



# THE FLAGSTAFF FOOD SYSTEM: A SOCIAL NETWORK ANALYSIS

*PREPARED BY*

**NEW VENTURE ADVISORS & RODRIGO ALDECOA  
FOR THE CITY OF FLAGSTAFF & FLAGSTAFF FOODLINK**

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# Introduction

This report presents a Social Network Analysis (SNA) conducted on key stakeholders in the regional food system surrounding the City of Flagstaff, Arizona. SNA is a methodological approach for examining the relationships and interactions among individuals or groups within a specific network, in this case, a food system. The process entails collecting data on the connections among entities, representing these connections graphically, and analyzing the graph through mathematical and statistical techniques.

**The purpose of this SNA is to identify the central players in the Flagstaff regional food system, understand the structure of community networks, and highlight bridge organizations that connect different parts of these networks.** The analysis draws on survey responses from 33 organizations engaged in various aspects of the food system, including agricultural production, food retail, institutional food procurement, and food access.

This analysis aims to provide actionable insights for enhancing collaboration, identifying critical areas for intervention, and supporting decision-making processes among stakeholders in the regional food system.

## Methodology and Report Structure

This Social Network Analysis was conducted in the spring of 2024, concurrent with the creation of a Community Food System Assessment for the City of Flagstaff and its regional food system. Key food system organizations were identified throughout the assessment process, and then emailed an online survey for the SNA. The questions asked representatives from key food system organizations to identify their relationships with other organizations in the regional food system.

This SNA utilizes an "average centrality" metric to measure an organization's influence and activity within the network. This method combines several factors to show us not just who is most connected, but also who plays a crucial role in bringing others together, who is more actively involved, and who might work well together in the future.

**The report is divided into three main sections:**

- **Centrality Metrics:** We discuss the average centrality measure and its implications for identifying key organizations within the network.
- **Community Detection:** We analyze the structure of the network to identify distinct communities or clusters of organizations with shared interests or goals.
- **Bridges:** We use betweenness centrality to highlight organizations that act as intermediaries, facilitating the flow of information and resources across different parts of the network.

Only the most relevant networks or networks where there is a clear pattern of any of the metrics discussed are shown in this report.

# Social Network Analysis

## Organization Awareness

The organization awareness network was constructed by mapping directed links from Organization A to Organization B whenever A is cognizant of B. This information was gathered from our survey, where each organization was asked whether they are aware of the other organizations.

Centrality analysis emerges as a powerful tool to discern the relative prominence or recognition of organizations within the food network ecosystem.

Figure 1 visualizes the average centrality scores for each organization, offering insights into their standing and influence within the network.

**Organizations such as Northern Arizona University, the City of Flagstaff Sustainability Office, Coconino County Health & Human Services, and Flagstaff Foodlink are currently the most central nodes within the network. Their high centrality scores suggest they are well-recognized by other organizations in the network.**

The central positions of these organizations suggest they might serve not just as focal points of information and activity, but potentially as influential decision-makers and leaders in the food system. Their prominent roles could be leveraged to disseminate information effectively, advocate for system improvements, and drive collaborative initiatives within the network.

Average Centrality score in the awareness network

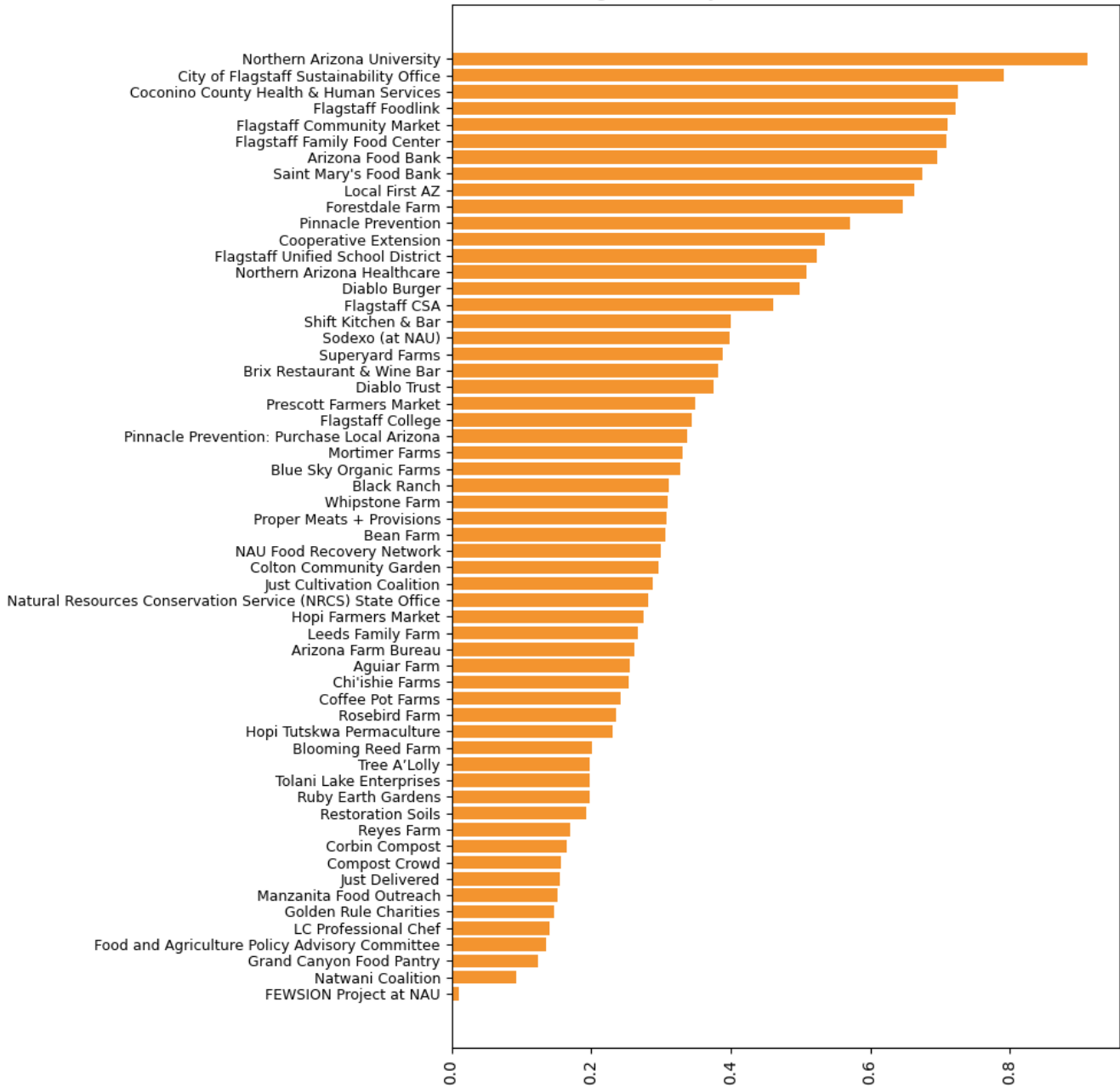


Figure 1: Average centrality score in the awareness network.

Note: In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

## Trust

The trust network is created by assigning a directed link from Organization A to Organization B whenever A deems B as trustworthy. This relationship is defined by Organization A's affirmative response to the statement "We consider this to be a trustworthy organization."

The trust network within Flagstaff's food system exhibits a high level of connectivity, reflecting a generalized sentiment of trust among the participating organizations.

Despite the prevalence of trust, the hierarchy of trustworthiness does show variations when compared to the network's previous organizational awareness ranking. While organizations previously identified as most well-recognized (from Organization Awareness) retain high trust scores, the order among the top-ranking organizations shifts, indicating nuances in how trust is accorded compared to general awareness (see figure 2).

**Analyzing the centrality scores within the trust network reveals that Forestdale Farm, Flagstaff Family Food Center, the City of Flagstaff Sustainability Office, Flagstaff Foodlink, and Local First AZ are pivotal in shaping the trust landscape of Flagstaff's food system.**

These organizations, by leading in average centrality, demonstrate a balanced combination of influence, connectivity, and trustworthiness among their peers. Their high scores suggest they are not only widely recognized and trusted within the network but also play significant roles in facilitating collaboration and information flow. This highlights their potential as key agents for spearheading initiatives, fostering a collaborative environment, and driving positive change within the community's food system.

