SOCIAL NETWORK ANALYSIS: A THEORY AND METHOD FOR ASSESSING AND SUPPORTING MULTI-DISCIPLINARY, MULTI-INSTITUTIONAL RESEARCH PROJECTS

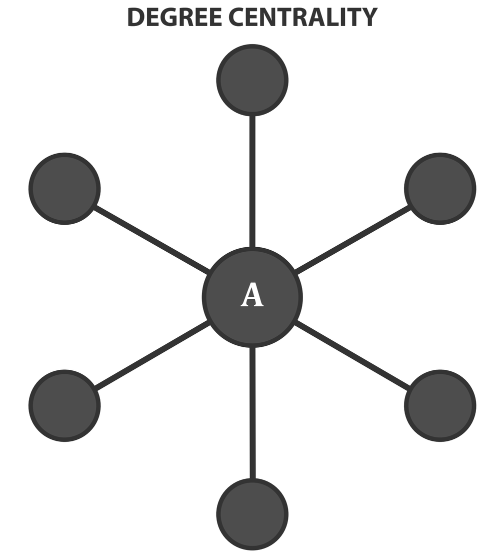
JOCELYNE HELBLING (UNIVERSITY OF IDAHO)**; DAVID MEYER** (BOISE STATE UNIVERSITY)

INTRODUCTION: Collaboration and integration have become increasingly important within the scientific community because complex challenges, like climate change or cancer prevention, often require the expertise of many academic disciplines, research institutions, and stakeholder groups. Yet, concepts such as integration and collaboration are often ambiguously defined making it difficult for research teams to establish goals and metrics for collaboration and knowledge integration (Tress, Tress & Fry, 2006). The REACCH social network analysis helps illustrate the collaboration activities across our intellectually diverse and geographically distant research teams. This research combines network centrality measures with team science metrics and measurements (self-reported perspectives of trust and productivity within the project) to provide a one-time snapshot of the collaborative relationships, trust, and perceived productivity across the REACCH team (Masse et al., 2008; Gajda, 2004; Tress, Tress & Fry, 2006). Social network analysis (SNA) provides a methodological approach to measure the relational patterns across a network of individuals or groups. Research in network science has led to the development of a family of metrics, collectively referred to as centrality, that describe how networks are organized as a whole and the potential for influence that is provided by a given position within the network (Freeman, 1979; Krackhardt, 1994; Wasserman, et al., 1994; Borgatti & Foster, 2003; Stephenson & Zelen, 1989). The results illustrated here provide quantitative measures of the connections across individuals and graphic illustrations of key nodes that may serve to connect areas of the network that are otherwise less connected due to specialty or geographic location. Coupling social network and team science information with qualitative information on the nature of connections across the network structure may provide additional insight for managing complex research projects with multiple disciplines, institutions, and stakeholder groups.

METHODS: The REACCH Social Network was compiled from survey data collected by Adam Bond and David Meyer during the REACCH 2013 Annual Meeting. The survey consisted of a list of all REACCH participants, and asked respondents to identify the nature of their interaction with each individual on a five point scale based on previous work by Gajda (2004) and Tress, Tress & Fry (2006). The five point scale included: (1) Don't know the person, (2) No Direct Contact: you know who this person is, but do not have direct contact with them, (3) Communication: you have shared information with this person to meet project goals, (4) Collaboration: you have actively worked together to set common goals, realized a shared goal or contributed to collaborative knowledge or (5) Integrated thinking: you believe there has been a strong integration of ideas, merging of perspectives, and growth of common understanding. These interactions were then mapped in a network diagram where each individual was represented as a node or point and connections with others in the network were represented as a lines or edges, with the strength of the interaction being represented by the line weight. This poster focuses on the Collaboration Network Analysis, which includes only those interaction reported as being either collaborative or integrative level. The REACCH Social Network Analysis focuses on two centrality measures in particular: degree centrality and betweenness centrality.

