Using social network analysis to characterize the collaboration network of backyard poultry trainers in ackCalifornia

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ABSTRACT

In order to better understand collaboration among trainers in the backyard poultry community (i.e. feed store managers, youth development programs (i.e. 4-H), veterinarians, government agencies, extension resources and backyard poultry club leaders), Social Network Analysis (SNA) was used as a tool to better characterize and quantify the current collaboration network structure of backyard poultry trainers in California. Invited trainer attendees of two "Train-the-Trainers" poultry workshops (n = 67) held in Northern and Southern California were given a survey that asked them to list contacts that they collaborated with on backyard poultry (BYP) related work. The collaboration network in this study included a total of 109 trainers, 18 practitioners, and 32 individuals who are both trainers and practitioners for a total of 170 nodes (11 individuals did not have affiliation information available). In order to help identify central actors or collaboration leaders, the surveys were analyzed using Social Network Analysis (SNA), which allows for a quantitative analysis of relationships among various stakeholders. While the SNA showed that the existing collaboration network is disconnected with a clustering coefficient of 0.043 and median total degree centrality of 1 (range 9) and therefore not conducive for collaboration, key insights that could help restructure and improve the network were identified. As an example, among different poultry groups, 4-H was identified as the organization with the second highest median coverage score and fifth highest median centrality score. In addition, 4-H group leaders act as both trainers and practitioners. Consequently, outreach to 4-H group leaders throughout the state would potentially have the greatest impact with respect to overall coverage both inside and outside the 4-H network due to their high centrality and boundary spanning roles. Using SNA to strengthen the collaboration network infrastructure of backyard poultry trainers ultimately offers a more targeted approach toward extension for backyard poultry owners, which could ultimately facilitate communication and knowledge-sharing with BYP owners during a disease outbreak.

1. Introduction

Backyard poultry ownership is undergoing an unprecedented level of growth nationally and in California. According to a 2010 APHIS-NAHMS study that surveyed four major cities (Denver, Los Angeles, Miami and New York City), 0.8% of participating households had backyard chickens, and 3.8% more households planned to have backyard chickens within the next five years (NAHMS, 2013). More specifically, 1.2% of participating households in Los Angeles had backyard chickens and 4.6% more households planned to own backyard chickens within the next five years (NAHMS, 2013). At the same time, California's resources to educate BYP owners are limited. For instance, the number of University of California Cooperative Extension (UCCE)

specialists and advisers have drastically decreased due to significant budget cuts (Cline, 2003; Fruit Grower News, 2007). With respect to poultry health resources in California, there are currently only two poultry specialists and no poultry farm advisers within UCCE's network. Therefore, in order to meet the identified growing demand for trainers, maximizing resources in a targeted fashion is essential to provide BYP owners with information that will allow them to recognize and report problems including the presence of infectious diseases.

One approach is to use social network analysis (SNA), which is a scientific methodology for studying relationships and visualizing and quantifying patterns of interaction among stakeholders. While SNA has been used in poultry, the majority of the publications focus on using SNA to understand disease spread with a particular focus on modeling

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avian influenza transmission (Martin et al., 2011; Poolkhet et al., 2013). Less studied are the interactions between different stakeholders which are key to understanding knowledge sharing/transfer and social relationships (Macau et al., 2016). Social learning (i.e. learning from others) and the relationships associated with that learning is an important learning pathway that accelerates cooperation and learning in agricultural systems (Lubell and Fulton, 2007; Lubell et al., 2014; Hoffman et al., 2015). Therefore, understanding the existing structure of the collaboration network of backyard poultry trainers by identifying central trainers and strengthening the network by connecting trainers with other trainers has the potential to improve the dissemination of accurate information among trainers and ultimately BYP owners. In other words, restructuring the network so it is more connected (i.e., adding more nodes anTHd links) can make it more efficient as an outreach pathway (Valente, 2012). Ultimately, the goal of network-smart outreach informed by SNA is to make individuals aware of the resources and experts around them, encourage individuals to keep up to date on others work, and make those resources easily accessible and inexpensive to obtain (Borgatti and Cross, 2003).