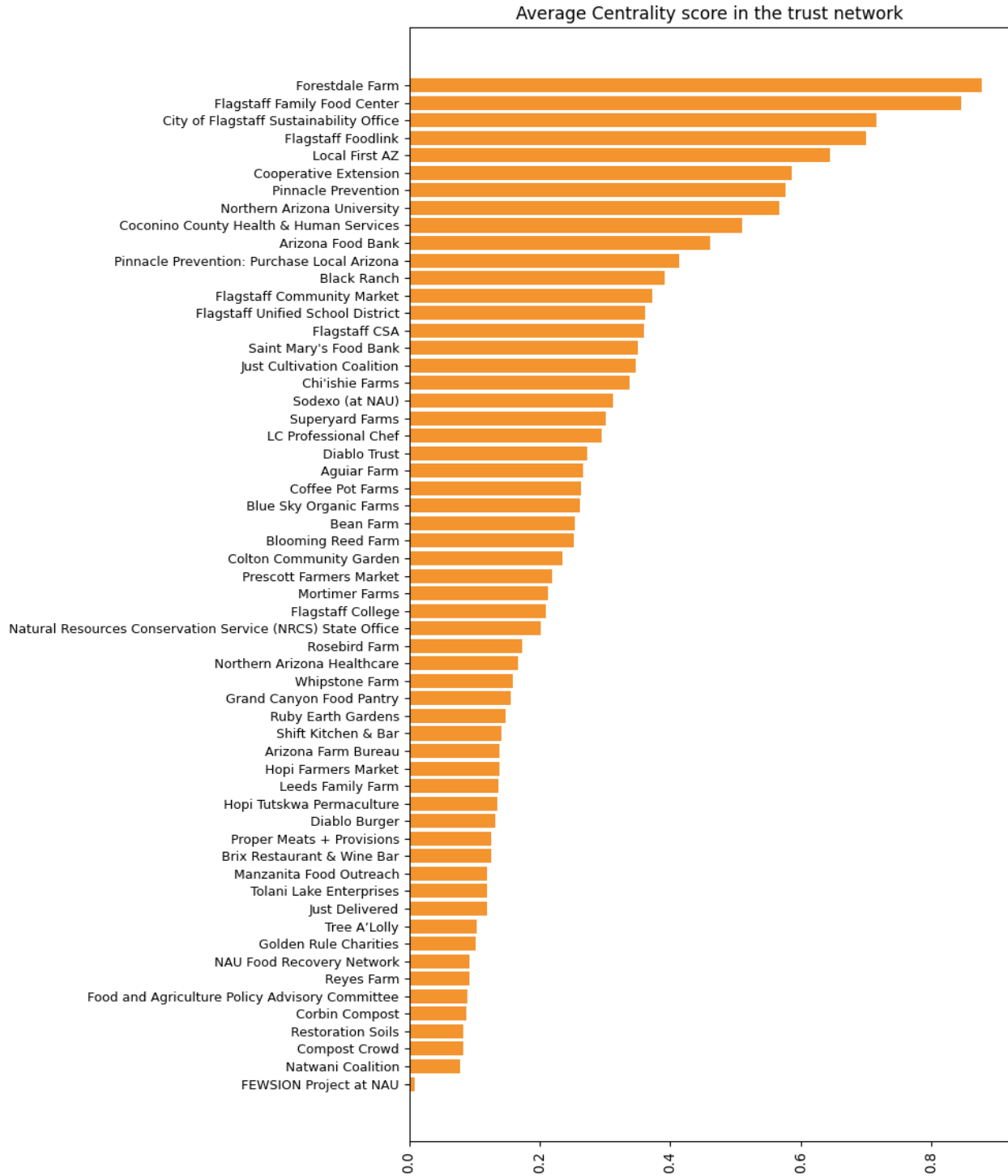


Figure 2: Average centrality score in the trust network.

Note: In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

## Information

The information network is formed by establishing a directed link from Organization A to Organization B whenever A regards B as a key source of information. This connection is determined by A's agreement with the statement, "When we have questions about the Northern Arizona food system this organization is a 'go-to' source."

**In the information network, Pinnacle Prevention, Flagstaff Foodlink, City of Flagstaff Sustainability Office, Forestdale Farm, and Northern Arizona University emerge as the top five organizations based on average centrality.** This ranking underscores their critical function as hubs of knowledge and information within the network. Their prominent average centrality scores indicate that these organizations are not merely well-connected; they are central to the flow of information, acting as vital resources that others turn to for guidance and expertise.

This positions them as influential leaders in disseminating knowledge, setting standards, and potentially guiding the strategic direction of the food system in Northern Arizona. Their role suggests a significant capacity for impacting decision-making processes, resource allocation, and the overall dissemination of innovations and best practices within the community.



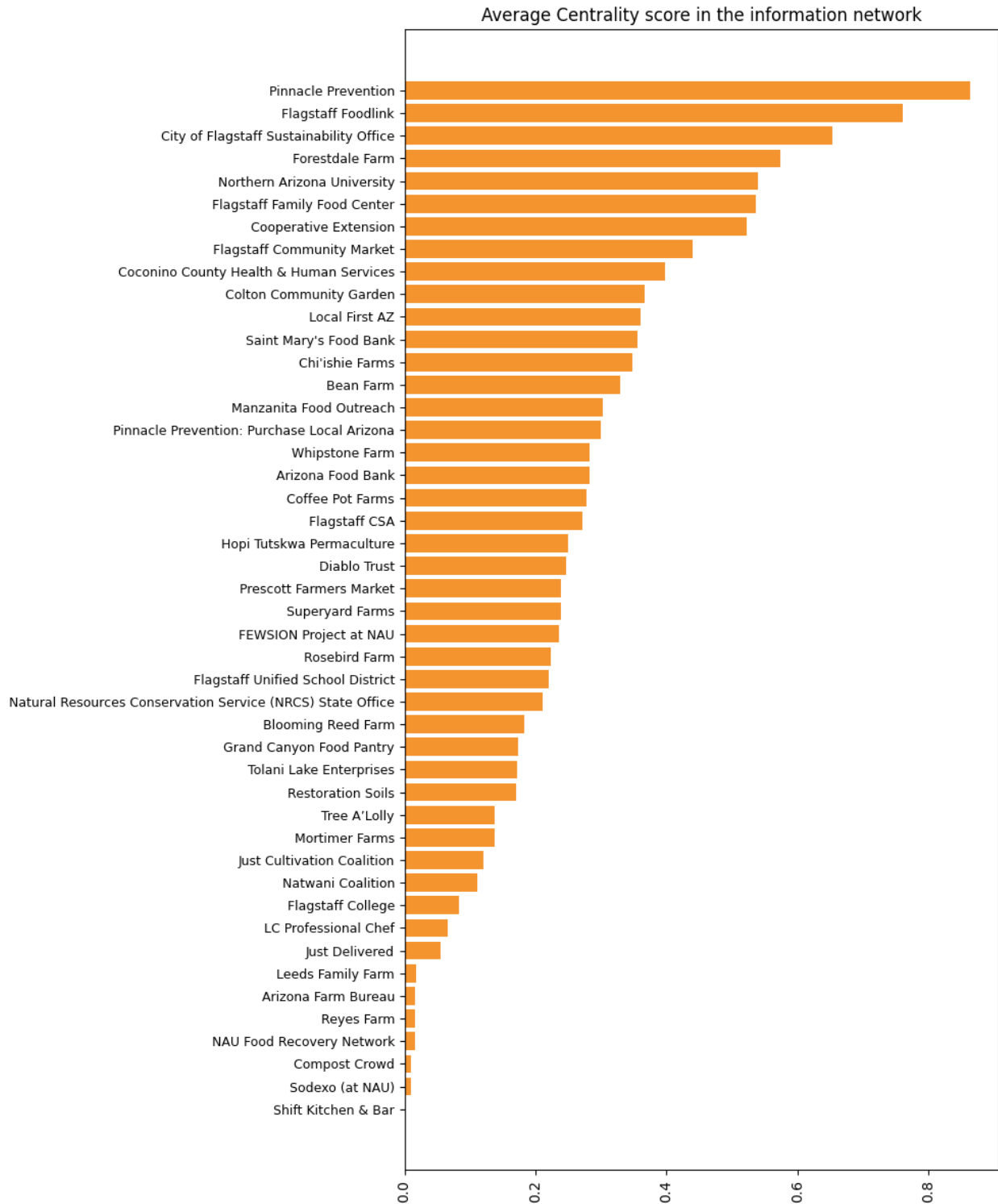


Figure 3: Average centrality score in the information network.

Note: In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

In figure 4, the information network is presented, with the size of each organization reflecting the number of other organizations that rely on it as a primary source of information.