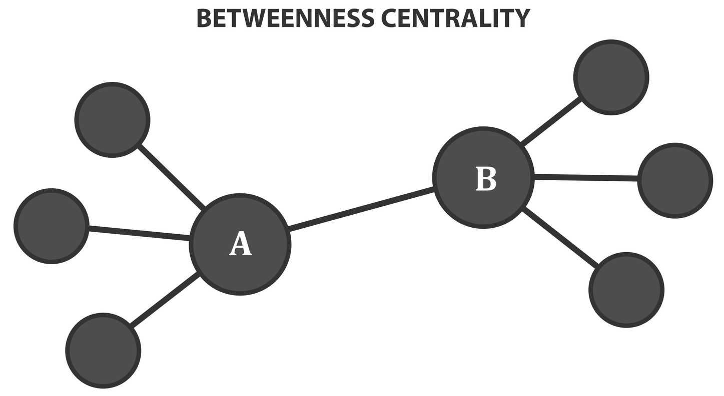
NETWORK METRICS: Perhaps the most intuitive measure of a node's influence within a network is that of degree centrality. A node's degree refers to the number of other nodes with which it is directly connected. These nodes are considered potentially influential because it is likely that an individual with a large proportion of direct connections would consider themselves, and be considered by others as an important source of information within the network. Because these individuals are in contact with a large percentage of the network's communication flow they are often considered to be "in the know" and aware of what is going on within the organization. Nodes with high Degree Centrality are considered central to the network because they not only receive a large portion of information, but also have potential control over information dissemination by generating or transforming much of the information flowing throughout the network. Nodes with many direct connections may be perceived or identified as the formal or informal leaders of the organization.