As the number of scientific-based BYP resources remain limited and the number of BYP enthusiasts continues to increase in California (Cline, 2003; NAHMS, 2013), targeted outreach and collaboration (i.e. working together on BYP related work) with BYP stakeholders is essential. For this reason, the California Department of Food and Agriculture (CDFA) sponsored two, two-day "train-the-trainer" poultry workshops in two locations: Davis and Los Angeles, California. Attendees of these workshops received training on food safety, animal health, husbandry, welfare and behavior along with a survey asking them to list collaborators they frequently contacted with poultry related questions. The goal of the survey was to identify central trainers and understand the structure of their current network among backyard poultry stakeholders. Once identified, outreach professionals including farm advisors, 4-H group leaders and feed store managers can leverage stakeholder connections for quicker dissemination of information (e.g. notify BYP enthusiasts of a disease outbreak) and promote valuable resources that are available to backyard poultry enthusiasts. Using this approach, network-smart extension can connect those with questions to those with answers more efficiently.

2. Materials and methods

2.1. Study population

The target population for the meetings and the survey were backyard poultry trainers from various poultry stakeholder groups (i.e. CDFA, UCCE, 4-H) from counties in Northern and Southern California (Table 1). Feed store managers, outreach professionals (i.e. UCCE specialists/advisors), regulatory agents (i.e. CDFA employees, county agricultural commissioners), small-scale producers with backyard-sized flocks (i.e. less than 1000 birds) and veterinarians who self-identify as BYP practitioners were identified as eligible for participation in the train-the-trainer workshops. Because there was no geographical data available on the location of backyard poultry premises in California, the location of the workshop in Northern California (Davis) was selected based on anecdotal observations that backyard poultry ownership was

increasing in Northern California and the location of the workshop in Southern California (Los Angeles) was selected based on the APHIS-NAHMS study (NAHMS, 2013). Specifically, Los Angeles was one of four U.S. cities (Denver, Miami, Los Angeles and New York City) surveyed in the APHIS-NAHMS study, which suggested that backyard poultry ownership was going to increase (NAHMS, 2013).

In order to identify feed store trainers, feed stores were selected based on their proximity to the locations of the workshops. In some cases, feed stores were found to hold workshops for backyard poultry owners and/or had newsletters for customers. Feed store managers were invited to the workshops by phone or email. Outreach professionals include University of California Agriculture and Natural Resources (UC ANR) affiliates, BYP group leaders, community farm garden leaders and BYP enthusiasts. UC ANR academic coordinators (n = 21), county directors (46), UCCE advisors (173), UCCE specialists (142) and 4-H group leaders were all invited to the workshops via email by UC ANR. BYP group leaders were defined as backyard poultry owners with an administrative/organizer status on social media sites and were subsequently contacted directly via their respective social media sites. As an example, social media sites include Meetup and Facebook with group sizes as high as 1500 members (i.e. Los Angeles Urban Chicken Enthusiasts Meetup group). Leaders from community farm gardens with backyard poultry that were interested in holding poultry workshops asked us if they could attend the workshops. Due to their trainer role, community farm garden leaders were eligible to attend the workshops. BYP enthusiasts were defined as individuals that do not own poultry but promote BYP ownership or train BYP owners through their activities (i.e. agricultural podcast hosts) or self-identified trainers. BYP enthusiasts requested attendance to the workshops. Due to their trainer role, BYP enthusiasts were also eligible to attend the workshops. Government agents include agents from CDFA and county agricultural commissioners. All agents were contacted via email either by CDFA or our team. Veterinarians listed on the UCCE poultry webpage who self-identified as experts in BYP were invited to the workshops via email.

2.2. Train-the-trainer meetings

In June 2015, the California Department of Food and Agriculture (CDFA) sponsored two, two-day "train-the-trainer" poultry workshops in two locations: Davis and Los Angeles, California. Attendees of these workshops attended hour-long lectures on nutrition, preventing disease in small flocks, food safety, husbandry, production management, welfare and behavior, regulations, biosecurity, common diseases and parasites of poultry and the California Animal Health and Food Safety diagnostic (CAHFS) lab. Additionally, attendees received hands-on training on how to perform necropsies on chickens. The lecture topics and lab were the same at both locations and were given by speakers from UC Davis, CDFA, CAHFS and UCCE.

2.3. Data collection using surveys

At the end of both meetings surveys were given to all the attendees and filled out in paper form or online. While the survey consisted of five sections, this paper will only focus on the results from the collaboration

Table 1
Number of attendees by stakeholder group and city.

Feed store managers		Outreach[a] professionals		Regulatory[b] agents		Small-scale producers[c]		Veterinarians		Total	
Davis	LA	Davis	LA	Davis	LA	Davis	LA	Davis	LA	Davis	LA
1	3	22	18	11	3	2	4	3	0	39	28

[a] Outreach professionals refers to individuals that do outreach and training related to backyard poultry (i.e. UCCE specialists/advisors).
[b] Regulatory agents include CDFA employees and county agricultural commissioners.
[c] Small-scale producers with backyard-sized flocks (i.e. less than 1000 birds).