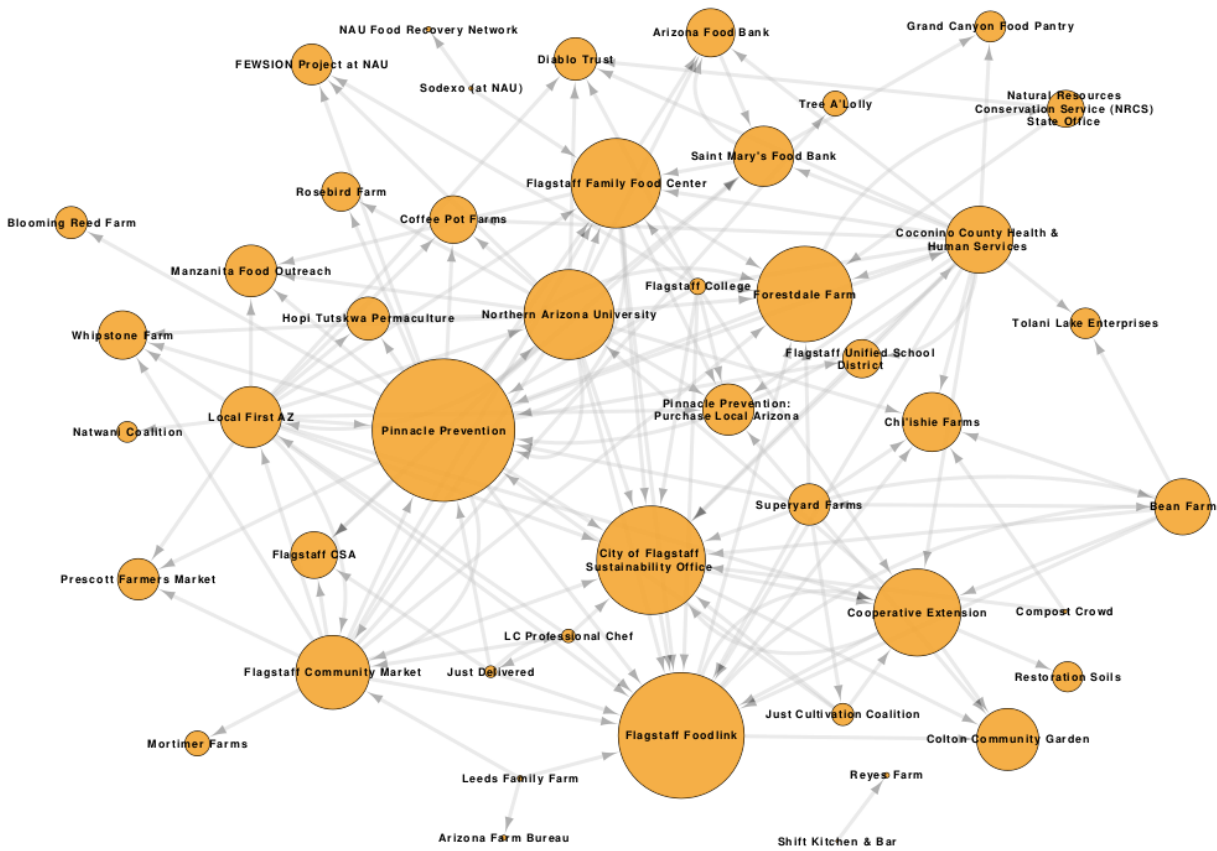


Figure 4: Information network depicted with varying organization sizes.

Note: each is proportional to the count of other entities depending on it as a principal information source.

Note: In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.

## Collaboration

The collaboration network is established by connecting Organization A with Organization B whenever there is a history of joint ventures, as indicated by mutual collaboration on programs (i.e. "We have collaborated on a jointly run program with this organization"). Given the reciprocal nature of such partnerships, the network is inherently undirected, signifying that collaboration is a two-way relationship.

Central nodes in a collaboration network typically represent organizations that are highly active in joint initiatives. They are often the hubs of partnership and cooperative effort, indicating that they have engaged with multiple entities in mutually run programs. Their centrality signifies a pivotal role in the network, suggesting these organizations might be:

- *Key Collaborators*: They frequently participate in, or even spearhead, collaborative projects, indicating they have the capacity, resources, or strategic interest in such ventures.
- *Influential Partners*: Due to their extensive collaborative ties, central nodes are likely to influence practices and trends within the network, potentially guiding the direction of collaborative efforts.
- *Cohesion Builders*: By participating in various joint programs, these organizations contribute to the network's cohesion, linking different clusters that might otherwise remain disconnected.
- *Resource Hubs*: Central nodes may have access to a variety of resources, either through their own reserves or through partnerships, and can be instrumental in resource sharing within the network.
- *Information Centers*: These organizations often become repositories of knowledge and information, accumulated through diverse collaborative experiences, which can be disseminated to other network members.

Figure 5 displays the centrality of each organization in the collaboration network.

In the collaboration network of Flagstaff's food system, the top organizations based on average centrality serve as foundational pillars. **Northern Arizona University is at the forefront, suggesting it plays a pivotal role in fostering collaborative efforts. Pinnacle Prevention, Local First AZ, Flagstaff Foodlink, and the City of Flagstaff Sustainability Office are also key, each demonstrating a strong capacity for partnership and joint initiatives.**

These organizations, due to their high average centrality scores, are crucial in creating a tightly knit network, vital for promoting collective endeavors and the sharing of resources among all members of the food system.

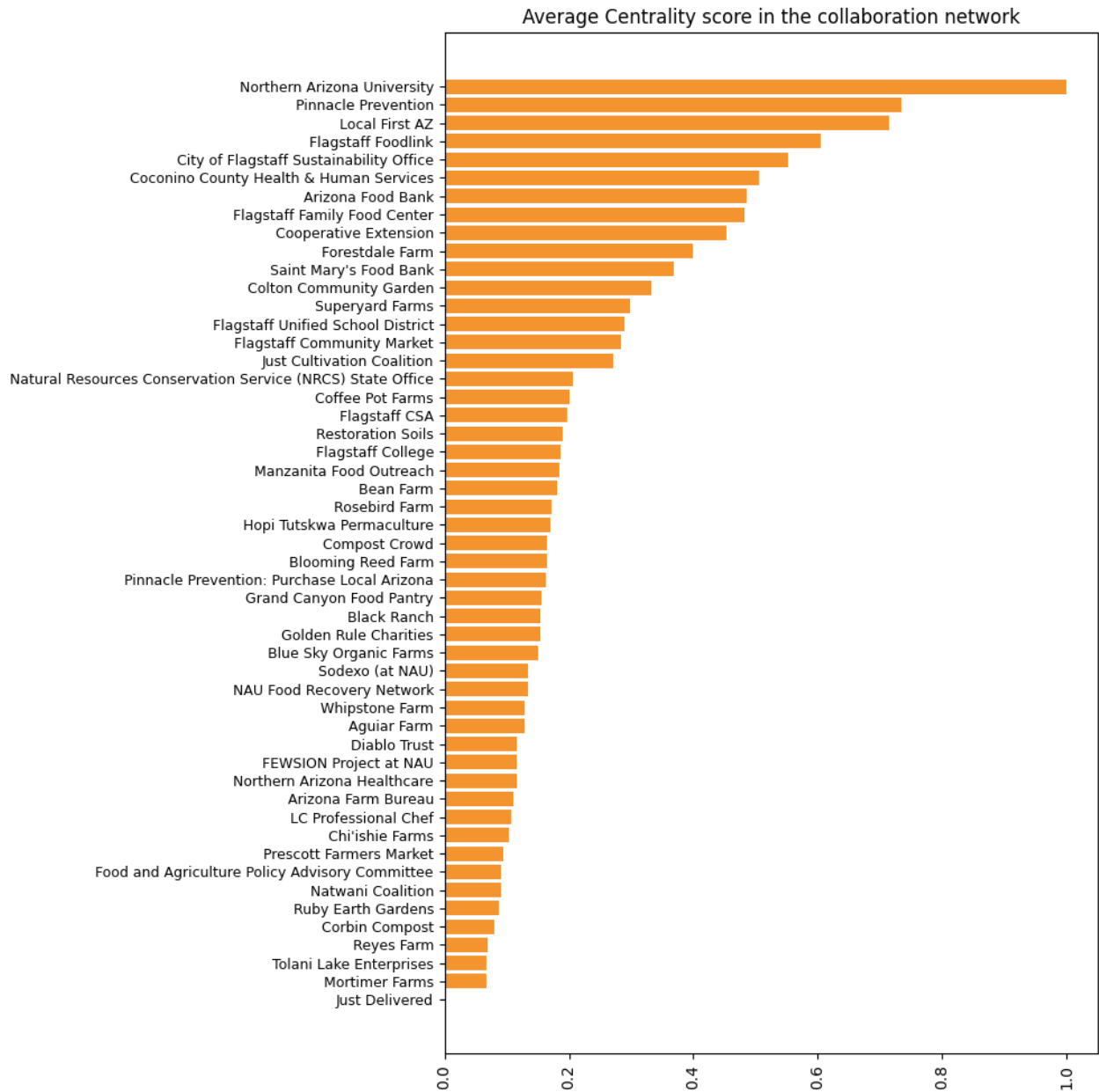


Figure 5: Average centrality score in the collaboration network.