DEGREE CENTRALITY



NODE A HAS HIGH DEGREE CENTRALITY. IT IS DIRECTLY CONNECTED TO A LARGE PROPORTION OF OTHER NODES IN THE NETWORK

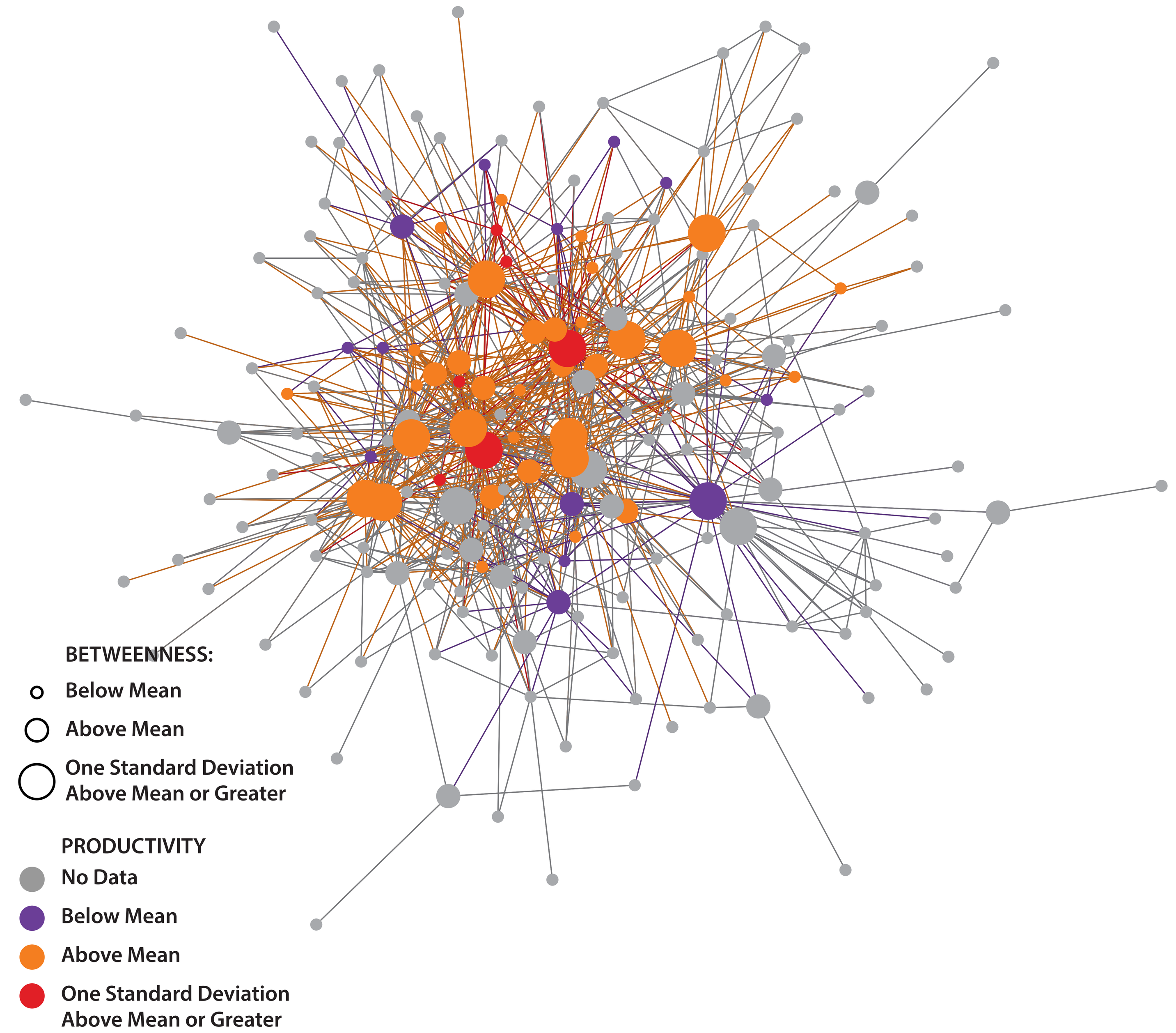
BETWEENNESS CENTRALITY



NODES A AND B HAVE HIGH BETWEENNESS CENTRALITY. OTHER NODES IN THIS NETWORK ARE INDIRECTLY CONNECTED THROUGH THESE NODES.

Betweenness centrality describes the extent to which an individual or node is between other nodes, that is to what extent a node is directly connected to other nodes which are not directly connected to each other, thereby creating an indirect connection, or bridge, between these other nodes. betweenness centrality may indicate a node's potential influenced based on the premise that the node's role in connecting other nodes gives it a level of control over information flow. An individual between two nodes may serve as a coordinator of information by maintaining communication paths that connect resources and expertise in different areas of the network. The more nodes within the network that a node is between the higher its betweenness centrality measure.

