

University of Vermont

ScholarWorks @ UVM

Transportation Research Center Research Reports

7-15-2012

Social Network Analysis of Sustainable Transportation Organizations

Richard Watts

University of Vermont, rwatts@uvm.edu

Aaron Witham

University of Vermont

Follow this and additional works at: <https://scholarworks.uvm.edu/trc>

Recommended Citation

Watts, Richard and Witham, Aaron, "Social Network Analysis of Sustainable Transportation Organizations" (2012). *Transportation Research Center Research Reports*. 216.

<https://scholarworks.uvm.edu/trc/216>

This Report is brought to you for free and open access by ScholarWorks @ UVM. It has been accepted for inclusion in Transportation Research Center Research Reports by an authorized administrator of ScholarWorks @ UVM. For more information, please contact donna.omalley@uvm.edu.



A Report from the University of Vermont Transportation Research Center

Social Network Analysis of Sustainable Transportation Organizations

TRC Report #12-008 | Watts and Witham | July 2012

“Social Network Analysis of Sustainable Transportation Organizations”

UVM Transportation Research Center

July, 15, 2012

Prepared by:

Richard Watts, Ph.D.
Aaron Witham

Transportation Research Center
Farrell Hall
210 Colchester Avenue
Burlington, VT 05405

Phone: (802) 656-1312
Website: www.uvm.edu/transportationcenter

Acknowledgements

The research team would like to acknowledge Dr. Tao Sun of the department of Community Development and Applied Economics at the University of Vermont for his significant contribution helping to design this project, build the survey, analyze the data, and co-author academic papers on the findings. We also want to thank University of Vermont professor Curt Ventriss of the Rubenstein School of Environment and Natural Resources for his contribution co-authoring an article related to this research. Former UVM student, Emily Clark, also deserves significant credit for collecting the data on media coverage. Finally, we want to thank Dr. Stephanie Kaza of the Rubenstein School and all the transportation professionals who provided feedback on this research. This research was funded by the University of Vermont's Transportation Research Center under the US Department of Transportation.

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the UVM Transportation Research Center. This report does not constitute a standard, specification, or regulation.

Table of Contents

1. Introduction	1
2. Background & Methods	2
2.1 Participating Organizations	2
2.2 Data Collection	3
2.3 Data Analysis.....	4
3. Results & Discussion	6
3.1 What do the Networks Look Like and Who is Central Within Them?	6
3.2 Does Network Position Relate to Perceived Influence?	15
3.3 What Network-derived Characteristics Relate to Nonprofits' Perceived Influence?	17
3.4 Does Network Position Relate to Appearance in the Media?	18
4. Conclusion	20
Appendix.....	21
References.	22

List of Tables

Table 2-3. Summary Statistics	5
Table 3-1-A. Network Position of Maine Organizations	8
Table 3-1-B. Network Position of New Hampshire Organizations.....	10
Table 3-1-C. Network Position of Vermont Organizations	12
Table 3-1-D. Mean Indegree by Cohort in Maine	13
Table 3-1-E. Mean Indegree by Cohort in New Hampshire.....	13
Table 3-1-F. Mean Indegree by Cohort in Vermont	13
Table 3-2-A. Correlations between Centrality & Perceived Influence	16
Table 3-2-B. Correlations between Number of Cliques & Perceived Influence.....	17
Table 3-3. Correlations between Characteristics & Perceived Influence (Among Nonprofits).	18
Table 3-4. Correlations between Organizational Characteristics and Media Coverage	19

List of Figures

Figure 2-3. Example of a Clique	4
Figure 3-1-A. Maine’s Communication Network	7
Figure 3-1-B. New Hampshire’s Communication Network	9
Figure 3-1-C. Vermont’s Communication Network	11
Figure 3-1-D. Group Density by State.....	14
Figure 3-1-E. Number of Cliques by State.....	14
Figure 3-2. Vermont’s Communication Network with Node Size Corresponding to Influence	15

1. Introduction

Studying how organizations communicate with each other can provide important insights into the influence, and policy success of different types of organizations. This study examines the communication networks of 121 organizations promoting sustainable transportation policy in northern New England during 2010. Transportation is a leading contributor to greenhouse gas emissions, air pollution and public health concerns. For this reason, sustainable transportation is an important issue for the health of the environment and the public.