Note: In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

## Strategic importance of Community Detection in the Collaboration Network

Of special interest are communities of organizations in these collaboration networks, since they often represent groups that have established stronger, more frequent, and more intensive collaborative relationships over time. Detecting such communities is of strategic importance for several reasons:

- *Resource Allocation:* Communities may indicate groups that are optimizing the use of shared resources, allowing for targeted support and resource allocation where it's most effective.
- *Policy Impact:* Understanding how organizations cluster in terms of collaboration can help policymakers and funders tailor interventions that reinforce successful community structures or address gaps in collaboration.
- *Network Resilience:* Communities within a network can contribute to overall resilience, as they may provide mutual support and assistance among members during challenges.
- *Best Practices Dissemination:* Strong collaborative communities can serve as models of effective partnership, setting benchmarks and disseminating best practices throughout the broader network.
- *Enhanced Impact:* Organizations within a community may have aligned goals and complementary capacities, leading to collaborations that can amplify their collective impact on the food system.
- *Networking Efficiency:* Identifying communities helps to understand the network's sub-structures, making it easier to navigate and engage with the network efficiently for new or external organizations.

Figure 6 shows the most significant partition of the collaboration network into five communities. Each color represents a different community, and organization size circle corresponds to their centrality in the network.

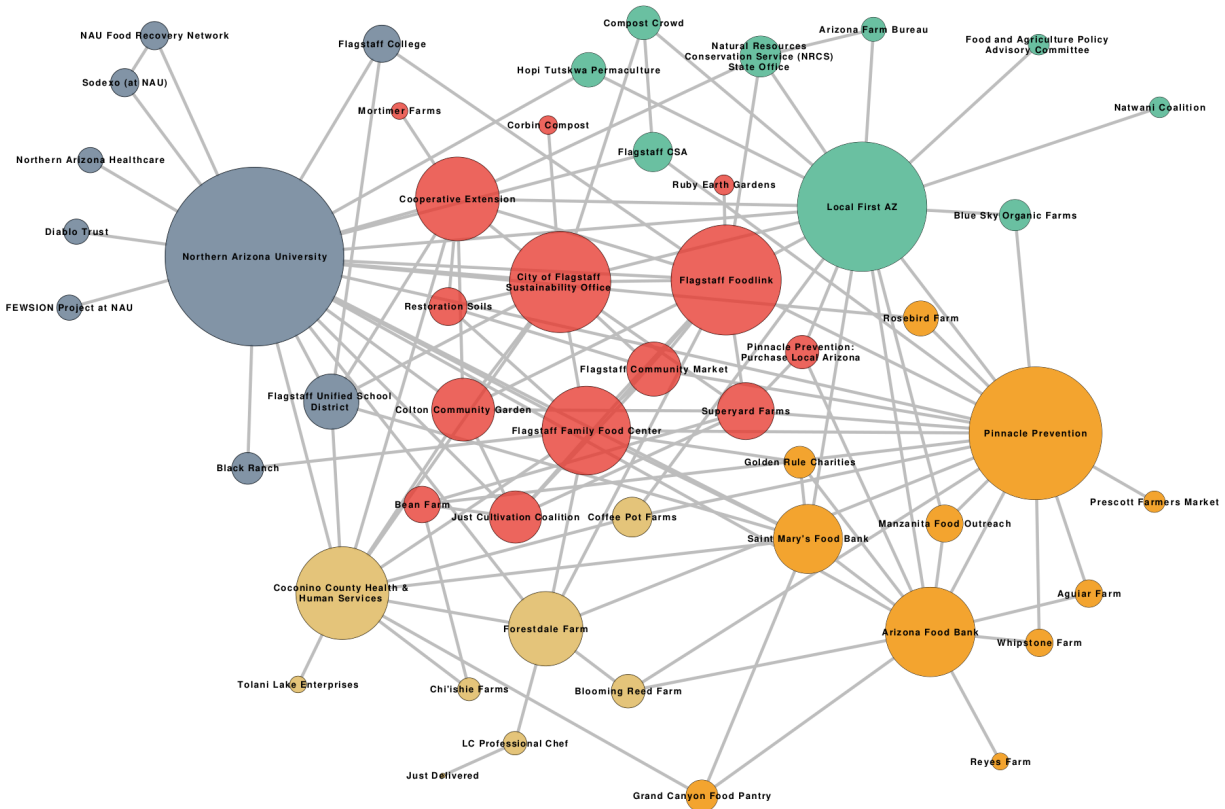


Figure 6: Community structure in the collaboration network.

Note: each color denotes a distinct community, and the size of each organization reflects its centrality score. In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.

Three out of five identified communities are centered around one or two key organizations, indicative of their influential roles.

- The blue community is notably dominated by Northern Arizona University, which stands out as the central hub.
- Similarly, Local First AZ holds a pivotal position within the green community, acting as the primary connector.
- In the orange community, Pinnacle Prevention, Arizona Food Bank Network, and Saint Mary’s Food Bank are the principal entities driving collaborative efforts.
- The brown community is led by two major organizations: Coconino County Health & Human Services and Forestdale Farm.
- The red community is distinctive, comprising several vital organizations that engage in numerous collaborations, both intra-community and with external groups.

It is noteworthy that all highly connected nodes in the network, irrespective of their community affiliations, are interconnected (see figure 7), forming a structure known as “central core.” This feature, commonly observed in many social networks, highlights a significant aspect of network dynamics, where the most influential organizations, despite differing community memberships, tend to form an elite cluster of collaboration and influence.

The 9 most central organizations in the collaboration network are shown below in figure 7. They form a central core that interconnects the different communities and show a high degree of connectivity between them.

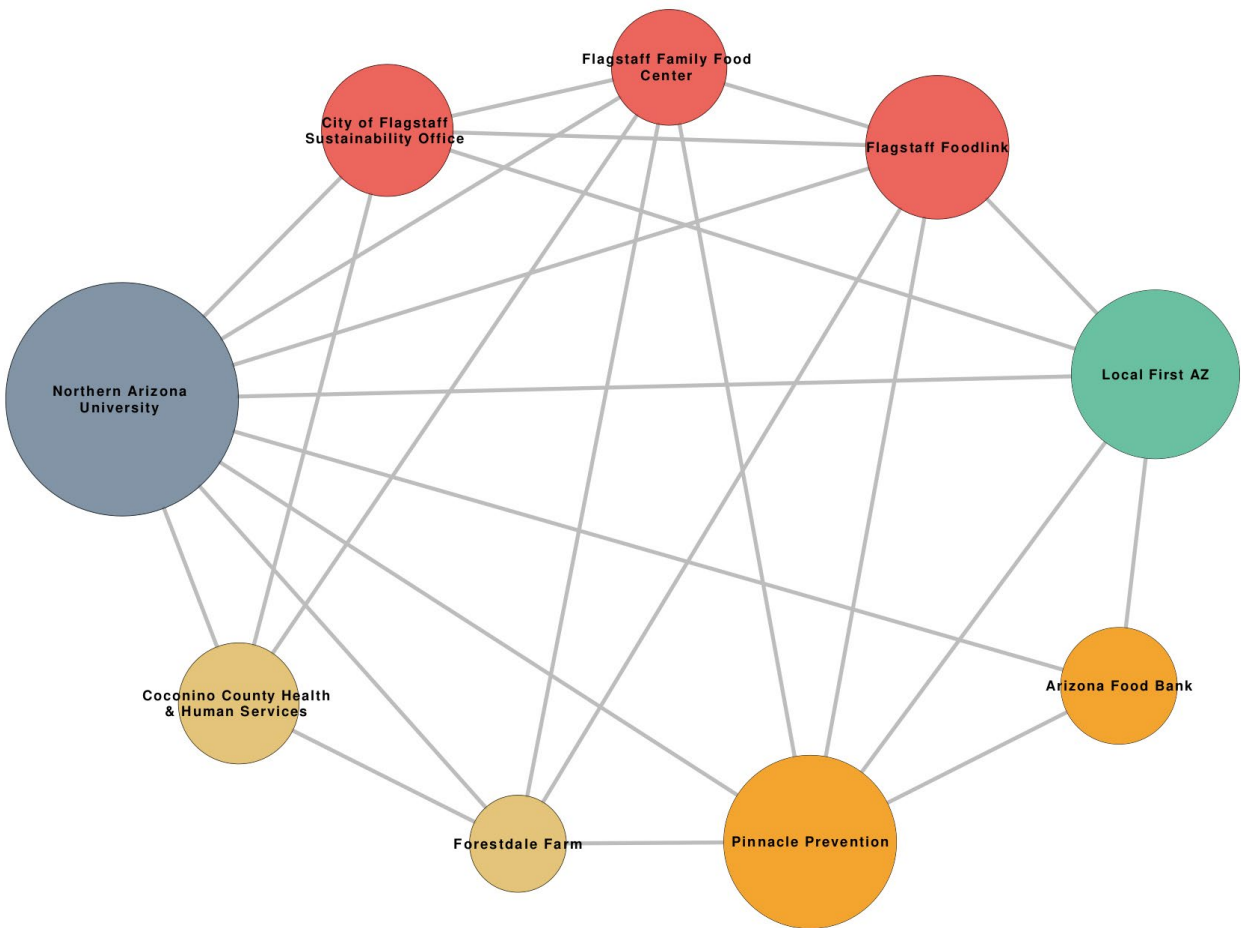


Figure 7: Central core of the collaboration network.