REACCH 2013 COLLABORATION NETWORK: PRODUCTIVITY & BETWEENNESS CENTRALITY

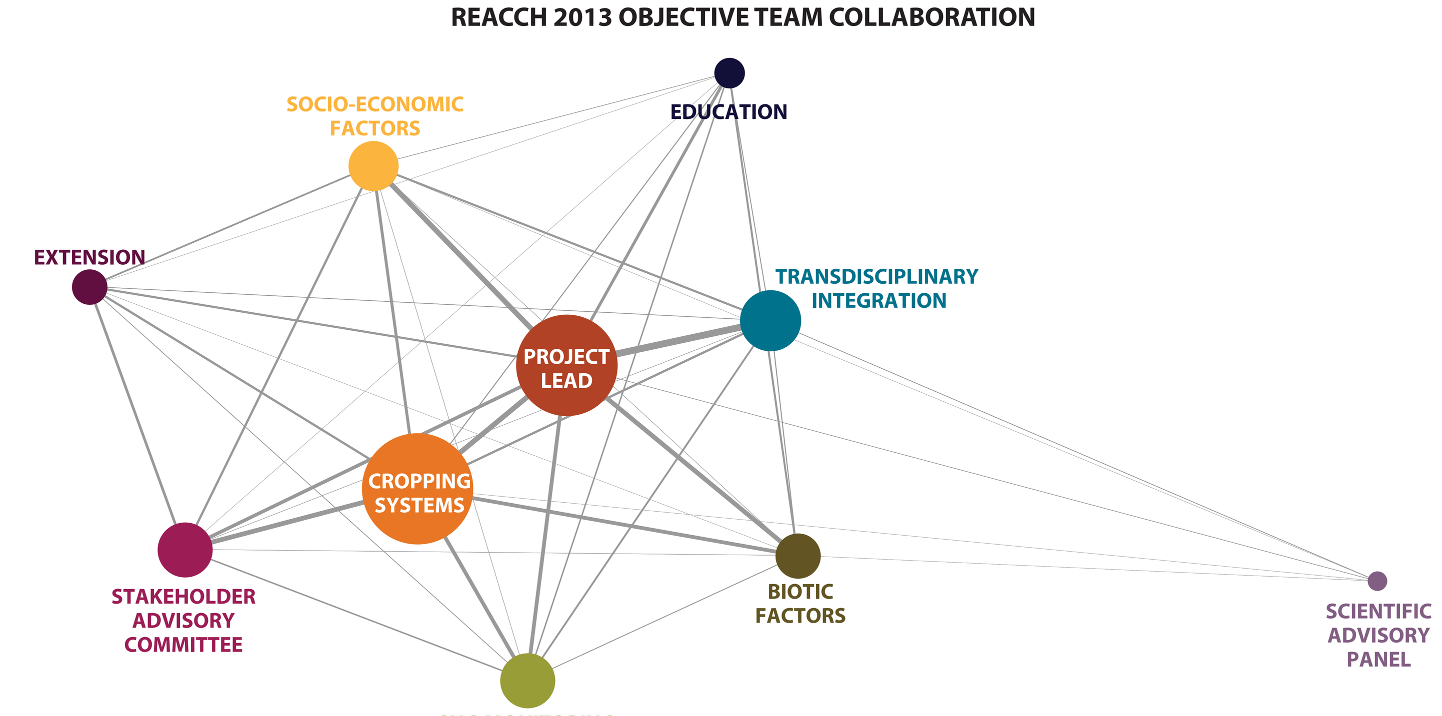


In the REACCH Collaboration Network: Productivity and Betweenness Centrality visualization Masse productivity scale is applied to nodes within the network. The average betweenness centrality measure (0.025) among participants reporting a higher than average productivity level is nearly 3 times higher than the average betweenness centrality measure for the entire REACCH Collaboration Network (0.009). A position of high betweenness centrality within the network may increases an individual's perceived level of productivity, possibly due to increased access to resources needed to complete their tasks. Analysis of the Masse survey data also revealed a significant difference in self-reported productivity levels between participants located in the Moscow/Pullman area and those based in other locations. Average betweenness centrality measures for participants in the Moscow/Pullman area (0.01) are also higher than the average betweenness centrality measure for participants in other locations (0.008).

REACCH 2013 COLLABORATION NETWORK: TEAM LEADERSHIP & DEGREE CENTRALITY

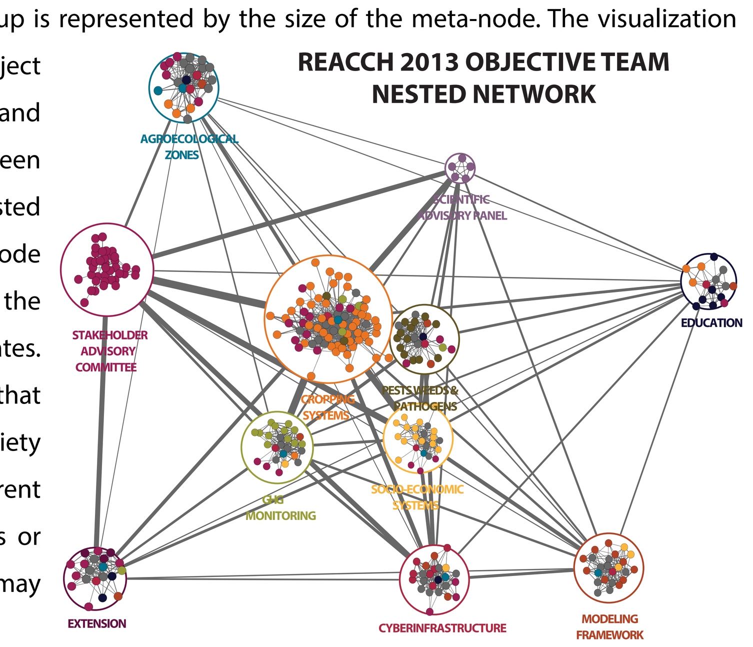
The REACCH Collaboration Network: Degree Centrality & Team Leads visualization shows the degree centrality of project management and team leaders throughout the network. As would be expected, most management and leadership individuals show high degree centrality. In addition to these prescribed leaders a number of project members also show high degree centrality. These individuals may represent the project's informal leaders—people who may be seen by others as trusted and knowledgeable sources of information. Individuals characterized by below average degree centrality scores also have a critical role to play as they may have better access to diverse knowledge and resources outside of the high degree centrality nodes. Over 50 years of research on group dynamics in complex problem solving situations suggests that more heterogeneous groups may be better equipped to solve complex problems (McGrath 1984; Mulder 1960; Shaw 1954; Shaw 1981) or able to implement solutions to difficult problems like climate change (Held & Edenhofer 2008; Norgaard 2005). More recent research in social networks also suggests that individuals with lower degree centrality may be highly valuable contributors due to their connections to other communities, ideas, and resources (Granovetter, 1974; Krebs and Holley, 2006).

