the importance of measuring social networks to understand the group effects on individuals.

Social networks and the influence of groups on individual behavior

Social networks are important in understanding the relationships between members and the effects those relationships have on individual behavior and attitudes. Social networks provide a framework to understand the structure of a social group including the strength of ties between members of the social group. Ties connecting individuals are understood as any interaction among individuals including knowledge and social exchanges. This combination of ties creates the social network (Appendix A, Figure 2). Social network analysis provides insight into these interactions and is useful in understanding the effects of social groups on individual behavior rather than relying on assumptions about the connection between individual behavior and group influence (Frank, 1998). Using social network analysis also allows for identifying influential actors and patterns of communication within a group.

Social network analysis is increasingly being applied to understand natural resource management problems (Bodin et al., 2006; Prell et al., 2007). Crona and Bodin (2010) applied social network analysis to look at informal power structures, knowledge sharing, and consensus building to see how these interactions affected the possibility of transitioning a community to using collective fishery management. In the village studied, family income was dependent on access to fishing gear, making gear exchange an essential network for fishermen. A gear exchange network was used to explore power relations in the community. Thus, a network analysis was used to identify powerful individuals who could influence the community and promote change.

In a more general approach, Prell et al. (2007) used social network analysis to conclude that many conservation initiatives fail due to lack of attention to characteristics

and relationships of stakeholders. They found that social networks can be used to inform stakeholder analysis. In this project, we evaluated the role that social networks played in influencing individual cooperative members' doe harvest behaviors. Based on network analysis, we also provide some insight into how members function and relate with one another within the cooperatives.

Deer cooperatives & study area description

Deer cooperatives have become increasingly common across the country (Ross, 2013). In Michigan, there are over 50 known deer cooperatives. This study examined 16 cooperatives ranging in membership size from 25 – 300 (preliminary descriptive findings from this study are used to describe cooperatives in this section). Total number of acres landed by cooperative members varied from about 2,000 acres to 9,000 acres with individual ownership ranging from 0 - 1,800 acres (Table 1). The median acreage owned by individual cooperative members was 66 acres. The cooperatives studied have existed for an average of 7 years with an average membership of about 6 years.

Average individual doe harvest was 2.4, while the average number of bucks harvested by an individual was 1.1. Buck to doe ratio of harvested deer within cooperatives was about 1:2 (Figure 1). This compares to the buck to doe ratio of harvested deer in southern Michigan of about 1:1.2 (Frawley, 2012).

To aid in developing and meeting shared management goals, meetings were typically held once or twice a year. Arrangements were often made to have guest speakers at meetings to talk about deer management, habitat management, or data collection. Often, there were prizes and raffles, buck and doe harvest contests, shared consumption of venison, and time set aside to chat with fellow cooperative members.

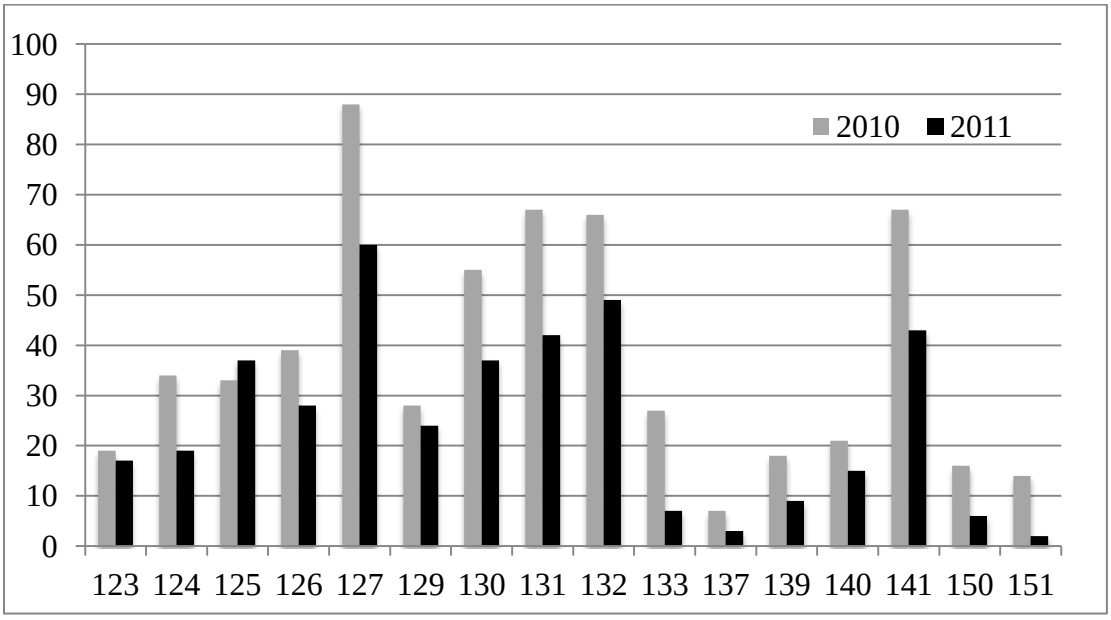
While the structure of these meetings varied significantly, their intent was to support coordination of efforts to improve deer hunting in their area.

Table 1. Descriptive statistics of the cooperatives studied. Table entries include information on the approximate memberships size as defined by the cooperative leader, the number of member respondents (*n*), the year the cooperative started, and approximate cooperative acres. Southern Michigan, USA. 2010-2011.

Co-op	Approx. Membership	*n*	Year Started	Approx. Acres
123	90	19	2008	4,900
124	35	21	2009	5,500
125	90	24	1999	9,134
126	300	18	2005	5,000
127	116	64	2006	8,000
129	50	23	2009	5,000
130	250	37	2005	7,500
131	100	36	2009	9,000
132	50	47	2006	2,500
133	55	23	2004	2,500
137	116	15	1997	7,000
139	72	18	2008	5,000
140	40	11	2008	3,500
141	50	38	2010	4,000
150	25	14	2005	5,000
151	35	6	2009	2,500

The focus of many cooperatives' management efforts and coordination revolved around two basic goals: improving deer habitat and deer herd quality. Managing deer habitat typically entailed implementing various techniques including hinge cutting, food plots, and cover planting. Cooperative members discussed these techniques at meetings or conducted property tours of cooperative members who have initiated such habitat work on their property. Improving the deer herd primarily meant passing young bucks to increase the age structure of the males and harvesting more does in areas of high deer density to decrease the overall population levels.

Figure 1. Doe harvest by deer cooperative in years 2010 and 2011. Southern Michigan, USA.



According to Quality Deer Management Association (QDMA), our study area has the highest deer cooperative densities in the state, and possibly the country. Southern Michigan (deer management unit 486) is known for its high densities of deer and has been a focus area for increasing doe harvest to aid in decreasing the deer population. For the last several years the Michigan Department of Natural Resources (MDNR) has allowed the purchase of 10 antlerless licenses per hunter and liberal overall quotas (Michigan Department of Natural Resources, 2011). The MDNR may also provide landowners with Deer Management Assistant Permits (to take antlerless deer in season) and allowing out-of-season harvest of antlerless deer. As decreasing the deer population is of particular concern in this area, and deer cooperatives are abundant, studying the influence these cooperatives have on individual doe harvest behavior in this setting proved ideal.

METHODS

The selection of cooperatives for participation in the study began by contacting the state office of the Quality Deer Management Association (QDMA), as they were the main organizing force behind many cooperatives in Michigan. The QDMA is a deer hunting organization that many cooperatives consult for information on appropriate goals and objectives for deer management. We also contacted the MDNR to identify other cooperatives. We presented our research plan to several cooperative groups in the area in the summer of 2010. The final list of 16 cooperatives was largely based on leader response and pilot survey response rates.

Two surveys were distributed to cooperative members: one (2010 season survey) in the winter of 2011, and another (2011 season survey) in the winter of 2012. The 2010 survey (i.e. time 1) consisted of 23 questions pertaining to basic demographic information, social networks, harvest data, and harvest standards before joining the cooperative. The 2011 survey (i.e. time 2) consisted of 35 questions. Basic demographic information was requested again along with harvest data, habitat management activities, and current harvest standard.

Questions regarding social networks asked (at time 1) members (i.e. nominators) to identify other cooperative members (i.e. nominees) belonging to four networks: 1) With whom members hunt, 2) With whom members share hunting information, 3) With whom members share habitat management information, and 4) With whom members socialize.

We used three methods to disseminate the surveys. A mail survey was sent out using the member addresses supplied by cooperative leaders. Some of the surveys

contained cover letters from Kip Adams (QDMA Director of Education and Outreach), while others did not based on leaders' assessments of whether inclusion of the letter would improve response rates. Each mailed survey was followed-up by a reminder postcard after about two weeks. We also utilized online surveys for cooperative leaders who had access to their members' email addresses. Finally, we distributed paper surveys at cooperative meetings. Approximately 55% of the data was collected at meetings, 28% were mailed in through the Postal Service, and about 17% of surveys were collected via email (PDF forms) or Survey Monkey.