Table 2
Social network analysis of backyard poultry trainers in California. Descriptive statistics of network size, centrality and cohesion of the collaboration network.

Parameter	Collaboration network
Network size:	
Number of nodes	170
Number of directed links	149
Size	28,730
Diameter	4
Measures of centrality:	
Median total degree (min, max)	1 (0, 9)
Median in-degree (min, max)	1 (0, 4)
Median out-degree (min, max)	0 (0, 8)
Median betweenness (min, max)	0 (0, 19)
Total degree centralization	0.043
In-degree centralization	0.019
Out-degree centralization	0.043
Betweenness centralization	0.110
Measures of cohesion:	
Density (directed)	0.005
Clustering coefficient	0.043

network section. For this study, a network was built similar to G. Han et al (2016) with collaboration defined as working together on BYP related work. Therefore, nodes consist of trainers and their nominees with ties representing collaboration relationships. The collaboration network section of the survey asked trainers to list up to eight individuals that they collaborated with on BYP related work and their affiliation (i.e. organization, institution or business). These individuals did not have to be in attendance at the meeting, but could be any individual or organization with whom the responder has collaborated in the context of BYP.

2.4. Data management and analysis

Using the attendees' information and the contacts and affiliations they listed in the collaboration section of the survey, a relational binary matrix (i.e. 1 = two nodes collaborate or 0 = they do not collaborate) and attribute file was built manually. Individuals were labeled by the stakeholder group (i.e. 4-H, CDFA) based on the results from the survey. In order to ensure contacts were connected appropriately, individuals with similar names, affiliations and county information were searched online and in some cases, the survey respondent was contacted to verify the same person was being nominated by different individuals. In addition, individuals were labeled by group type as "trainers", "practitioners" or "both" based on their affiliation and whether or not they owned poultry. For the purposes of this study, "trainers" are individuals whose responsibilities include advising backyard poultry producers/owners. Trainers advise in a formal capacity (e.g. UCCE advisors, veterinarians) or informal capacity (e.g. feed store staff, BYP group leaders). "Practitioners" are defined as individuals who directly engage with poultry as backyard poultry owners. In some cases, trainers are also practitioners themselves; hence the "both" category. For example, commercial producers who own poultry and also train workers are considered both practitioners and trainers.

The matrix was then analyzed and visualized using the SNA software ORA (Pittsburgh, PA, USA). Specifically, centrality (i.e. total degree, in-degree, out-degree and betweenness), network size and network cohesion measures were calculated using ORA. In-degree, out-degree and betweenness centralization measures were calculated using Freeman's centralization formula (Freeman, 1979). For this study, the collaboration network is made up of nodes representing trainers and their nominees with ties representing collaboration relationships.

3. Results and discussion

The target population for this SNA was deliberately focused on trainers to better understand how collaboration among these backyard poultry training stakeholders occurs in California. The total number of attendees for both meetings was 67 (Table 1). Training participants that were invited included formal (i.e. UCCE specialist, CDFA) and informal (i.e. feed store manager, 4-H group leaders) trainers. The goals of the train the trainer meetings included: 1) dissemination of the information presented at the meetings to various trainers engaged in BYP in California and 2) creation of a baseline "snapshot" of the current collaboration network of BYP trainers.

Of the 67 attendees, 53 completed the survey for an overall response rate of 79%. While this gives us an idea of the collaboration network structure it is important to note that these results are not representative of how connected backyard poultry owners are in California. The goal in this study was to develop a baseline understanding of the collaboration network of BYP trainers in order to facilitate targeted outreach and extension.

3.1. Collaboration network structure

The resulting collaboration network consisted of 170 nodes that represent individuals that attended the meeting and their nominees with a total of 149 directed links representing collaboration relationships (Table 2). The network density of 0.005 (149/28,730) indicates the network has a low density in that out of all the possible ties (n = 28,730) only 149 ties were present (Table 2) (Lockhart et al., 2010). In addition, the clustering coefficient of 0.043 (i.e. probability of a node being connected directly to another node) indicates that the network is not well connected (Lockhart et al., 2010). As seen in Fig. 1, the BYP collaboration network is fragmented with the majority of the clusters (22 independent clusters) having a relatively low density, meaning that few of the nodes (i.e. trainers) are connected to each other. This decentralized structure is further supported by the total degree centralization measure of 0.043, which indicates the network is not centered around one node. However, the out-degree centralization (0.043) was greater than the in-degree centralization (0.019) indicating the presence of hub nodes (Table 2). Hub nodes and resulting hub and spoke structures are seen in Fig. 1.