Note: each color indicates a different community and organization size reflects centrality score

Note: In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.

The existence of a central core underscores several critical points of interest:

- *Enhanced Cohesion and Resource Flow:* The central core can facilitate a more efficient flow of information and resources across the network, as these central nodes often serve as major conduits for collaboration and communication.
- *Stability and Resilience:* Networks exhibiting a central core structure can be more resilient to disruptions. The interconnectedness of central nodes can help maintain network integrity and continuity of operations, even in the face of challenges affecting peripheral nodes.
- *Innovation and Spread of Best Practices:* The central core, due to its comprised entities' leadership and expertise, can be a hotbed for innovation. It can play a crucial role in initiating and disseminating new ideas and best practices throughout the network.
- *Potential for Strategic Interventions:* Understanding the central core structure within a network offers strategic entry points for interventions aimed at enhancing collaboration or introducing new initiatives. Engaging with this influential group can amplify the impact of such interventions across the network.

**While the central core effect can have many benefits, it also poses a risk of creating an over-centralized network structure where too much reliance is placed on a few nodes. This can lead to vulnerabilities where the departure or failure of these key nodes significantly impacts the network.**



## Bridging Roles in Collaboration Networks

To assess the significance of each organization within the network, we identify entities that serve as bridges or intermediaries among various community segments, enhancing the flow of information and resources. This role is determined using "betweenness," a measure that essentially quantifies how often an organization lies on the shortest path between other pairs of organizations, indicating its role in connecting different parts of the network (see figure 8).

**In the collaboration network, Northern Arizona University maintains its position as the most influential node with the highest betweenness centrality, indicating its role as a major connector and influencer across various entities.** Local First AZ and Pinnacle Prevention also stand out significantly in this context, serving as critical hubs for collaboration and information dissemination within the network. These organizations are instrumental in bridging different groups, which suggests their involvement in multiple collaborative projects and their capacity to influence a broader spectrum of the network.

The strategic positioning of these entities underscores their potential as key partners in initiatives aimed at enhancing the effectiveness and cohesion of the food distribution system in Flagstaff. Enhancing collaborative ties with and between these central organizations could lead to more integrated and efficient network dynamics, potentially fostering more robust and sustainable food distribution practices across the region.

**The significant betweenness centrality scores of the top organizations contrast sharply with the very low values observed for most other entities in the network. This stark disparity highlights a concentrated locus of influence within a few key organizations, while many others play relatively minor roles as connectors.** Such a distribution suggests that while a select group of organizations facilitates the majority of collaborative efforts and information flow, there is potential to develop and strengthen the bridging capacities of the less central organizations. Enhancing these connections could lead to a more evenly distributed network resilience and a broader dissemination of resources and knowledge across all participants.

Within each community, we observe the presence of one or several organizations with high betweenness scores, functioning as pivotal connectors. These bridge nodes not only consolidate the integrity of their respective communities by ensuring internal cohesion but also play a crucial role in linking smaller organizations to the broader network. By acting as conduits, these bridge organizations facilitate the dissemination of communication, information, and procedural knowledge throughout the network. Their position and function underscore their importance, as they enhance the network's overall connectivity, resilience, and efficiency, ensuring that even the most peripheral members remain informed and integrated.

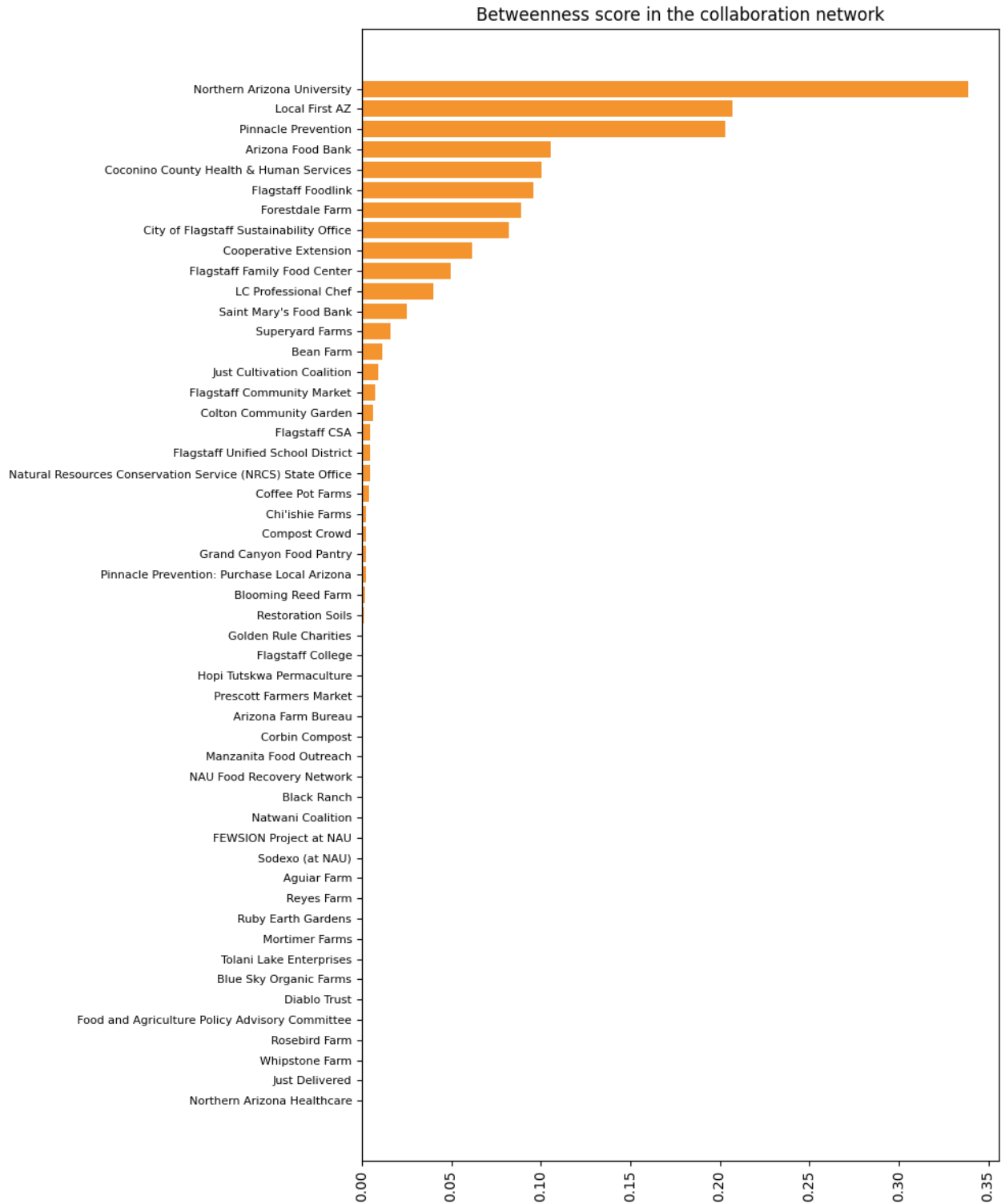


Figure 8: Betweenness scores for each organization within the collaboration network

Note: In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

Figure 9 illustrates the collaboration network, with the size of each organization now adjusted to reflect their betweenness centrality score.