Assessing survey response rates was difficult as cooperative membership was ill-defined. Based on observations of cooperative meetings and discussion with cooperative leader, our response rate, based on "core" or "active" members was roughly 81% versus 24% for general members. We defined an active or core member as someone who appeared to be actively engaged with the cooperative; they attended meetings and participate in cooperative events. A general member was defined as someone who engaged with the cooperative at least once but not regularly, whether that included attending a meeting, event, or corresponding with a leader regarding harvest, observations, or questions.

Data analysis was done using SAS[2] and KliqueFinder (Frank, 1996 & 1995). KliqueFinder was used to create social network maps using Netdraw. In SAS general linear regression was used for the statistical modeling.

[2] The analysis for this paper was generated using SAS software, Version 9.2 of the SAS System for Windows. Copyright © 2013 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

The influence model for doe harvest

Using information on members' social networks, we modeled how an individual's behaviors were affected by those with whom they interacted (Frank, 2011). Doe harvest behavior was chosen because it is a primary management focus in areas of high deer density. All of the cooperatives in our study (except one) were in areas of high deer densities and expended significant time and energy through discussions and guest speakers at meetings emphasizing the need to increase doe harvest. Our dependent variable (i.e. the measured behavior) was doe harvest at time two.

As stated previously, we asked members about their interactions with other cooperative members in four types of social networks. Of the four networks considered and after including each of the four networks in our models, we determined the social network as most influential. We included the network term as in a standard influence model the interaction hunter *i* reported with *i'* between time one and time two. We then took the average of the others with whom a hunter interacts.

The influence (i.e. exposure) variable was log transformed to ensure normality. The model was then:

$$\text{Doe harvest time } 2_i = \beta_0$$

$$+ \beta_1 \text{ exposure to previous doe harvest of network members}_i$$

$$+ \beta_2 \text{ doe harvest time } 1_i$$

$$+ e_i$$

Other controls in the model included doe harvest at time one (Table 2), education, income, years as cooperative member, and age. Education was represented as five groups

(high school, trade school, some college, college, graduate school) as was income ($0-25,000; $25,000-50,000; $50,000-75,000; $75,000-100,000; above $100,000). Acres owned was included as it serves as a proxy for access to or opportunity for doe harvest. Years of membership may affect harvest behavior because peer influence may be greater on members with more years of members than on newer member. Age was included as observations made at cooperative meetings suggested that older members may be less likely to harvest does, possibly due to their hunting experiences when deer number were low (Table 3).

Table 2. Doe harvest mean, median, minimum, maximum, standard deviation, and sample size (*n*). Southern Michigan, USA. 2010-2011.

Variables	Mean	Median	Min	Max	Std. Error	*n*
Doe Harvest (time one)	1.532	1	0	17	1.839	391
Doe Harvest (time two)	1.140	1	0	12	1.509	349

Table 3. Demographic descriptive statistics of cooperative members. Mean, median, minimum, maximum, standard deviation, and sample size (*n*). Southern Michigan, USA. 2010-2011.

Variables	Mean	Median	Min	Max	Std. Error	*n*
Acres Owned	122.432	65	0	1800	204.611	399
Years Hunt	29.586	30	1	60	13.561	413
Years in Coop	4.794	4	0	35	4.017	403
Age	46.429	47	15	78	13.605	413
Education	3.028	3	1	5	1.307	391
Income	3.508	4	1	5	1.212	372

RESULTS

Influence analysis

The influence of the network (i.e. the mean previous behavior of others in one's social interaction network) on doe harvest by individuals was statistically significant ($t \leq .05$) and positive. The effect size of influence varied by cooperative. Across all cooperatives, a one-unit increase in exposure to others' behaviors was associated with a

0.4 increase in the number of does shot (Table 4). Prior doe harvest behavior was a statistically significant variable (t≤.001). For each increase of one doe harvested at time one, an increase of 0.53 doe was predicted for time two. The number of acres owned was another significant predictor (t≤.05); for every increase of 1,000 acres owned, an approximate increase of one doe (0.80) was expected. Non-significant variables included buck harvest, education, income, years in cooperative, and age.

Table 4. Doe harvest influence model. Deer cooperatives, Southern Michigan, USA. 2010-2011.

Parameters	**Coefficients**	**Std. Error**
Intercept	1.012*	0.392
Influence (exposure)	0.423*	0.182
Doe Harvest (time one)	0.535***	0.036
Education	-0.014	0.059
Income	0.051	0.063
Acres Owned	0.001*	0.000
Years in Coop	-0.009	0.028
Age	0.005	0.005

(* t ≤ .05, ** t ≤ .01, *** t ≤ .001)

The mean doe harvest varied among the cooperatives (Table 5), adjusting for the other terms in the model. Cooperative 125 showed the largest mean doe harvest (1.85) while cooperative 137 had the lowest (0.21). Cooperative 137 might be considered an outlier, because they are located farther north than the other cooperatives where habitat supports lower deer densities.

We looked at network influence at the cooperative level (Table 6). Since influence was a significant variable (t ≤.05, we were able to use it as an interactive variable, cooperative-by-cooperative. When comparing cooperative 125 and 137, we see that the network influence effect is .7 stronger in 137 than in 125. Also note that while cooperative 137 had the lowest mean doe harvest, their social networks were most

influential. Positive coefficients indicate that behavior is being reciprocated through influence. For example, if the members nominated by the individual harvested many deer in 2010, and the individual harvested many deer in 2011, the influence would be positive; likewise if the nominated individuals harvested few deer in 2010, and the individual harvested few deer in 2011. Negative coefficients indicate that the opposite behavior occurred than the behavior of the nominators. For example, if the members nominated by the individual harvested many deer in 2010, and the individual harvested few deer in 2011, the influence would be negative.

Table 5. Mean doe harvest among the cooperatives. Southern Michigan, USA. 2011.

Cooperative	***n***	**Mean**	**Std. Error**	**Min**	**Max**
123	14	1.214	1.311	0	4
124	18	1.056	1.162	0	4
125	20	1.850	1.694	0	5
126	17	1.647	2.849	0	12
127	53	1.132	1.225	0	6
129	21	1.143	1.352	0	5
130	23	1.609	2.190	0	8
131	32	1.313	1.378	0	4
132	43	1.186	1.500	0	6
133	19	0.368	0.684	0	2
137	14	0.214	0.579	0	2
139	14	0.643	0.842	0	2
140	10	1.500	1.780	0	6
141	35	1.229	1.457	0	5
150	10	0.600	0.843	0	2

Table 6. Influence at the cooperative level. The coefficients are centered around the cooperative with the median value of influence. The positive and negative values are relative to the median cooperative. Corrected coefficients are based on the actual influence values given that cooperative 139 is .423. Deer cooperatives, Southern Michigan, USA. 2010-2011.

Parameters	Coefficients	Corrected Coefficients	Std. Error
Influence*CoopID 123	0.208	0.631	0.583
Influence*CoopID 124	-0.353	0.07	0.445
Influence*CoopID 125	0.722	1.145	0.522
Influence*CoopID 126	0.259	0.682	0.472
Influence*CoopID 127	0.089	0.512	0.361
Influence*CoopID 129	-0.52	-0.097	0.539
Influence*CoopID 130	-0.159	0.264	0.266
Influence*CoopID 131	-0.315	0.108	0.292
Influence*CoopID 132	-0.284	0.139	0.338
Influence*CoopID 133	-0.704	-0.281	0.994
Influence*CoopID 137	1.372	1.795	1.382
Influence*CoopID 139	0	0.423	.
Influence*CoopID 140	0.138	0.561	0.551
Influence*CoopID 141	-0.012	0.411	0.212
Influence*CoopID 150	-0.546	-0.123	1.475

DISCUSSION

The doe harvest influence model showed that an individual's social interaction network affects their harvest behavior. If one's peers are more (or less) likely to harvest does, so is the individual, and if one's peers were less likely to harvest does then one decreased doe harvest.

Looking at doe harvest at the cooperative level, we saw large differences. As noted above, cooperatives 125 and 133 had the highest and second lowest mean doe harvests respectively. A likely explanation for the difference in mean doe harvest between these two cooperatives is the difference in acreage between the two groups, despite similar membership size. Cooperative 125 has 9,134 acres while cooperative 133 has 2,500. With increased acreage come greater opportunities to harvest more does.

The influence of social networks on individual behavior also varied among cooperatives. Comparing cooperatives 125, 133 and 137, cooperative 137 showed the greatest influence effect (1.4) of all the groups. While they didn't harvest many deer (10 does over two years of those surveyed, n = 14), it was apparent that the behavior of the nominees had influence on the harvest behaviors of the nominators. We expected grouping within the cooperative because of the high levels of influence. It is illustrated by increased homogeneity, or similarity in harvest behavior, among subgroups within the cooperative. This means that cooperative members are influenced by those with whom they interact within their subgroups.