Contributions to the fragmented network may have included the survey design. Specifically, the collaboration network section of the survey asked respondents to list up to eight individuals in attendance or not in attendance at the training session that they collaborated with on BYP related work but no snowball sampling was done. Hence not every "node" in the network was able to respond to the survey. Yet even this "snapshot" of the network suggests there may be disconnected training subgroups (i.e. component, in network analysis terminology), based on expertise and interests. For example, the largest observed training subgroup in the network consists primarily of researchers and government agency staff specifically CDFA (Fig. 1). These results suggest that the training networks for some of the trainers (i.e. CDFA and 4-H) are siloed by organization. In other words, the pattern of contact in which actors with shared attributes tend to attract and interact with each other, or homophily, is present in the network. While homophily is common in social networks and can facilitate the sharing of complex information (Skvoretz et al., 2004; Prell et al., 2009), too much homogeneity can be a major impediment to the dissemination of new or different ideas (Crona and Bodin, 2006; Newman and Dale, 2007). This pattern of contact in combination with a disconnected structure means that there is potential for improvement with intervention when it comes to collaboration and knowledge sharing (Borgatti and Halgin, 2011; Valente, 2012).
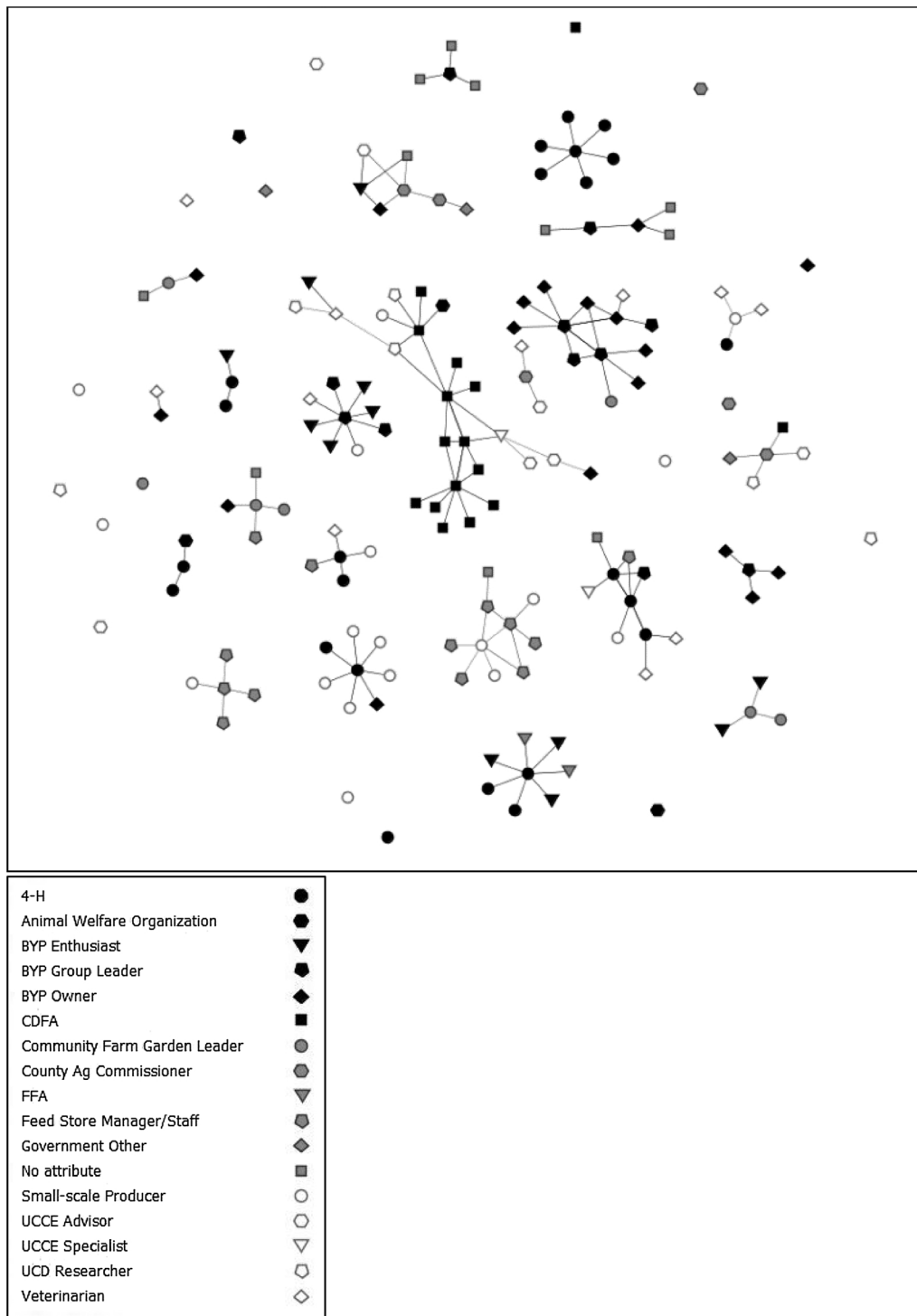
4-H ●
Animal Welfare Organization ⬢
BYP Enthusiast ▼
BYP Group Leader ⬟
BYP Owner ◆
CDFA ■
Community Farm Garden Leader ●
County Ag Commissioner ⬢
FFA ▼
Feed Store Manager/Staff ⬟
Government Other ◆
No attribute ■
Small-scale Producer ○
UCCE Advisor ⬡
UCCE Specialist ▽
UCD Researcher ⬠
Veterinarian ◇