REACCH 2013 OBJECTIVE TEAM COLLABORATION



In addition to analyzing relational patterns between individuals within a group, SNA can be applied to connections between subgroups of a population by combining nodes belong to the same subgroup into a single meta-node. The REACCH 2013 Objective Team Collaboration Network (figure 3) combines all nodes with the same primary objective into a single meta-node. Because some objectives have very few individuals who claim it as their primary objective, some objectives were aggregated into a single subgroup. The number of nodes in each group is represented by the size of the meta-node. The visualization shows Project Leadership as being very central to the project with the Scientific Advisory Panel playing a more distant and adjacent role, and fairly distributed connections between objectives. The 2013 Objective Team Collaboration Nested Network creates a similar view of the objective meta-node network however in this case each node is included in both the primary and any secondary objectives in which it participates. Each Objective was assigned a color, node color indicates that individual's primary objective. Objectives with a wider variety of colors have a larger number of participants from different objectives. In future iterations alternative node attributes or characteristics such as individuals' expertise or disciplines may provide a more in-depth picture of collaboration.

REACCH 2013 OBJECTIVE TEAM NESTED NETWORK



REFERENCES: Borgatti, S.P. and Foster, P.C. (2003). The Network Paradigm in Organizational Research: A Review and Typology. Journal of Management 29:991-1013; **Freeman, L. (1979).** Centrality in Social Networks Conceptual Clarification. Social Networks 1, 215-239; **Gajda, R. (2004).** Utilizing Collaboration Theory to Evaluate Strategic Alliances. The American Journal of Evaluation (25(1), 65-77; **Granovetter, M.S. (1974).** The Strength of Weak Ties. American Journal of Sociology, 78(6): 1360-1361; **Held, H. and Edenhofer, O. (2008).** Climate protection vs. economic growth as a false trade off: Restructuring global warming mitigation. In G. Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C Pohl, C.; U. Wiesmann, and E. Zemp (Eds.). Handbook of Transdisciplinary Research. Pp. 191-294. Springer Science; **Krackhardt, D. (1994).** Graph Theoretical Dimensions of Informal Organizations. In K. Carley and M. Prietula (Eds.), Computational Organizational Theory. (pp. 89-111). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc; **Krebs, V. and Holley, J. (2006)** Building Smart Communities through Network Weaving. www.orgnet.com/BuildingNetworks.pdf; **Masse, L.C., Moser, R.P., Stokols, D., Taylor, B.K., Marcus, S.E., Morgan, G.D, et al. (2008).** Measuring Collaboration and Transdisciplinary Integration in Team Science. American Journal of Preventative Medicine 35, 151-160; **McGrath, J. E. (1984).** Groups: Interaction and performance. Englewood Cliffs, NJ.: Prentice-Hall; **Mulder, M. (1960).** Communication structure, decision structure and group performance. Sociometry, 23(1): 1-14; **Norgaard, R. B (2005).** Collectively seeing complex systems: The nature of the problem. Bioscience (0006-3568), 55 (11): 953; **Shaw, M. E. (1954).** Some effects of problem complexity upon problem solution efficiency in different communication nets. Journal of Experimental Psychology, 48(3): 211-217.. **Shaw, M.E. (1981).** Group dynamics: The psychology of small group behavior (3rd ed.) New York: McGraw-Hill book Co. **Stephenson, K. and Zelen, M. (1989).** Rethinking Centrality: Methods and Examples. Social Networks 11, 1-37; **Tress, B., Tress, G. and Fry, G. (2006).** Defining Concepts and the Process of Knowledge Production in Integrative Research. In B. Tress, G. Tress, G. Fry and P. Opdam (Eds.), From Landscape Research to Landscape Planning: Aspects of Integration, Education and Application (pp. 13-26). Wagenigen UR; **Wasserman, S. and Faust, K. (1994).** Social Network Analysis: Methods and Applications. New York, NY: Cambridge University Press.

OSU Oregon State University · Washington State University · University of Idaho · USDA Agricultural Research Service www.ars.usda.gov · USDA United States Department of Agriculture · National Institute of Food and Agriculture · REACCH Regional Approaches to Climate Change

***"Regional Approaches to Climate Change for Pacific Northwest Agriculture"* is funded through award #2011-68002-30191 from the National Institute for Food and Agriculture**