Cooperative is the oldest of those being studied, having been organized for 35 years. Many of the members surveyed have been members for 30 plus years. Cooperative 137's social network (Appendix A, Figure 3) illustrates 21% connectivity (i.e. the percentage of connections made out of all possible connections) among individuals; arrows express directionality of which individual nominated who. While there is some grouping, we see that 1187, 1181 and 1185 bridge the subgroups together. Actors 1187 and 1181 are cooperative leaders.

Cooperative 125 showed modest levels of influence (0.70). The doe harvest over two years was 33 in 2010 and 37 in 2011 (of those surveyed, n = 21). The network for cooperative 125 (Appendix A, Figure 4) illustrates subgrouping within the cooperative, and connectivity of 12%, roughly half that of cooperative 137 and 133. Rather than each individual being connected to each other, there are three distinct and separate groups. Again, separation into subgroups is consistent with high influence occurring within the social interaction networks inside the cooperative. This is because subgroups, or social

interaction networks, within the cooperative are influencing individual behaviors. We do not see any actors who bridge the subgroups. The cooperative leader is 1557 and he receives the greatest number of social interaction nominations within this cooperative.

Finally, cooperative 133 displayed the lowest levels of influence (-0.70). Negative influence is illustrated (Appendix A, Figure 5) by the connections made between the two subgroups (red and blue). Instead of individuals within the subgroups influencing each other, (as in cooperative 137 and 125), we see here that the red subgroup influenced the harvest behavior of the blue subgroup. The doe harvest over two years was 27 in 2010, and 7 in 2011 (of those surveyed, n = 20). The red subgroup's average change in harvest between 2010 (15 does) and 2011 (2 does) was almost zero (-.20), while the average change in harvest for the blue subgroup (3 does in 2010 and 2 does in 2011) was close to -1 (-1.11). This indicates that members were not influenced by their social interaction networks, but the doe harvest of the blue subgroup did change in 2011 compared to 2010 because of influence of the red subgroup. Perhaps a cooperative level standard is developing and bridging these two groups.

The blue subgroup consists of older (avg. age 55 years) who farmed together for many years. The red subgroup is made up of younger (avg. age 38 years) men who seem to be initiation the change in doe harvest, and influencing the group of older men. The main actors, also cooperative leaders, in this network are 1058 and 1339. Individual 1302, although not in a leadership role, is the social hub of the group. All of the social gatherings are at his home. Their network connectivity is 23%, slightly higher than cooperative 137. While this cooperative is only 3 years younger than 125, the history of the members hunting together, talking about deer, playing poker, and farming goes back

many years. The cooperative leader (1339), part of the younger red subgroup, may have a role in developing this change and bringing together the two groups in to a new cooperative level doe harvest behavior.

CONCLUSION

Through implementation of traditional management approaches, wildlife managers have effectively applied harvest regulations to restrict harvest of deer, but struggle to effectively promote adequate harvest of antlerless deer to achieve control of impacts caused by abundant populations (Brown et al., 2000; Cote et al., 2004; Giles & Findlay, 2004). If antlerless harvest is increased by the formation and function of private land deer management cooperatives, wildlife managers may be able to promote the formation of cooperatives and encourage them to operate in ways associated with achieving harvest outcomes relevant to management objectives.

GREATER HUNTING SATISFACTION: A RESULT OF DEER COOPERATIVE PARTICIPATION?

Anna M. Mitterling, Daniel B. Kramer, Shawn J. Riley[3], and Brent A. Rudolph[4]

INTRODUCTION

State wildlife agencies depend substantially on revenue from hunters to fund wildlife conservation and management programs. This revenue currently is diminishing because of declining hunting participation (Wright et al., 2001; Jacobson & Decker, 2006). Hunter satisfaction is one attribute thought to motivate hunting participation (Decker & Connelly, 1989). Therefore, state agencies have a vested interest in improving hunter satisfaction to hopes to increase motivations to hunt.

There are many ways to measure hunting success. Initially "game bagged" was used as an indication of success. It became apparent that simply bagging game was not the only factor affecting hunter success when viewed from the perspective of the hunter (Hendee, 1974). "Days afield" became an updated metric of success. Although a viable measurement, it assumes that the benefits are consistent per hunter, per day, regardless of success or quality the days presented (Hendee, 1974).

Although satisfaction is a motivation for participation, other specific indicators may be used to gauge the benefits or successes of hunting that motivate hunters to go afield. Potter et al. (1973) stated that more important than harvest or days afield are the "many associated experiences and satisfactions." At least for a short time period, the "appeals of quality big game hunting" are independent of a "particular record of success"

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(Stankey et al., 1973). Realizing that satisfaction is an important aspect to hunting, a multiple satisfactions approach to explain motivations for hunting participation has been well developed (Hendee, 1974; Vaske et al., 1986; Decker et al., 1980; Hazel et al., 1990; Hammitt et al., 1990; Woods et al., 1996). The determinants of hunter satisfaction include nature, skill, companionship, community, knowledge, harvest success, and game observed (Potter et al., 1973; Kennedy, 1974; Hazel et al., 1990; Woods et al., 1996).

Community, collective management & satisfaction

Community is typically associated with a sense of belonging (Bradshaw, 2008) and solidarity or a common identity and set of shared norms (Bhattcharyya, 2004). Collective management within communities can build trust and encourage the development of shared norms (Pretty & Smith, 2004), which are important components of fit within a group or community. Fit is defined as compatibility between members, and can lead to positive outcomes for individuals (Jansen & Kristof-Brown, 2006) and for the group. Fit can also be predictive of commitment to the group (Jansen & Kristof-Brown, 2006).

In fields such as organizational behavior, management psychology, and marketing, researchers have found a positive statistical relationship between group fit and individual satisfaction levels (Carlson, 1969; Bohlmann et al., 2006; Wheeler et al., 2007). The more the individual and the group share similar values, the greater the satisfaction of the individual (Kristof, 1996).

Individual satisfaction levels can be influenced by opinions of members within a group. A study by Bohlmann et al. (2006) looked at the effects of the opinions of others in a group had on individual members' satisfaction. They found that how the individual

identifies with group norms was not based on the reality of other group members' opinions, but how the expressed values of other group members align with the individuals' expectations (Bohlmann et al., 2006). Similarly, Kennedy (1974) found that being part of a hunting party influences information, expectations, perceptions, and reactions. These influences had an impact on how the hunting experience was evaluated by the individual. These findings suggest individual satisfaction with a given experience is influenced by the group of which the individual is a part.

Satisfaction within deer cooperatives

Hunter satisfaction has been researched within quality deer management properties. Woods et al. (1996) studied quality deer management hunting areas and considered six determinants of a satisfying hunting experience. The satisfaction determinants in the quality deer management areas included: buck sign and sightings, deer herd quality, the hunters' knowledge, management involvement, hunter conduct of other hunters participating within the quality deer management area, and perceived image to non-hunters. Of these factors, the conduct of other hunters had the strongest relationship to individual satisfaction with deer herd quality and knowledge also being important (Woods et al., 1996). Thus we included some of these factors in our study, as they may also be of concern to members of Michigan deer cooperatives, many of which practice quality deer management.

Being a part of decision making and understanding personal roles within a group are also important factors in determining cooperative member satisfaction. Enck et al. (2001) collected baseline attitudinal and behavioral data on 36 private landowners in New York whose properties established a 12,000 acre deer cooperative in order to evaluate the

cooperative's harvest strategy designed to balance concerns of landowners and hunters regarding deer-related impacts. They found that landowners and hunters joined a cooperative based on assumptions about how well collective management worked and whether individual harvest standards could be changed by better information or through the influence of peers.

Objectives

The main question this study addressed was: Why do changes in satisfaction between current satisfaction levels and those prior to joining a cooperative vary among cooperative members? The specific objective we addressed includes: describe satisfaction and fit levels of deer cooperative members.

METHODS

Relying on the insights from previous work (Woods et al., 1996; Kennedy, 1974; Enck et al., 2001; Hazel et al., 1990; Hammitt et al., 1990; Decker et al., 1980), we assessed changing satisfaction levels of current cooperative members based on agreement among cooperative members on buck harvest goals, fit within the cooperative, years hunting experience, age, acres owned, income, years in cooperative, and the extent of their hunting information network.

Study area

In Southern Michigan there has been an increase in numbers of deer cooperatives since about 2006. Deer cooperatives commonly consist of private land that is managed cooperatively by a group of individuals. While the group makes management decisions, the landowners retain legal rights over their individual properties. Cooperatives are becoming increasingly common across the country (Ross, 2013).