Fig. 1. BYP network with nodes (n = 170) representing attendees and nominees by stakeholder group and linkages representing collaboration ties.

3.2. Centrality and coverage by affiliation

Total degree centrality is an individual-level measurement that counts the number of ties a node has (Wasserman and Faust, 1994; Knoke and Yang, 2008). As shown in Table 3, the BYP trainers with the highest median degree centrality were UCCE specialists (median 2.5, range 3), BYP group leaders (median 2, range 8), county agricultural commissioners (median 2, range 4), CDFA (median 1, range 8) and feed store manages/staff (median 1, range 4). In summary, these results suggest that trainers such as UCCE specialists, BYP group leaders and county agricultural commissioners, CDFA employees and feed store

employees are well-positioned in the network to act as collaboration leaders (Valente, 2012; Hoffman et al., 2015). Individuals that are most central in the collaboration network are more likely to be collaboration leaders since they have the greatest potential to be aware of others projects, can rapidly coordinate new projects, establish partnerships, and mobilize assets because they are connected to others who themselves are connected to many others who have access to additional or different resources (Hoffman et al., 2015).

In SNA, coverage is a population-level measurement that is the product of the average number of collaboration relationships of a given job type (mean or median total degree centrality) and the total number

Table 3
Descriptive statistics of total degree centrality by stakeholder group. Top 5 highest ranking median centrality groups are highlighted in light gray. Top 5 highest ranking median coverage highlighted in dark gray. Note that some of the individuals were both trainers and practitioners but for the purposes of clarity and our goal of understanding trainers, the groups were separated by their main role.

	Stakeholder group	Mean Centrality (SD)	Median Centrality (min, max)	Median Centrality Rank	Population size (n)	Mean Coverage	Mean Coverage Rank	Median Coverage	Median Coverage Rank
Trainers									
	BYP group leader	3 (2.6)	2 (0, 8)	2	12	36	3	24	1
	4-H	2.4 (2.2)	1 (0, 7)	5	23	54.1	1	23	2
	CA Depart. of Food and Agriculture (CDFA)	2.5 (2.5)	1 (0, 8)	4	16	40	2	16	3
	Feed store manager/ staff	1.9 (1.3)	1 (1, 5)	6	13	24.1	4	13	4
	County agricultural commissioner	2 (1.8)	2 (0, 4)	3	6	12	7	12	5
	BYP enthusiast (self-identified trainer)	1.2 (0.6)	1 (1, 3)	8	12	14.4	5	12	6
	Veterinarian	1.1 (0.7)	1 (0, 3)	9	11	12.1	6	11	7
	UCCE advisor	1 (0.8)	1 (0, 2)	10	7	7	9	7	8
	Community farm garden leader	1.7 (1.4)	1 (0, 4)	7	7	12	8	7	9
	UCD researcher	1 (1.1)	1 (0, 3)	11	6	6	10	6	10
	UCCE specialist	2.5 (2.1)	2.5 (1, 4)	1	2	5	11	5	11
	Government other	0.7 (0.6)	1 (1, 1)	13	3	2	13	3	12
	Animal welfare organization	0.7 (0.6)	1 (0, 1)	14	3	2	14	3	13
	Future Farmers of America (FFA)	1 (0)	1 (0, 1)	12	2	2	12	2	14
Practitioners									
	BYP owner	1.4 (1)	1 (0, 4)	1	18	25.2	1	18	1
	Small-scale producer	1.2 (1.4)	1 (0, 6)	2	18	21.6	2	18	2

of individuals within that type (*n*) (Hoffman et al., 2015). Coverage is highest for well-connected categories of stakeholders who also have large numbers in the overall population. The stakeholders with the highest median coverage were BYP group leaders (median coverage 24), 4-H (median coverage 23), CDFA (median coverage 16), feed store managers/staff (median coverage 13) and county agricultural commissioners (median coverage 12). The members of these groups tend to be dispersed over wide geographical regions in relatively large numbers (i.e. 4-H groups in every county) and based on centrality measures they also tend to have many ties. Therefore, it is not surprising to see an association between mean degree centrality and coverage rankings with stakeholders with a high median centrality ranking (i.e. highlighted in light gray) also having a high median coverage ranking (i.e. highlighted in dark gray) (Table 3).