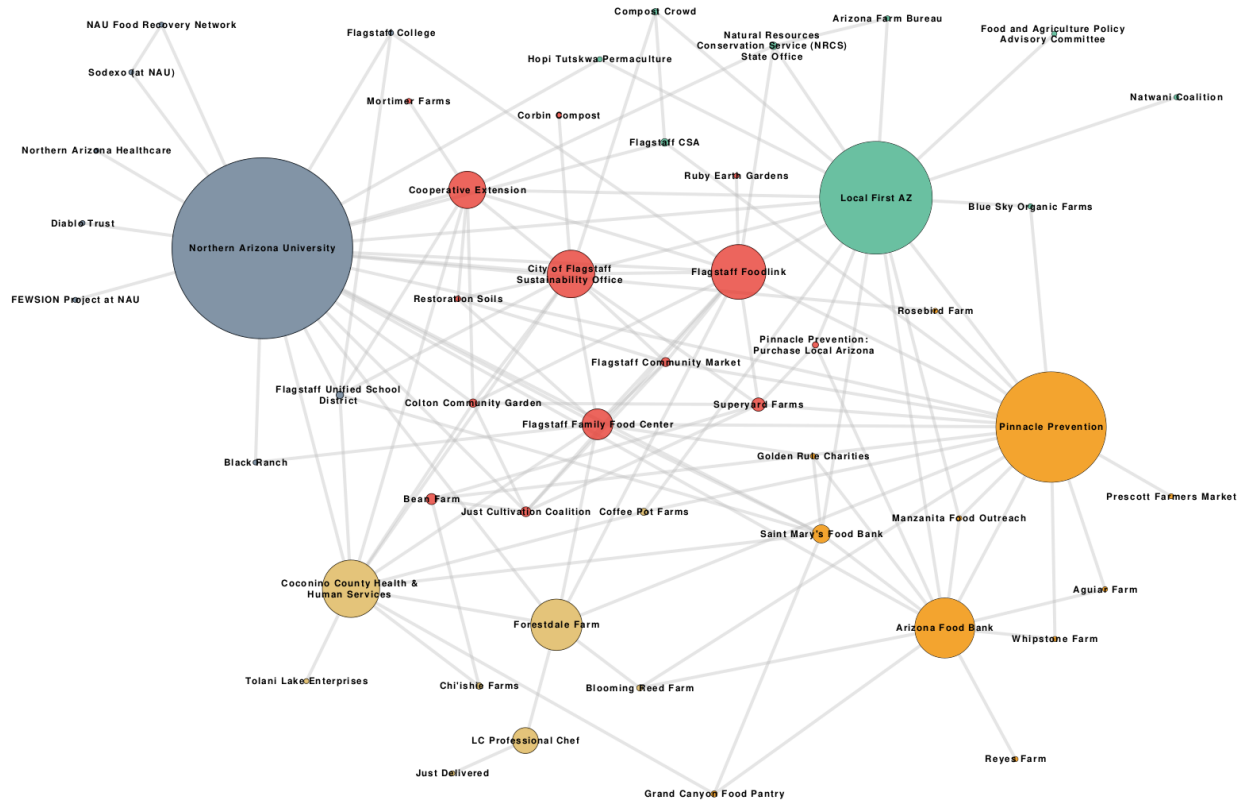


Figure 9: Community structure in the collaboration network.

Note: each color represents a different community. Organization circle size corresponds to their betweenness score. In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

## Funding

To examine the flow of funding within the network and identify which organizations are the primary funders and recipients, we construct the network by synthesizing responses from two distinct survey questions: “We have received funding from this organization,” and “We provide funding to this organization.”

Ideally, these two networks should mirror each other: if A has received funding from B in one network, then in the other, B should be identified as a funder of A. However, due to various factors, a complete reciprocal mapping of funding links is not always observed. For instance, the respondent from organization A may not be privy to all financial interactions, particularly if they are not directly involved with the department that manages or receives funding from organization B, leading to potential gaps in the reported funding relationships.

Merging these two networks provides a fuller picture of funding flows, better highlighting key funders and recipients despite data gaps.

Figure 10 illustrates the funding flow network, where the size of each organization circle corresponds to the number of different organizations it provides funding to. Conversely, figure 11 presents the same network, but here the node size represents the number of different organizations that fund each entity. It's important to mention that this analysis focuses solely on the connections of funding relationships and does not account for the actual amounts of funding given or received, as this information was not collected in the survey.

**In the network of funding distribution, Pinnacle Prevention emerges as the most prolific donor, extensively supporting a wide array of organizations, reflecting its central role in resource allocation and its significant impact on the network's direction.** Among the top receivers, the Flagstaff Family Food Center and Forestdale Farm stand out, each being targeted by multiple funders, which underscores their crucial roles in executing diverse projects and their trusted status within the community.

**Additionally, Northern Arizona University and the City of Flagstaff Sustainability Office illustrate a balanced dynamic, acting both as key donors and prominent recipients.** This balance indicates their integral roles in fostering collaborative efforts and maintaining the vitality of the network, ensuring a symbiotic relationship that enhances the entire community's resilience and efficacy.

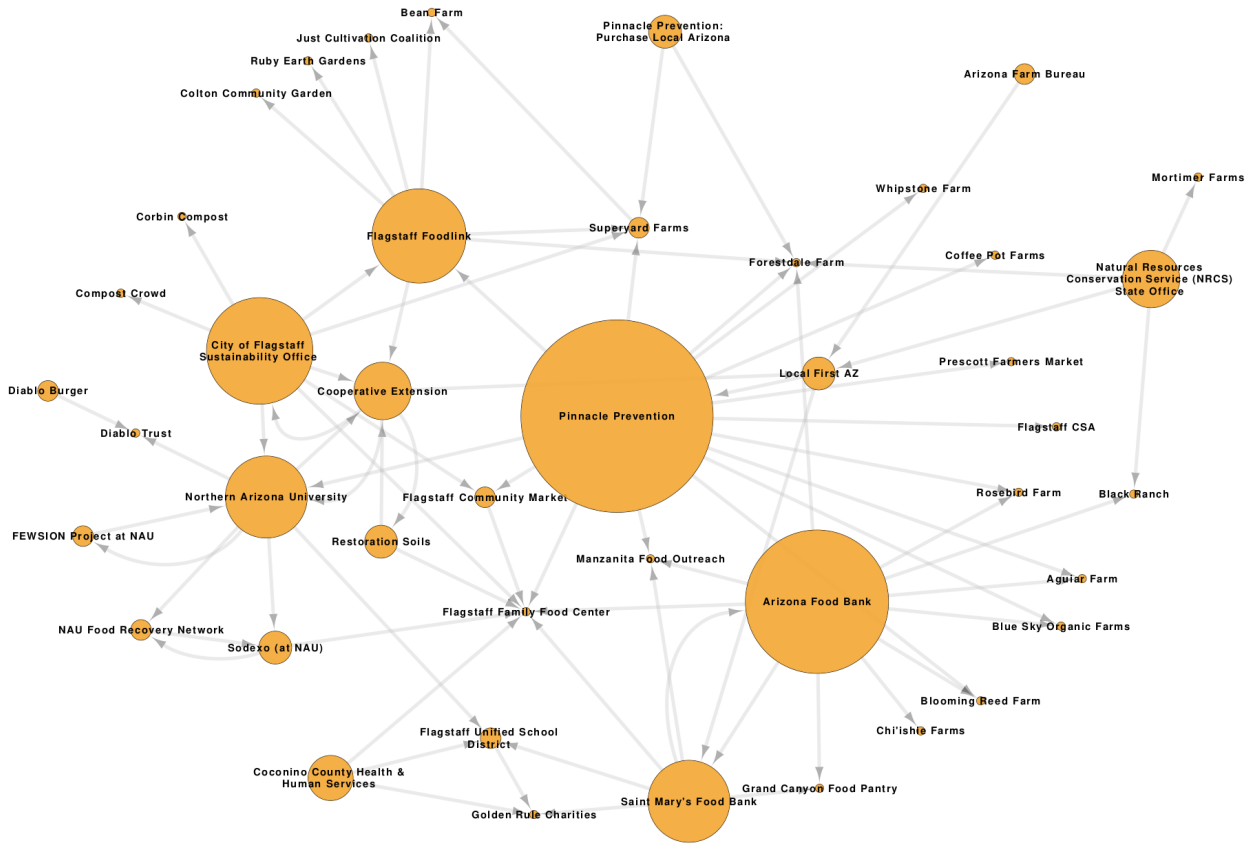


Figure 10: Funding flow network.

Note: the size of each organization corresponds to the number of different organizations it provides funding to. In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.