By joining a cooperative, members gain the advantages of a larger land-base within which to coordinate management and harvest strategies based on group objectives (Developing Successful QDMA Deer Management Cooperatives brochure). The guidelines vary somewhat based on location, deer densities, and habitat types and variously address antler points, deer age, and doe management needs. To aid in developing and meeting shared management goals, meetings are typically held once or twice a year. Arrangements often are made to have guest speakers at meetings to talk about deer management, habitat management, or data collection. Often, there are prizes and raffles, buck and doe harvest contests, shared consumption of venison, and time set aside to chat with fellow cooperative members. While the structure of meetings varies among cooperatives, their intent supports coordination of efforts to improve deer hunting in their area. According to Quality Deer Management Association (QDMA), there are over 50 known deer cooperatives in Michigan. This study surveyed 16 deer cooperatives.

Sampling and data collection

The selection of cooperatives for participation in the study began by contacting the state office of QDMA, as they were the main organizing force behind deer hunting cooperatives in Michigan. QDMA is a deer hunting organization that many cooperatives look to for information on appropriate goals and objectives. We also contacted the Michigan Department of Natural Resources (MDNR) to identify other cooperatives. We presented our research plan to several cooperative groups in the area in the summer of 2010. The final list of 16 cooperatives was largely based on leader response and pilot survey response rates.

Two surveys were distributed to cooperative members: one in 2010 and another in 2011. The 2010 survey (i.e. time 1) consisted of 23 questions pertaining to basic demographic information, social networks, harvest data, and harvest standards before joining the cooperative. The 2011 survey (i.e. time 2) consisted of 35 questions. Basic demographic information was requested again along with harvest data, descriptions of habitat management activities, and current harvest standard (i.e. number of antler points, age of buck, antler score, etc.). Likert scales were used to measure satisfaction and levels of fit (scale of 1-5, 5 being greatest).

The satisfaction questions were structured as: 1) *How satisfied are you with your overall hunting experience in your cooperative?* 2) *How satisfied were you with your hunting experience* ***before*** *you joined your cooperative?* The five point Likert scale was defined on the scale of very important to not important. This question was compared to MDNR's Deer Harvest Survey Report, and was structured as: *How satisfied were you with your overall hunting experience?* The five point Likert scale used by Frawley (2012) was defined as very satisfied to strongly dissatisfied. Due to the differences with how the scales were defined, when comparing the two results, they were grouped as "satisfied" if survey participants selected the two highest satisfaction options.

We used three methods to disseminate the surveys. A mail survey was sent out using the member addresses supplied by cooperative leaders. Some of the surveys contained cover letters from Kip Adams (QDMA Director of Education and Outreach), while others did not based on leaders' assessments of whether inclusion of the letter would improve response rates. Each mailed survey was followed-up by a reminder postcard after about two weeks. We also used online surveys for cooperative leaders who

had access to their members' email addresses. Finally, we distributed paper surveys at cooperative meetings. Approximately 55% of the data was collected at meetings, 28% were mailed in through the Postal Service, and about 17% of surveys were collected via email (PDF forms) or Survey Monkey. Each survey method indicated not to fill out additional surveys if previously filled out. Response duplication was not found to be an issue.

Overall response rates were calculated in two ways. The first one took the total number members indicated by the cooperative leaders and used it to define the population. Total cooperative membership response rate was 24%. Secondly, we also calculated a response rate based on "core" membership. Cooperative leaders indicated how many members they felt were consistently at cooperative meetings. This total number was used to define response rates as well given that these members are more engaged with the cooperative and were sampled at a greater level than the population as a whole. The response rate of core members was 81%.

Model description

The satisfaction model is as follows:

$$\Delta sat = intercept + ba_i + hi_i + m_i + a_i + yr_i + \mu\,(bh_{i(t-1)} + bh_{i(t)}) + i_i + f_i$$

The dependent variable (Δsat) is the change in satisfaction from prior to joining a cooperative to current levels. This variable was entered using a five point Likert scale, however it was coded as a binary attribute for analysis: the two categories included change in satisfaction and no change to a negative change in satisfaction. The independent variable, ba_i, is based on a survey question asking members how strongly

they agree (five point Likert scale) that members of their cooperative pass young bucks, a common cooperative goal.

The independent variable (hi_i) refers to the number of members in the cooperative with whom the respondent regularly sought deer hunting information. This variable was chosen to capture the importance of information flow and camaraderie. Other variables included years as cooperative member (m_i), acres owned (a_i), years as a hunter (yr_i), average number of bucks harvested ($bh_{i(t-1)}$+$bh_{i(t)}$, between time one and time two), and income (i_i).

Fit (f_i) is a proxy for how members believe they "fit" with their cooperative. Respondents were asked the extent of their agreement with the following five statements: 1) *I fit in well with my cooperative; 2) My cooperative has affected the way I see myself as a hunter; 3) My options on deer management matter to other members of my cooperative*; 4) *Other members of my cooperative have interests similar to mine;* and *5) Other members of my cooperative have values similar to mine*. The mean of these responses was used to calculate fit.

Data analysis was done using SAS[5]. Logistic regression was used for the modeling. Both categorical and continuous data were used. The convergence criterion was satisfied for this method. Analysis of maximum likelihood estimates and odds ratios were used for interpretation.

[5] The analysis for this paper was generated using SAS software, Version 9.2 of the SAS System for Windows. Copyright © 2013 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

RESULTS

Assessing survey response rates was difficult because cooperative membership was ill-defined. Based on observations of cooperative meetings and discussion with cooperative leaders, our response rate, based on "core" or "active" members was 81% versus 24% for "general" members. We defined an active or core member as someone who appears to be actively engaged with the cooperative; they attend meetings and participate in cooperative events. A general member is someone who engaged with the cooperative at least once, whether that be attending a meeting, event, or corresponding with a leader regarding harvest, observations, or questions.

Our study cooperatives ranged in membership size from 25 to 300 members. Acreage ranged from 2,000 to 9,000 acres. Individual ownership ranged from 0 - 1,800 acres (median = 66 acres). The cooperatives have existed for an average of 6.9 years (3 - 35 years) with an average membership of 6 years (Range 0 - 35 years) (Table 7).

Average individual doe harvest was 2.4 deer, while the average number of bucks harvested by an individual was 1.07 deer. Buck to doe ratio of harvested deer within cooperatives was about 1:2. Cooperative level fit measures ranged from 3.3 to 4.5. Overall satisfaction averaged 4.36 (standard deviation .85). The average change in satisfaction from before joining cooperative to after joining the cooperative was an increase in satisfaction of .73 (Table 8).

The MDNR estimated that approximately 46% of Michigan deer hunters responding to the 2011 Deer Harvest Survey were satisfied with their overall deer hunting experience in 2011 (Frawley, 2012). Our study indicated 44% of hunters retrospectively indicated they were satisfied with their overall hunting experience prior to

joining a cooperative. Hunters in our study indicated that their current hunting satisfaction within their cooperative increased to 75%. This change raised questions regarding factors to which the increased satisfaction could be attributed, especially considering the similarity of satisfaction among cooperative members prior to joining a cooperative to estimated overall satisfaction levels of hunters in southern Lower Michigan. However, we understand we cannot draw many comparisons between state satisfaction and cooperative satisfaction because we do not have data on the hunters prior to joining the cooperative. As a result, we sought to understand why satisfaction increased within cooperatives.

Table 7. Descriptive statistics of the cooperatives studied. Table entries include information on the approximate membership size as defined by the cooperative leader, the number of members sampled (*n*), the year the cooperative started, and approximate cooperative acres. Southern Michigan, USA. 2010-2011.

Co-op	Approx. Membership	*n*	Year Started	Approx. Acres
123	90	19	2008	4,900
124	35	21	2009	5,500
125	90	24	1999	9,134
126	300	18	2005	5,000
127	116	64	2006	8,000
129	50	23	2009	5,000
130	250	37	2005	7,500
131	100	36	2009	9,000
132	50	47	2006	2,500
133	55	23	2004	2,500
137	116	15	1997	7,000
139	72	18	2008	5,000
140	40	11	2008	3,500
141	50	38	2010	4,000
150	25	14	2005	5,000
151	35	6	2009	2,500

Table 8. The average fit and satisfaction levels of cooperative members by cooperative on a scale of 1 (high) to 5 (low). Southern Michigan, USA. 2010-2011.