Fig. 1 highlights the network position of those individuals by stakeholder groups such as CDFA and UCCE. Understanding where these individuals fall in the collaboration network is key to leveraging existing connections for the dissemination of relevant information such as regulatory and scientific-based information. An important observation here is that CDFA makes up a majority of the network's largest cluster, and collaborates with other important institutions including UCCE, UCD researchers, and some other trainers (Fig. 1). While county agricultural commissioners and CDFA agents mainly have a regulatory role with offices and staff distributed across the state (CDFA, 2017), their high median degree centrality and coverage (Table 3) most likely reflect their collaborative work with private industry (i.e. small and large poultry producers, feed stores) and academia. However, the network also indicates that CDFA could improve at collaborating with other important training network actors, especially 4-H which is well connected to BYP owners (Fig. 1). While 4-H had a median degree centrality of 1 (range 7) (Table 3), 4-H members were dispersed across ten network components (Fig. 1). Additionally, 4-H had the second highest median coverage (Table 3). Therefore, 4-H members are well-positioned for collaboration because they tend to have many ties and are dispersed across the network as formal trainers (Fig. 1). Therefore, CDFA and UCCE could improve outreach efforts by strengthening

relationships with 4-H group leaders, which can help link or bridge groups of people that are fragmented (Borgatti and Halgin, 2011). Other studies have shown that linking to these "bridge" organizations can make the network more cohesive in a more efficient manner as opposed to reaching out to individual backyard poultry owners (Valente and Fujimoto, 2010; Valente, 2012).

In contrast, coverage is lower for stakeholders who are well-connected but with few individuals. For example, UCCE specialists had the highest median centrality but ranked 11 with respect to median coverage (Table 3). These results corroborate with the previously observed "UCCE coverage bottleneck" (Hoffman et al., 2015). While UCCE staff are well established in the network (i.e. staff have a high median centrality) they are too few in numbers to extend information effectively ultimately resulting in this "coverage bottleneck" (Hoffman et al., 2015).

Overall, based on the median centrality and coverage scores, extension professionals should consider BYP group leader, 4-H, CDFA and county agricultural commissioners as key allies. Specifically, in California since there are only 2 UCCE faculty with a poultry focus, based on these data they should focus their outreach efforts on these groups of trainers in order to amplify their message among BYP trainers throughout the state.