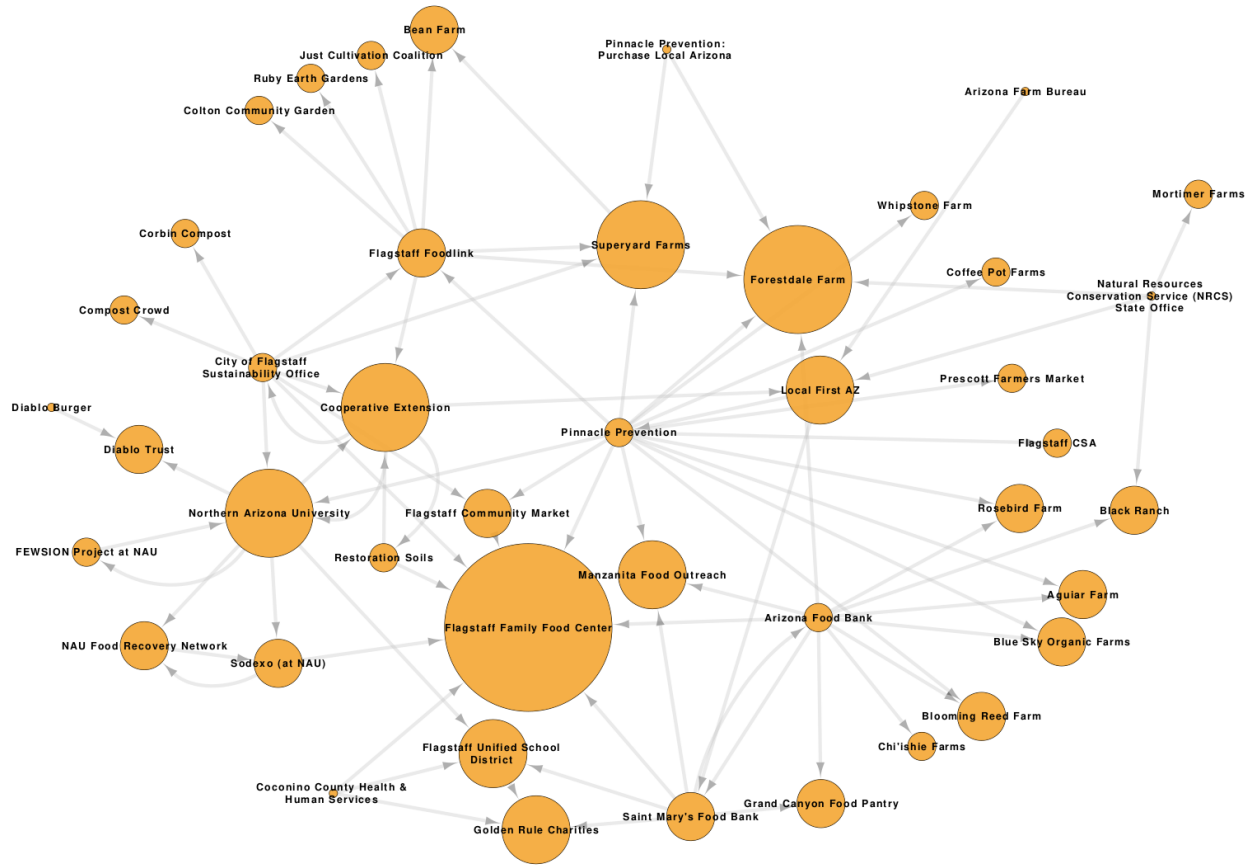


Figure 11: Funding flow network.

Note: the size of each organization is proportional to the number of different organizations providing it with funding. In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.

## Service

Similarly, we combine responses regarding service provision and receipt: "We provide services to this organization" with "We receive services from this organization."

The ensuing network visualizes the "A provides services to B" connections (where a link from A to B indicates service provision from A to B). In figure 12, the size of the nodes reflects each organization's betweenness centrality, indicating the significance of the organization as a bridge in sustaining the service network.

**Northern Arizona University holds the highest betweenness centrality, significantly higher than the rest, which indicates it plays a crucial role in facilitating service provision between various organizations.** It acts as a primary gateway through which services are channeled, positioning it as a central node for coordination and distribution.

Local First AZ and Flagstaff Family Food Center also stand out with high betweenness centrality, suggesting that they too are key conduits in the network, frequently engaged in mediating services between other members. Their strategic positions allow for a strong influence over the flow of services, enabling them to potentially control and shape the dynamics of service provision within this network.

**The large disparity between these central organizations and those with lower betweenness scores points to a hierarchical structure within the network, with a small number of organizations holding substantial control over service distribution.** This could imply potential risks where the removal or failure of these key nodes might disrupt the network's functionality. Conversely, it also opens opportunities for strengthening the network by developing the capacity of lower-centrality organizations to enhance the system's resilience and service redundancy.

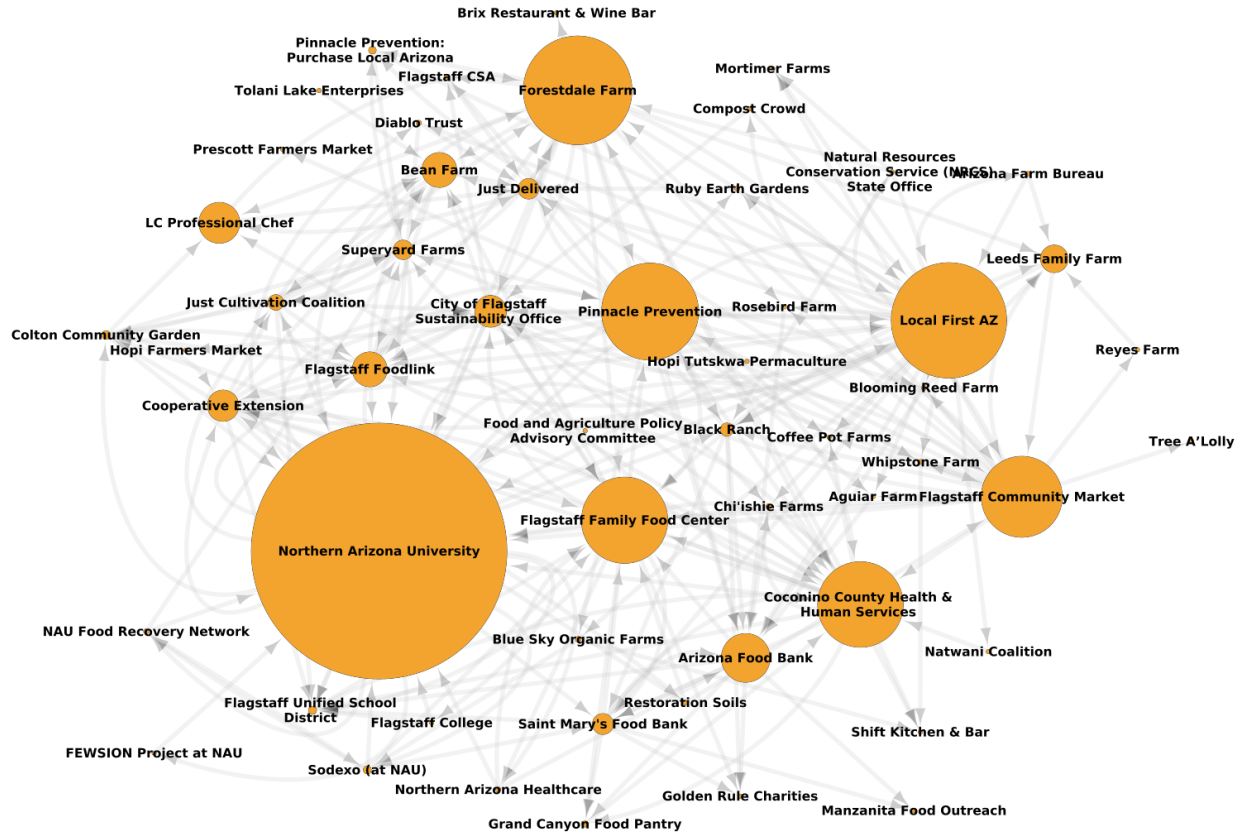


Figure 12: Service network.

Note: the size of each organization is proportional to its betweenness score. In the figure, the “Arizona Food Bank” refers to the Arizona Food Bank Network.



## Joint Funding Request

The "joint funding request" network is established by linking two organizations that have collaborated to submit a funding application as a partnership.

Figure 13 displays the network, with the node sizes reflecting the centrality score of each organization. Organizations with larger nodes are more established and are often sought after as partners by other entities looking to apply for funding collaboratively.