Co-op	Average Fit	Overall Satisfaction	Satisfaction Before	Satisfaction After
123	3.9 (0.689)	4.3 (0.704)	3 (0.845)	4.4 (0.737)
124	3.9 (0.838)	4.3 (0.767)	3.5 (1.150)	4.4 (0.702)
125	4.5 (0.508)	4.5 (0.738)	3.2 (1.220)	4.5 (0.740)
126	4.4 (0.516)	4.5 (0.632)	3.6 (1.064)	4.5 (0.624)
127	4.3 (0.832)	4.5 (0.918)	3.4 (1.036)	4.3 (1.017)
129	3.7 (0.764)	4 (0.767)	3.5 (0.759)	3.9 (0.809)
130	4.3 (0.681)	4.6 (0.662)	3.8 (1.053)	4.6 (0.662)
131	4.1 (0.852)	4.3 (0.999)	3.4 (0.871)	4.2 (1.023)
132	4 (0.843)	4.4 (0.791)	3.6 (0.914)	4.2 (0.989)
133	4 (0.775)	4.1 (0.963)	3.3 (0.749)	4.3 (0.749)
137	4 (1.009)	4.4 (0.842)	3.2 (0.699)	4.2 (0.975)
139	3.3 (0.990)	3.4 (0.938)	3.2 (0.975)	3.1 (0.997)
140	4.3 (0.755)	4.5 (0.707)	2.9 (1.524)	3.8 (1.317)
141	4.4 (0.692)	4.9 (0.284)	3.9 (0.938)	4.8 (0.453)
150	3.9 (0.622)	3.8 (0.919)	3.8 (1.135)	3.9 (0.928)
151	3.6 (0.388)	3.5 (0.837)	3.5 (1.643)	3.3 (0.816)

Standard errors are in parenthesis.

We assessed changing satisfaction levels (Table 9) of current cooperative members based on agreement among cooperative members on buck harvest goals, fit within the cooperative, years hunting experience, age, acres owned, income, years in cooperative, and the extent of their hunting information network (Table 10). The analysis of maximum likelihood estimates of buck harvest agreement within the cooperative, hunt information networks, average number of bucks harvested, years in cooperative, number of acres owned, years hunting, income, and fit on change in satisfaction levels were used in our model (Table 11). Years in cooperative (chi-square ≤ 0.05) and fit (chi-square ≤ 0.001) were positively significant variables. This indicates that the more years in a cooperative and the greater the feeling of fit within the group, both played a role in increasing satisfaction.

Table 9. Results from questions regarding satisfaction levels of cooperative members. Southern Michigan, USA. 2010-2011.

Variable	Mean	Median	Min	Max	Std Err	*n*
Overall Satisfaction	4.359	5	1	5	0.845	345
Satisfaction Before	3.474	3	1	5	1.014	348
Satisfaction After	4.271	5	1	5	0.926	347
Harvest Satisfaction	4.093	4	1	5	1.044	343
Habitat Satisfaction	4.018	4	1	5	0.992	342
Knowledge Satisfaction	4.333	5	1	5	0.864	348

Table 10. Descriptive Statistics for value and agreement questions of cooperative members. Southern Michigan, USA. 2010-2011.

Variable	Mean	Median	Min	Max	Std Err	*n*
Importance of Deer Hunting	4.793	5	2	5	0.545	348
Habitat Agreement	3.907	4	1	5	1.019	345
Harvest Agreement	3.965	4	1	5	0.999	345
Doe Harvest Agreement	4.314	5	1	5	0.881	344
Buck Harvest Agreement	4.319	5	1	5	0.831	348
Fit	4.107	4.2	1.6	5	0.801	348

Since years in cooperative and fit were statistically significant and positively associated with changes in satisfaction, we will look at them in closer detail using the odds ratio estimates (Table 12). When years in cooperative increases, the odds of a positive change in satisfaction versus no or negative changes is satisfaction are 1.14 times greater; given all other variable remain constant. When fit increases, the odds of a positive change in satisfaction versus no or negative changes in satisfaction are 2.90 times greater, given that all the other variables in the model are held constant. When average buck harvest increases, and buck harvest agreement is 4 or greater, change in satisfaction increases. The hunting information network, acres own, years hunt and income cause satisfaction to decrease as they increase.

Table 11. Satisfaction model analysis of maximum likelihood estimates. Buck harvest agreement refers to the level of agreement members feel there is within the cooperative regarding passing young bucks. Hunt info network considers the number of people members talk to within their cooperative. Average buck harvest looks at the average number of bucks harvested over 2010 and 2011. Years in cooperative, acres owned, years hunt, and income are measurements considered in this model, as well as how well members feel the fit within the group. Southern Michigan, USA. 2010-2011.

Parameters	Group	Estimate	Std Err
Intercept		-4.386	1.167
Buck Harvest Agreement	3	-0.318	0.456
Buck Harvest Agreement	4	0.192	0.365
Hunt Info Network		0.115	0.129
Avg. Buck Harvest	0	0.450	1.058
Avg. Buck Harvest	0.5	0.568	1.054
Avg. Buck Harvest	1	0.778	1.054
Avg. Buck Harvest	1.5	1.053	1.054
Years in Cooperative		0.133*	0.067
Acres Owned		-0.001	0.001
Years Hunt		-0.009	0.024
Income		-0.151	0.133
Fit		1.065***	0.254

(*chi-square ≤ 0.05, ** chi-square ≤ 0.01, ***chi-square ≤ 0.001)

Table 12. Satisfaction model odds ratio estimates for deer cooperative in Southern Michigan, USA. 2010-2011.

Effect	Point Estimate	95% Wald Confidence Limits	
Buck Agreement 3 vs 5	0.728	0.298	1.778
Buck Agreement 4 vs 5	1.212	0.592	2.481
Hunt Info Network	1.122	0.872	1.443
Avg. Bucks Harvest 0 vs 2	1.569	0.197	12.473
Avg. Bucks Harvest 0.5 vs 2	1.764	0.223	13.926
Avg. Bucks Harvest 1 vs 2	2.176	0.276	17.190
Avg. Bucks Harvest 1.5 vs 2	2.866	0.310	26.509
Years in Cooperative	1.142	1.003	1.301
Acres Owned	0.999	0.997	1.001
Years Hunt	0.990	0.966	1.014
Income	0.860	0.663	1.115
Fit	2.902	1.765	4.771

DISCUSSION

This study is the first of its kind to address satisfaction levels within deer cooperatives. Our results showed agreements with Potter et al. (1973), Kennedy (1974), Hazel et al. (1990), and Woods et al. (1996) in regards to hunter satisfaction determinants such as harvest success. While buck harvest was positively related to increased satisfaction, it was insignificant in our model. We found that the factor related to the greatest increase in satisfaction among southern Michigan deer cooperative members was levels of fit. This finding substantiates Kennedy (1974) in that sense of community is an important determinant of hunter satisfaction, but our research also suggests that in addition to being part of community, fitting in with the community may be what increases satisfaction.

Increased satisfaction could also be related to the involvement that cooperative members have in management decisions and harvest goals. Woods et al. (1996) indicated that because of the role hunter in his study had with managing the herd, they were more likely to have reasonable expectations for harvest success than hunters who were not directly involved with management.

The increase in satisfaction was less among those who were members for five years or more. It is possible this is because those members may not have as clear of memory to their satisfaction level prior to joining. It seems that memory recall will decline over time (Tourangeau et. al, 2000). It also may be that although respondent satisfaction changed, the newness of the cooperative experience is over and not as exciting as it was at the beginning. It may be that the goals of the younger hunters are different than those of the older hunters. While it is possible that increased satisfaction is

an instant reaction to joining a cooperative, it seems unlikely due to relative consistent increases in satisfaction across cooperatives regardless of how long they have been a formal group. However, if expectations are not met, satisfaction will most likely drop off quickly.

Revenue towards wildlife management is decreasing along with the decline of hunting participation (Wright et al., 2001; Jacobson & Decker, 2006). Agencies may be able to address this trend in declining participation by taking steps to increase hunter satisfaction, but most determinants of satisfaction are beyond the direct control of wildlife managers (Woods et al., 1996). Hunter satisfaction is greater among deer cooperative hunters in our study than that of hunters in Southern Michigan in general. Increases in satisfaction among cooperative members are related to how well members feel they fit in with the group, and how long they have been members.

However, fit and years of membership are just two areas identified in this study. More research needs to be done to determine additional significant variables related to the increase in satisfaction as a result of cooperative membership. It is evident that a wide variety of satisfactions are derived from hunting experiences and those satisfactions are direct products of game management (Potter et al., 1973). Efforts to promote formation and successful operation of deer management cooperatives may provide a way for agencies to replicate the improvement to hunter satisfaction documented in this study.

Beyond hunter satisfaction within deer cooperatives, wildlife managers may note a management improvement that stems from these deer cooperatives. The buck to doe ratio of harvested deer in southern Michigan was about 1:1.2 (Frawley, 2012). In deer cooperatives, however, doe harvest is twice as great (1:2.2). It may prove fruitful for

local agency personnel to seek out cooperative leaders and request attending a meeting. A healthy relationship of information sharing from both parties may aid in improved population management as well as increased hunter satisfaction levels.