3.3. Boundary-spanners

Boundary spanners are defined as attendees that were both trainers and practitioners (i.e. BYP owners). The collaboration network in this study included a total of 109 trainers, 18 practitioners, 32 individuals who are both trainers and practitioners and 11 individuals with no attributes (Fig. 2). Attendees that were both trainers and practitioners (i.e. boundary spanning individuals) had a higher median centrality of 3 (range 8) than those were just trainers (median 1, range 8) or just practitioners (median 1, range 4). Specifically, those who were both practitioners and trainers had 3 times (95% CI 2.03, 4.42) more collaboration ties than those who were only trainers. Similarly, those who were both practitioners and trainers had 3 times (95% CI 1.81, 5.92)
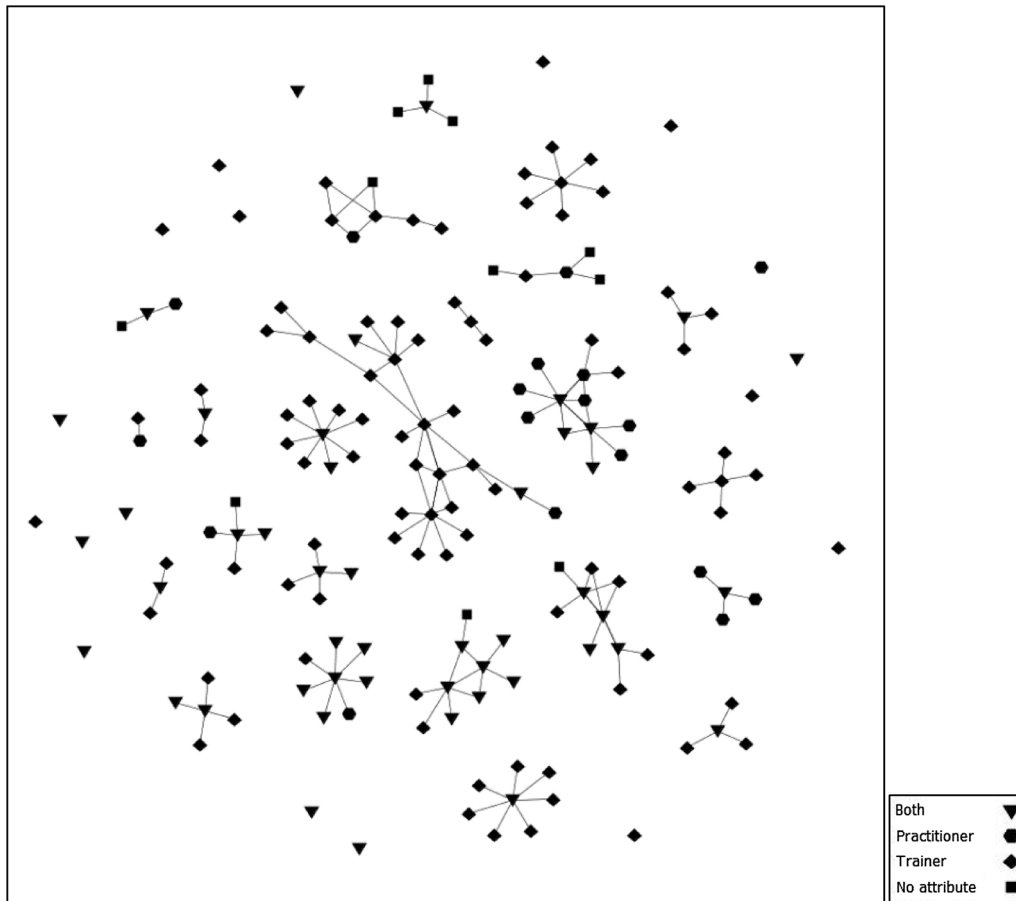
Fig. 2. BYP network with nodes (n = 170) representing attendees and nominees by group type.

more collaboration ties than those who were only practitioners. Though it is important to note that practitioners were not invited to the workshops and that they were not expected to be s part of the training network. Therefore, there is a bias against practitioners that should be considered. These results are consistent with other studies in that those who are both practitioners and trainers are more likely to be well-positioned in the network than those who are just practitioners or just trainers (Lubell et al., 2014). Additionally, those who fall into the "both" category should be considered "boundary-spanning" individuals because of their ability to span the boundaries between trainers and practitioners to broker knowledge between both groups and thus are more likely to be collaboration leaders because of their practical and professional knowledge (Gould and Fernandez, 1989; Lubell et al., 2014). Therefore, they can potentially facilitate the transfer of knowledge between trainers and practitioners who are not connected (Cross et al., 2013; Spiro et al., 2013) and serve as first points of contact and knowledge-brokers for BYP outreach programs.

As an example, 4-H members are based throughout California (H4-H History, 2017) and they tend to own livestock including poultry as part of their hands-on approach. Their boundary-spanning role along with their high coverage corroborates previous research that reports 4-H members tend to be well connected in their community (Adedokun and Balschweid, 2009). Similarly, results show that BYP owners that were group leaders (i.e. Los Angeles Urban Chicken Enthusiasts Meetup group) were more connected in the network than those that were solely BYP owners. Specifically, BYP group leaders had a higher median degree centrality (median: 2, range: 8) than those that were solely BYP owners (median 1, range 4) (Table 2). However, this could be due to the bias in this study with respect to targeting training stakeholders that were presumably well connected and not BYP owners. Though it is

important to note that while practitioners are an important stakeholder group because they are the end-receivers of BYP training, practitioners were not meant to be included in the network. However, trainers nominated BYP owners most likely due to the limited BYP resources (i.e. BYP trainers) available in CA resulting in BYP owners acting as informal trainers to some extent. This unexpected trainer group indicates that "Extension 3.0" or the strategic use of social networks and learning pathways in outreach (Lubell et al., 2014) can help provide insights about the current training infrastructure such as the role of BYP owners as informal trainers and the boundary-spanning roles of individuals such as 4-H members and BYP group leaders.