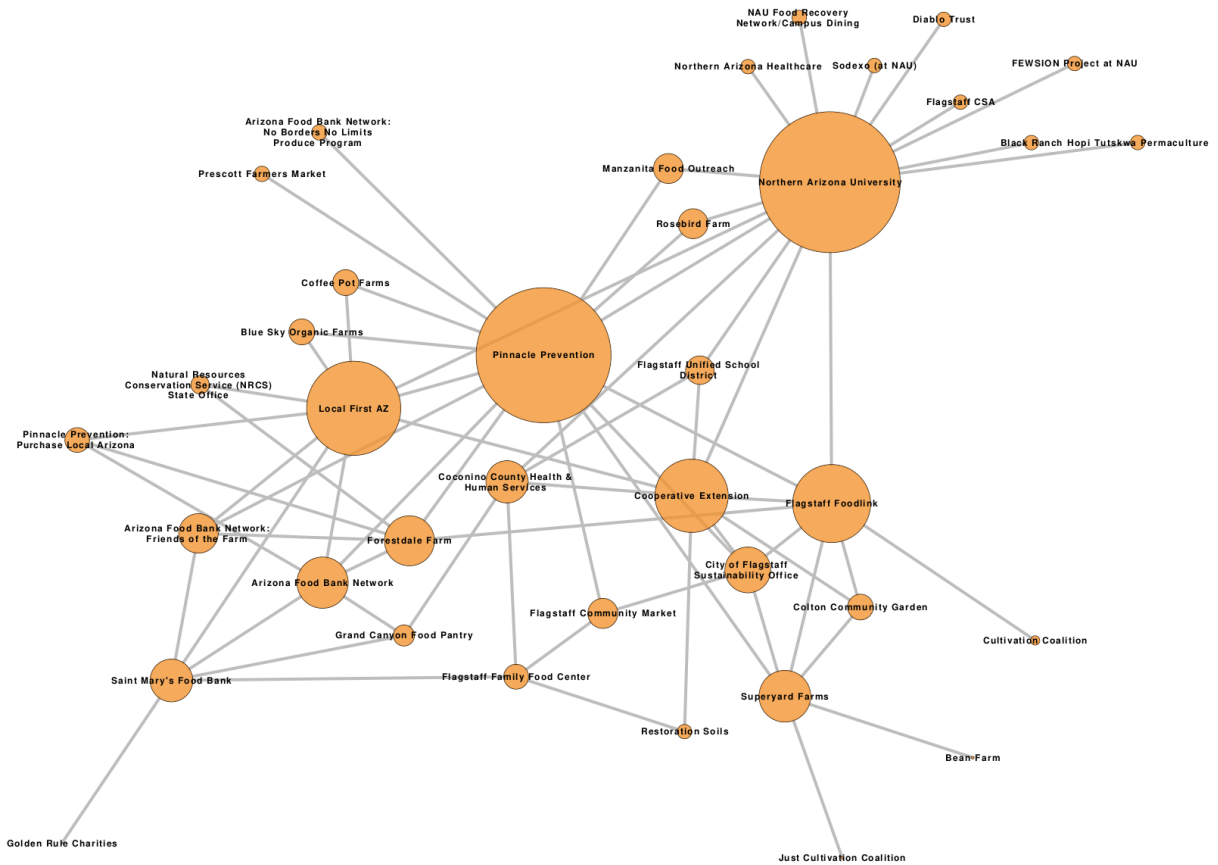


Figure 13: Joint funding network.

Note: the size of each node reflects the centrality score of each organization. In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

Upon mapping the communities within the network, we distinguish several key clusters: one centered on Northern Arizona University (grey), another encompassing non-profit organizations, farms, and food banks operating at the state level (orange), and two other communities (green and red) comprising both government entities and non-profit organizations active at both the county and Flagstaff city levels (see figure 14).

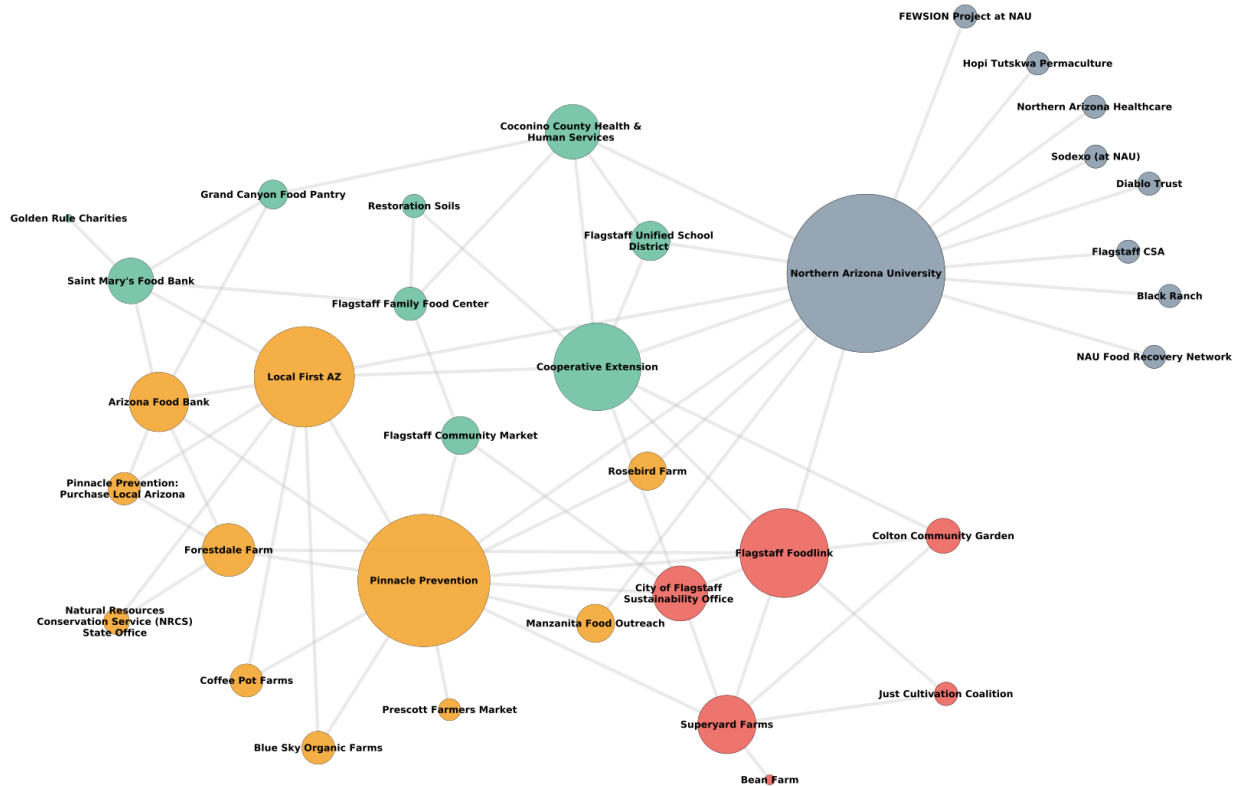


Figure 14: Community structure of the joint funding network.

Note: the size of each node reflects the centrality score of each organization. In the figure, the "Arizona Food Bank" refers to the Arizona Food Bank Network.

## Conclusion

The analysis reveals that entities like Northern Arizona University, the City of Flagstaff Sustainability Office, Pinnacle Prevention, Local First AZ, and Flagstaff Foodlink serve as keystones within the network, evidencing their vast influence and crucial roles in maintaining the flow of services, information, and funding. These organizations, owing to their central positions, have the potential to catalyze significant improvements across the system, propelling initiatives that could reshape the food system's landscape in the region.

However, the hierarchical structure observed, characterized by a few highly interconnected central nodes –the central core, indicates a possible point of fragility. The network's health is tightly linked to these few entities, where their incapacitation could lead to widespread disruption. Thus, while these nodes bolster the network, their prominence also necessitates the creation of a more robust and diversified structure to ensure resilience against potential shocks.

## Recommendations

**Decentralization of Influence:** To mitigate risks associated with over-reliance on central nodes, efforts should be directed towards decentralizing the network's influence. This can be achieved by empowering peripheral organizations, building their capacity for service provision, and integrating them more thoroughly into funding and information exchanges. Workshops, training programs, and resource-sharing initiatives could be instituted to elevate these organizations' roles within the network.

**Bridging Gaps in Collaboration:** Organizations with low betweenness scores represent untapped potential for enhancing network connectivity. By fostering partnerships with and between these entities, we can create more pathways for collaboration, leading to a denser, more interconnected network. Initiatives such as mentorship programs, collaborative grant opportunities, and regular networking events can bridge gaps and create a more cohesive food system.

**Strategic Community Building:** The identification of communities within the network offers a blueprint for targeted interventions. Policymakers and funders should concentrate efforts on reinforcing successful community structures and addressing collaboration gaps. By doing so, they can optimize resource allocation, support best practice dissemination, and ultimately, amplify the collective impact on the food system.

In conclusion, while the analysis has showcased the network's strengths, it has also highlighted areas for growth. By implementing these recommendations, stakeholders can not only enhance the network's efficiency and resilience but also foster an environment where innovation thrives, best practices are shared, and collective impact is amplified, ensuring that the regional food system can sustainably meet the needs of its community.