MANAGEMENT IMPLICATIONS

As wildlife managers build connections to deer cooperatives, they can make use of established networks to distribute information regarding management priorities and advisable management practices. Wildlife managers also have an opportunity to improve hunter satisfaction and potentially hunter recruitment and retention by assisting cooperative leaders in the formation and successful operation of deer cooperatives. Finally, in areas of high deer densities, cooperatives also included a greater proportion of does within their deer harvest in comparison to elsewhere in Michigan, and may more effectively contribute to deer population reduction.

Cooperative leaders are relied upon by multiple members as resources for insight on deer management. In addition to focusing effort on providing reliable information regarding habitat and harvest strategies, cooperative leaders should create opportunities to connect members with each other as they facilitate and organize distribution of information within their groups. Higher fit levels within a group are positively associated with satisfaction. Leaders may increase satisfaction among the group by creating avenues for members to get to know each other and implementing ways for connectivity to be built.

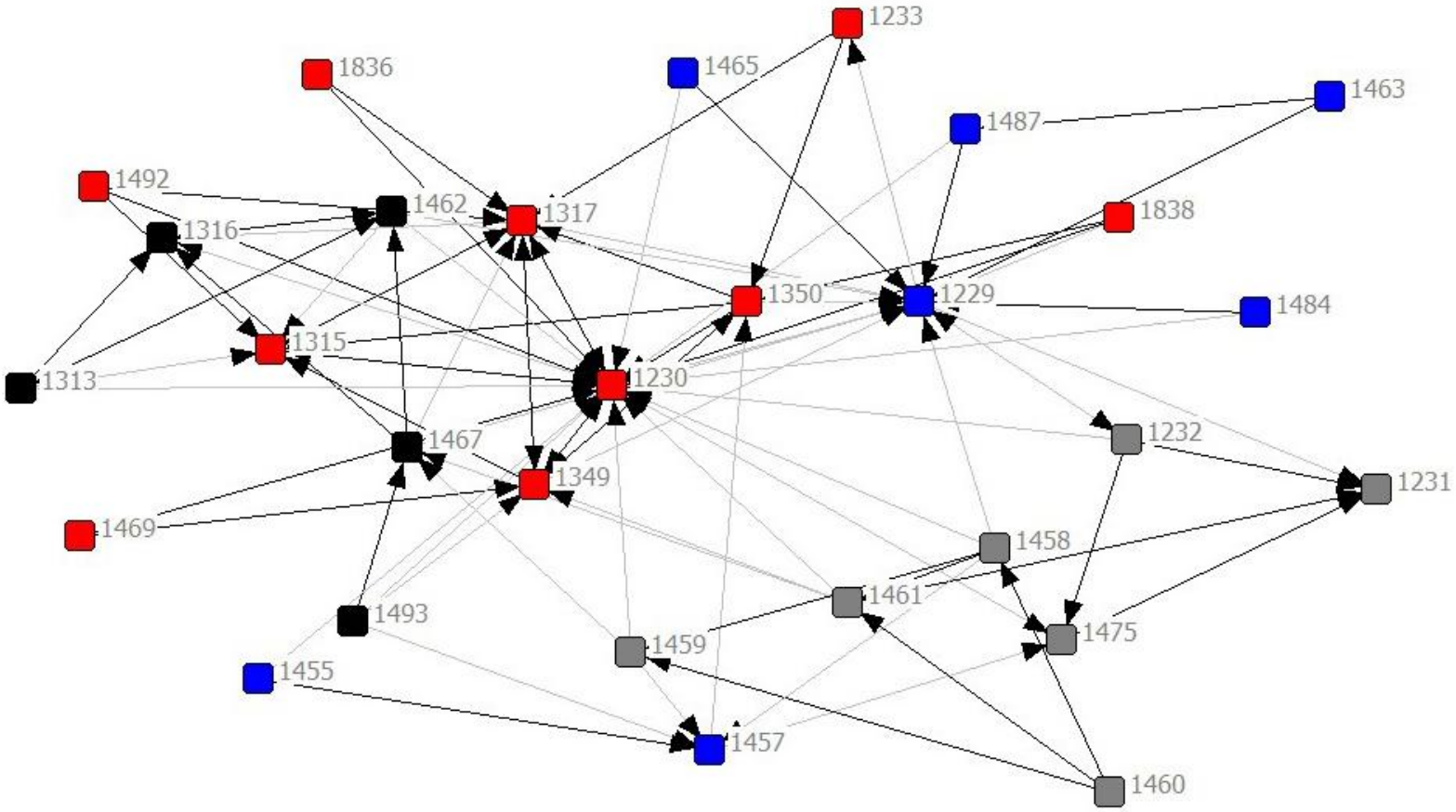
Cooperation between cooperatives and wildlife managers poses a strong possibility of mutual benefit. In times of disease outbreaks, or other wildlife circumstances, cooperatives can provide local information to wildlife managers, while in

return, wildlife managers can provide scientific information about the disease as well as a wide scale effect the disease outbreak is having on the deer population. The key here is mutual sharing of information.

APPENDICES

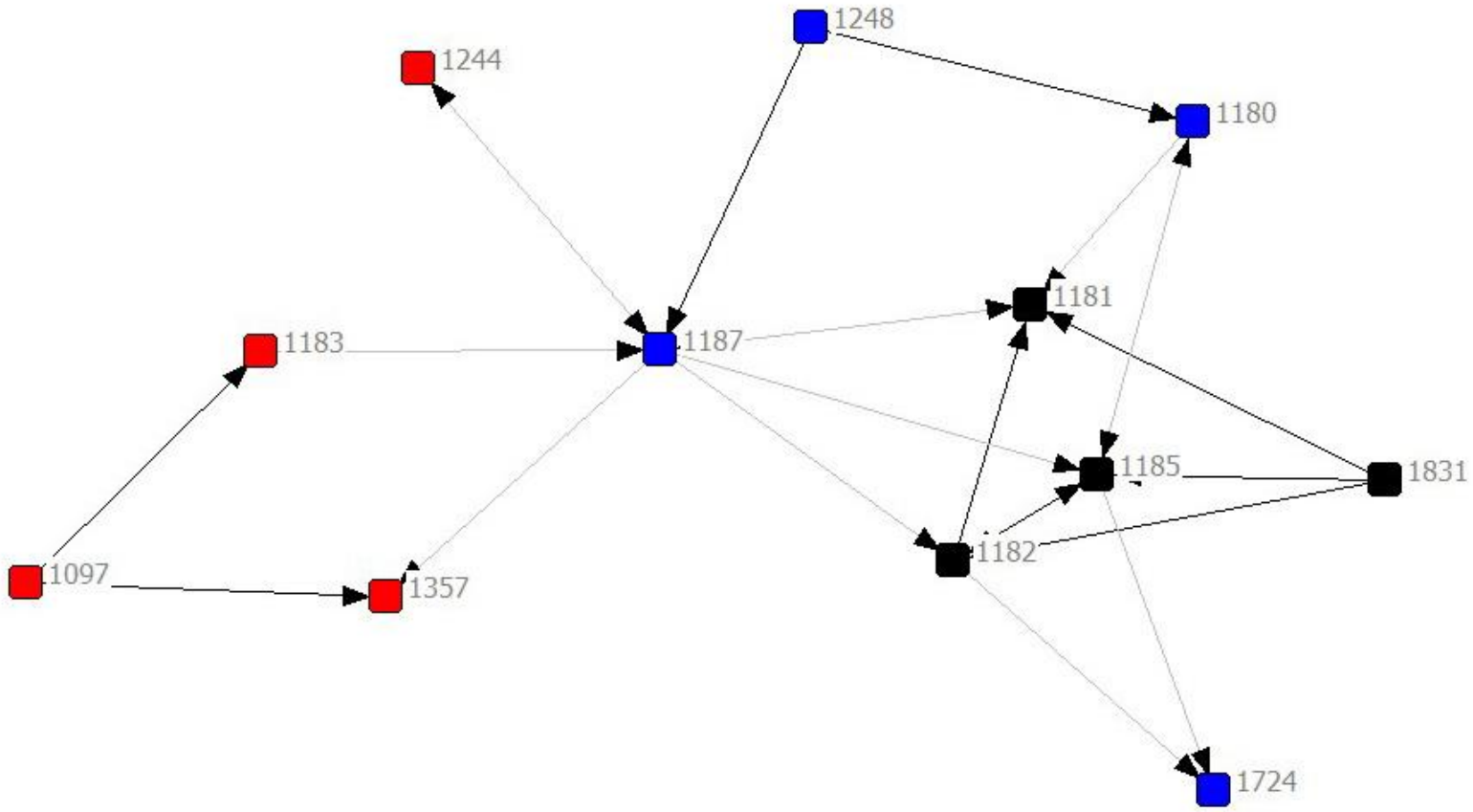
Appendix A

Figure 2. A social network of individuals who hunt together within a single cooperative (141). The nodes represent individuals, while the lines connecting them indicate they hunt with each other. The arrows represent the directionality of nomination. Color is indicative of grouping that is determined by an algorithm that maximizes ties within subgroups vs. between. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of the thesis.