3.4. Outreach insights

Due to the sheer number of backyard poultry owners in California outreach focused on "training the trainers" is essential (NAHMS, 2013). However, from an outreach and extension perspective incorporating targeted training that focuses on addressing gaps in the current training network is an essential approach to maximize the centrality and coverage of the trainers. In addition using SNA in a longitudinal fashion using a weighted matrix as opposed to a binary matrix could be used to assess changes in knowledge sharing over time and how those changes correlate with increased contact among nodes (as opposed to contact or not contact between 2 nodes). Among the trainers surveyed, results showed that individuals that were both practitioners and trainers were more central to the training network than those with a singular focus. Therefore, efforts should be made to focus training outreach through these potential collaboration leaders (i.e. trainers that are practitioners and trainers such as 4-H members). However, it is also important to keep in mind that working with those institutions who were found to

have low measures of centrality and coverage to boost their standing in this regard could help strengthen the network's capacity for collaboration. Trainers should be considered an intermediate target population for outreach because they tend to be well-positioned in the social network to take lead roles as collaborators. Additionally, trainers typically pose relatively high levels of both practical and scientific knowledge about BYP. Practitioners are the ultimate target population for outreach as they are the end-users of information and the ones who ultimately adopt (or don't adopt) best management practices. Therefore finding practitioners that are central to the network is also key.

While this study provides a "snapshot" of the BYP trainer community that to our knowledge has not been analyzed before, there are important limitations to consider. For example, the sampling population (n = 67) was relatively small and no snowball sampling was done. Therefore, it is not representative of the entire BYP trainer community. Increasing the sample size by administering more surveys in similar train-the-trainers events and conducting snowball sampling could improve the estimates and network structure. Nevertheless, general trends can still provide helpful insights such as how stakeholder groups connect relative to other stakeholder groups (i.e. CDFA agents tend to connect to other CDFA agents). Similarly while centrality and coverage scores are an underestimate of the true scores, the relative ranking of different stakeholders still provide helpful insights. For example this study supports the previously observed "UCCE coverage bottleneck" in which UCCE specialists are well connected (i.e. high centrality score) but there is few of them (i.e. there are only 2 UCCE poultry specialists in California) therefore they have a low coverage score and are limited in the number of people they can collaborate with.

In addition to affiliation/role, attendees were also asked to select the counties they worked at on poultry related work. Based on the attendees' responses, all of California's 58 counties were represented at the meetings. Hence, the resulting network mostly consisted of "trainers" that collectively extended their work to all of California's counties. These preliminary results along with other studies indicate that "train-the-trainers" workshops can be effective at amplifying the distribution of information presented at meetings (van de Fliert et al., 1995; Moore et al., 1996; Moore, 1998).

4. Conclusion

These preliminary results along with other studies indicate that "train-the-trainers" workshops can be effective at amplifying the distribution of information presented at meetings (van de Fliert et al., 1995; Moore et al., 1996; Moore, 1998). In addition to "train-the-trainer" workshops, organizers should consider integrating SNA in order to better understand the collaboration network of trainers and how the collaboration network changes over-time. In this study, the resulting SNA network is a first structured step towards understanding the BYP training community in California. Future studies could integrate a weighted matrix as opposed to a binary matrix in order to better understand the strength (i.e. the strength of each collaboration based on the number of contacts) of the different connections over time. In addition, although we did ask for county level information in this study, data was lacking for too many nodes thus we could not perform a geographical analysis.

Insights related to expanding coverage include how UCCE and CDFA can leverage the network to optimize collaboration sharing among BYP practitioners and trainers. Based on the results, UCCE and CDFA should focus on building new or strengthening existing relationships with those institutions that were found to have high measures of median centrality and median coverage. For instance, outreach partnerships with 4-H group leaders should be prioritized. By reaching out to 4-H group leaders, key organizations such as CDFA, UCCE and the UC Davis School of Veterinary Medicine would significantly increase their collaboration network. However, based on the results there does appear to be a disconnect between formal trainers (i.e. UCCE specialists and

CDFA agents) and practitioners who may not have been at the meeting. The SNA results show that these core knowledge developer agencies need to reach out to those pockets of users. This could be facilitated by expanded in-person extension and outreach, and various on-line approaches including webinars, websites, web-apps and social media. In addition, individuals who are both practitioners and trainers should be thought of as high-impact collaboration leaders. These individuals are integral in the network from both a collaboration perspective. Furthermore, any effort to help trainers gain practical and hands-on experience with BYP might help grow their capability to extend information and may also help them build new collaboration ties. Continual usage of SNA coupled with "train-the-trainers" workshops can allow further optimization of the training network in order to maximize collaboration among trainers and ultimately knowledge dissemination to backyard poultry owners.

Acknowledgements

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