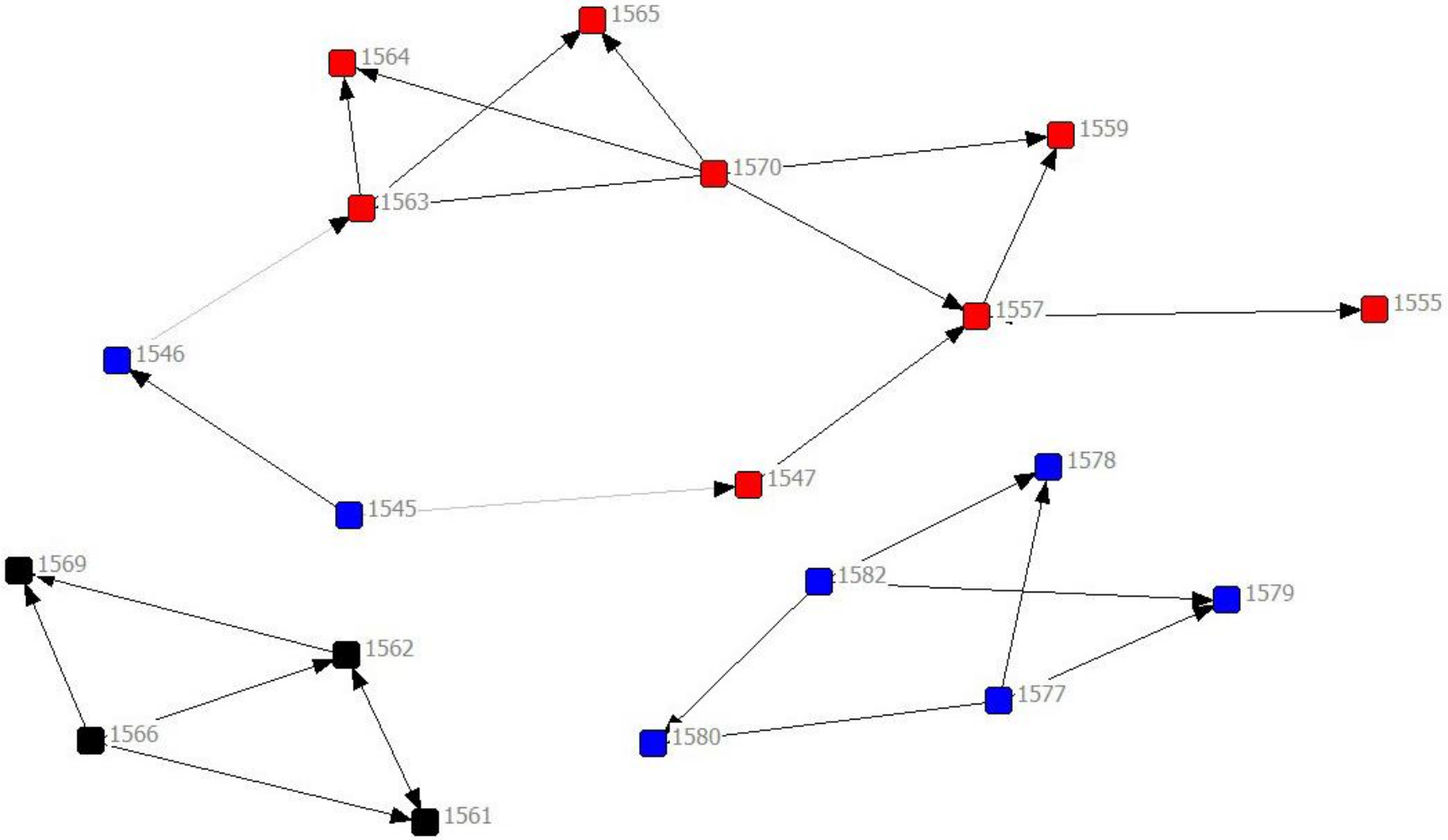
Appendix A

Figure 3. Social interaction network of cooperative 137. The individual nodes represent individual actors, while the arrows represent the directionality of who nominated who. Color variation refers to grouping within the cooperative.



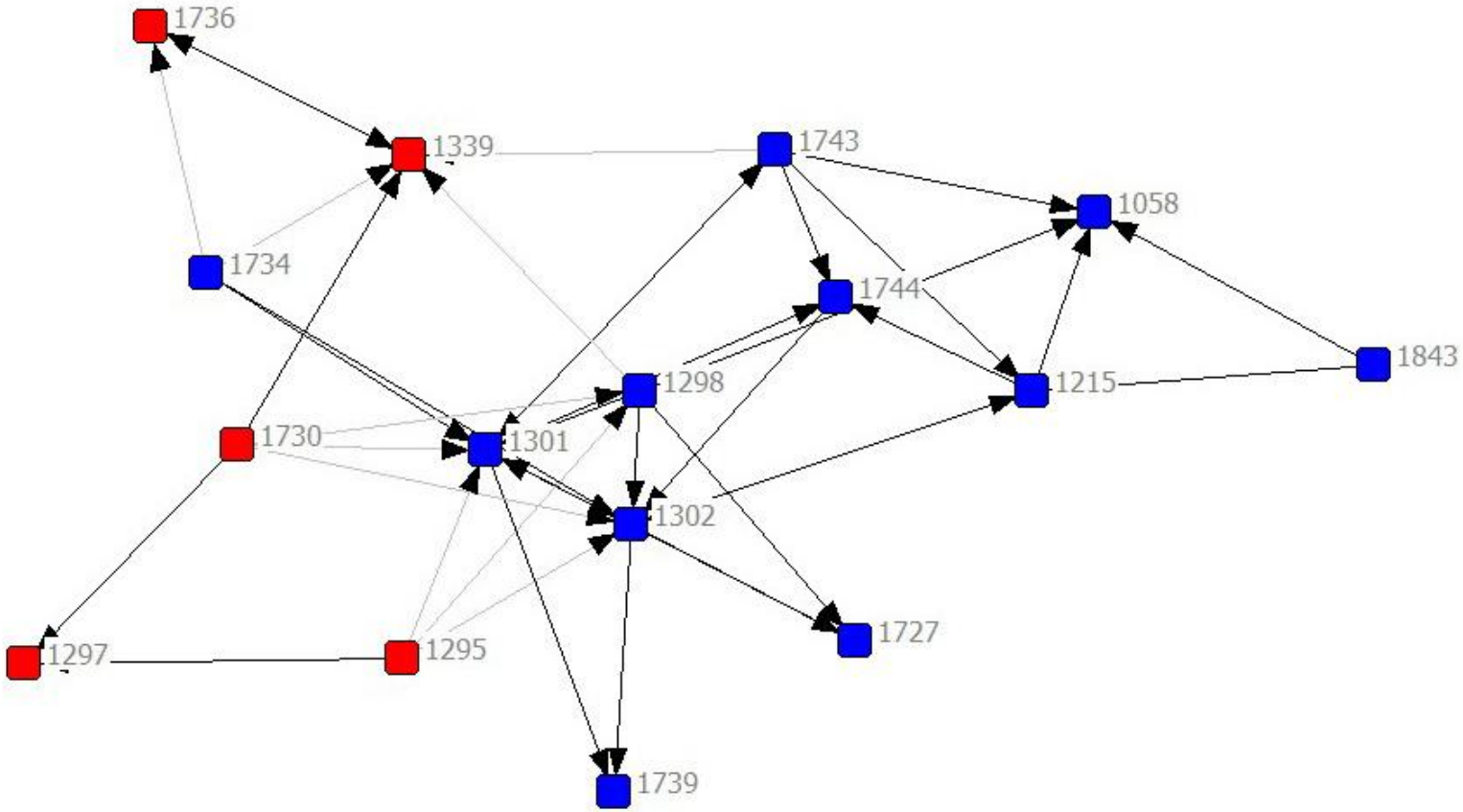
Appendix A

Figure 4. The social interaction network for cooperative 125. The individual nodes represent individual actors, while the arrows represent the directionality of who nominated who. Color variation refers to grouping within the cooperative.



Appendix A

Figure 5. The social interaction network for cooperative 133. The individual nodes represent individual actors, while the arrows represent the directionality of who nominated who. Color variation refers to grouping within the cooperative.



Appendix B

2010 Deer Seasons Data – MSU Deer Cooperative Study

My name is Anna (Hamilton) Mitterling and I am working on a research project for Michigan State University that is supported by the Michigan Department of Natural Resources. The project started this year. As part of the project, we are talking with members of deer cooperatives in Michigan's Lower Peninsula in order to understand the social networks of these organizations. We are asking members to answer some questions about how and with whom they interact in the cooperatives. **Your answers to these questions will not be shared with anyone else. They are private. When we look at the information you provide we will change your name to a number so that your name is not attached to your answers.** We really appreciate your time. The survey will take roughly 10-15 minutes to complete depending on your responses.

1. Date: _____

2. Name (First & Last): _____

3. Cooperative Name: _____

4. County & Township: _____

5. Cooperative Acres you own: _____

6. Years Hunted Deer: _____

7. Years with Cooperative: _____

8. Age: _____

9. Gender: ☐ Male ☐ Female

Knowledge Sharing & Social Interactions

10. Within your cooperative, who do you seek out deer hunting information from?

Name (First & Last):
10a.
10b.
10c.
10d.
10e.

11. Within your cooperative, who do you seek out deer habitat management information from?

Name (First & Last):
11a.
11b.
11c.
11d.
11e.

Appendix B

12. Within your cooperative, who do you hunt deer with?

Name (First & Last):	**Whose land?**		
12a.	☐ Yours	☐ Theirs	☐ Other
12b.	☐ Yours	☐ Theirs	☐ Other
12c.	☐ Yours	☐ Theirs	☐ Other
12d.	☐ Yours	☐ Theirs	☐ Other
12e.	☐ Yours	☐ Theirs	☐ Other

Knowledge Sharing & Social Interactions Cont.

13. Within your cooperative, who do you meet socially (e.g. dinner, drinks, cards, recreation) other than hunting?

Name (First & Last):
13a.
13b.
13c.
13d.
13e.

Harvest Management

In the **2010 deer seasons** please provide, to the best of your memory, the following information for each deer you individually harvested on or around your cooperative:

14. Please indicate the **total number of bucks** you harvested in the **2010** deer seasons:

_____

15. Please indicate the **total number of does** you harvested in the **2010** deer seasons:

_____

16a. Deer	16b. Sex	16c. Antler Points	16d. Antler Spread	16e. Age	16f. Dressed Weight	16g. Date Harvested	16h. Harvest Location
Deer 1	☐ M ☐ F						☐ Own Land ☐ Other Co-op Land ☐ Local Public Land
Deer 2	☐ M ☐ F						☐ Own Land ☐ Other Co-op Land ☐ Local Public Land
Deer 3	☐ M ☐ F						☐ Own Land ☐ Other Co-op Land ☐ Local Public Land
Deer 4	☐ M ☐ F						☐ Own Land ☐ Other Co-op Land ☐ Local Public Land

Appendix B

17. Did you harvest the amount of does you wanted to?

- ☐ More that I planned
- ☐ Fewer than I planned
- ☐ The number I planned

Harvest Management Cont.

18. Has your harvest changed as a **result of joining** the cooperative?

- ☐ Yes
- ☐ No (**Skip to question 20**)

19. Approximately, what was your harvest standard **before** joining the cooperative (Check all that apply)?

Check all that Apply	**Criteria**	**Define Standard**
☐	Antler Points	Ex: 6 points
☐	Antler Score	
☐	Body Size	
☐	Age	
☐	Other	
☐	No Standard	

Additional Information

20. What is your occupation?_____

21. Please select the highest education you have completed:

☐ High School ☐ Trade School ☐ Some College ☐ College
☐ Graduate School

22. Local Civic Organizations and/ Conservation Groups you are a member of (ex: Parent/Teacher Association, Lions Club, Kiwanis Club, QDMA, Ducks Unlimited, MUCC, National Wild Turkey Federation, etc.):

22a.
22b.
22c.
22d.
22e.
22f.

Appendix B

23. Annual Household Income:

- ☐ 0 to 25,000
- ☐ 25,000 to 50,000
- ☐ 50,000 to 75,000
- ☐ 75,000 to 100,000
- ☐ Above 100,000

Thank you for your valuable time. This is the end of the survey.

Appendix C
2011 Deer Seasons Data – MSU Deer Cooperative Study

My name is Anna (Hamilton) Mitterling and I am working on a research project for Michigan State University that is funded by the Michigan Department of Natural Resources. The project is in its second year. As part of the project, we are talking with members of deer cooperatives in Michigan's Lower Peninsula in order to understand the social networks of these organizations. We are asking members to answer some questions about how and with whom they interact in the cooperatives. **Your answers to these questions will not be shared with anyone else. They are private. When we look at the information you provide, we will change your name to a number so that your name is not attached to your answers.** We really appreciate your time. The survey will take about 10-15 minutes.

1. Date: _____

2. Name (First & Last): _____

3. Cooperative Name: _____

4. County & Township: _____

5. Cooperative Acres you own: _____

6. Years Hunted Deer: _____

7. Years with Cooperative: _____

8. Age: _____

9. Gender: ☐ Male ☐ Female

Harvest Management

Please provide information for each deer <u>you</u> individually harvested during the **2011 deer seasons** on or around your cooperative. Just fill out what you remember to the best of your ability.

10. Please indicate the **total number of bucks** you harvested in the **2011** deer seasons:

_____

11. Please indicate the **total number of does** you harvested in the **2011** deer seasons:

_____

Appendix C

12a. Deer	12b. Sex	12c. Antler Points	12d. Antler Spread	12e. Age	12f. Dressed Weight	12g. Date Harvested	12h. Harvest Location
Deer 1	☐ M ☐ F						☐Own Land ☐Other Co-op Land ☐Local Public Land
Deer 2	☐ M ☐ F						☐Own Land ☐Other Co-op Land ☐Local Public Land
Deer 3	☐ M ☐ F						☐Own Land ☐Other Co-op Land ☐Local Public Land
Deer 4	☐ M ☐ F						☐Own Land ☐Other Co-op Land ☐Local Public Land

13. In the 2011 deer seasons, did you harvest the number of does you wanted on or around your cooperative?

☐ More that I planned
☐ Fewer than I planned
☐ The number I planned

Harvest Management Cont.

14. What is your minimum harvest standard (Check and define all that apply)?

Check all that Apply	**Criteria**	**Define Standard**
☐	Antler Points	Ex. 8 pts
☐	Antler Score	
☐	Body Size	
☐	Age	
☐	Other	

Appendix C

Satisfaction and Values

For the following questions, think of your experience with your deer cooperative.

	Very Important		Somewhat Important		Not Important
15. How important is deer hunting to you?	☐	☐	☐	☐	☐
	Very Satisfied		Somewhat Satisfied		Not Satisfied
16. How satisfied are you with your overall experience with your cooperative?	☐	☐	☐	☐	☐
17. How satisfied are you with your hunting experience in your cooperative?	☐	☐	☐	☐	☐
18. How satisfied were you with your hunting experience **before** you joined your cooperative?	☐	☐	☐	☐	☐
19. How satisfied are you with harvest improvement on your property as a result of joining your cooperative?	☐	☐	☐	☐	☐
20. How satisfied are you with the quality of habitat as a result of joining your cooperative?	☐	☐	☐	☐	☐
21. How satisfied are you with the quality of deer hunting/management knowledge you have received as a result of joining your cooperative?	☐	☐	☐	☐	☐

For the following statements, think about your social interactions with members of your deer cooperative.

	Strongly Agee		Somewhat Agree		No Agreement
22. I fit in well with my cooperative.	☐	☐	☐	☐	☐
23. My cooperative has affected the way I see myself as a deer hunter.	☐	☐	☐	☐	☐
24. My opinions on deer management matter to other members of my cooperative.	☐	☐	☐	☐	☐
25. Other members of my cooperative have interests similar to mine.	☐	☐	☐	☐	☐
26. Other members of my cooperative have similar values to mine.	☐	☐	☐	☐	☐

Appendix C

Satisfaction and Values Cont.

For the following questions, consider the harvest and habitat management of yourself and members in your cooperative.

	Strongly Agee		Somewh at Agree		No Agreeme nt
27 There is agreement between members of my cooperative about harvest management practices.	☐	☐	☐	☐	☐
28. There is agreement between members of my cooperative about habitat management practices.	☐	☐	☐	☐	☐
29. Members of my cooperative harvest does.	☐	☐	☐	☐	☐
30. Members of my cooperative pass young bucks.	☐	☐	☐	☐	☐
31. It is important to me to attend cooperative sponsored meetings.	☐	☐	☐	☐	☐

32. Since joining the cooperative, how many cooperative sponsored meetings have you attended?

☐ None of the meetings
☐ A few of the meetings
☐ Most of the meetings
☐ All of the meetings

Habitat Management

33. In the last year, have you planted trees/grass/shrubs for the benefit of deer?

☐ Yes (Please indicate approximately how many acres: _____)
☐ No (**Skip to question 35**)

34. In the last year, have you planted a food plot?

☐ Yes (Please indicate approximately how many acres: _____)
☐ No

Contact Information

35. For the purpose of me contacting you to follow up on information you have given, please provide the best way for me to contact you if needed.

Mailing Address, Email Address, Phone Number:

Thank you for your valuable time. This is the end of the survey.

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REFERENCES

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