Who are the organizations at the center of the networks around sustainable transportation? How do they communicate with each other and with whom? We asked each of these 121 organizations who they send information to, who they receive information from and who they see as most influential in the network around sustainable transportation policy. Results from those questions are analyzed to show the relationships and communication patterns of the organizations in the study.

Networks are becoming a critical level of analysis for understanding how public policy is made and by whom. Environmental problems, such as sustainable transportation, engage a broad range of stakeholders including government entities, nonprofits, political advocacy organizations and business groups. The complicated nature of accomplishing sustainable transportation is easily beyond the scope of any single organization's political jurisdiction or technical capacity. Previous research has demonstrated how these networks of diverse interests affect organizations within them and how their position within the network affects their ability to succeed at their goals. For example, studies have indicated that who organizations communicate with affects their success. Their level of influence in a policy network can also boost their influence over the policy process. This influence can be derived by occupying certain positions. For example, organizations that provide bridges to other networks or provide bridges within a network play important functions of advancing policy goals.

This study examines the communication networks of 121 organizations promoting sustainable transportation policy in northern New England. "Sustainable transportation" is defined here as ameliorating transportation's contribution to greenhouse gas emissions ^[1], ground based air pollution ^[2], pollution in waters and streams ^[3], and human health issues such as obesity ^[4] and lung disease ^[5]. In a broad sense, it meets the needs of the present without compromising the needs of future generations ^[6]. Organizations promoting this goal include government agencies, planning commissions, nonprofits, transit providers and businesses. Communication patterns consist of the sending and receiving of information, which may be reflective of collaboration, sharing resources, and other relationships that influence an organization's power to affect the policy process. Maine, New Hampshire, and Vermont are the focus of this study because of their geographical proximity, and their similarities in terms of population densities and demographics, climates, and transportation challenges ^[7].

The researchers asked four broad questions of the networks:

1. What do the networks look like and which organizations are central in them?
2. Does being central matter to organizations by relating to their level of influence?
3. Do these relationships hold up within the cohort of nonprofits?
4. How does network position and network-derived power relate to media coverage?

2. Background & Methods

2.1 Participating Organizations

Participants were defined as organizations involved in sustainable transportation policy, either through having a registered lobbyist, through appearing in the news media as an advocate for a policy position, having testified in the Legislature, or through presenting plans that promote policies related to sustainable transportation. “Sustainable transportation policy” was defined as “being related to environmental themes, such as alternatives to private automobiles, walking, biking, public transit, passenger rail, smartgrowth, funding that promotes alternatives, position on gas taxes, VMT fees, or feebates.”

The organizations also had to be officially incorporated as a non-profit, business, or government agency. If they were a regional or national organization, they had to have an office in the state for which the network data was being collected. If they did not have a dedicated office space, they had to at least have dedicated staff working in the state beyond a hired lobbyist.

All organizations fitting these criteria were included in the study with a few exceptions. Groups focused exclusively on safety issues were excluded, such as insurance companies, as well as groups solely interested in acquiring money for projects, such as pavement companies. These groups were excluded so that the networks could be kept to a feasible size for analysis. Only the state chambers of commerce and each state’s chamber of commerce associated with its largest city were included. Although chambers of commerce are not usually strong proponents of sustainable transportation, they were included here to broadly represent the interests of private industry since most private businesses did not fit the criteria to be included. Only the largest transit providers in each state were included, as well as the state-wide transit agencies in cases where there was one. Transit providers were largely excluded because of their primary interest in providing service rather than influencing policy. Moreover, including all of them would have made the networks too large for the type of analysis the researchers were interested in. Additional organizations were eliminated because they had recently become obsolete or became obsolete during the study period of August, 2010 to November, 2010.

To find organizations that fit the criteria, a thorough internet search was conducted to develop a preliminary list. Then, these lists were vetted with a number of professionals in the transportation field from each of the three states. In the spirit of a snowball sampling approach, the professionals were encouraged to suggest additions so that the list could be as exhaustive as possible.

Most of the organizations identified for the study fell into one of the following categories: regional planning organizations and metropolitan planning organizations; state departments or agencies; non-profit advocacy organizations; and transit providers.

Nonprofits are the largest cohort with the networks. These nonprofits are concerned with the human health effects of transportation, transportation’s impact on the environment, issues of system accessibility, and others. Some of them are advocacy groups promoting specific policy solutions, while others are more focused on public education or program implementation. Regardless of their specific agenda, they are a fast growing cohort gaining power through state lobbying efforts and representation on special regional planning committees. In fact, the fastest growing segment of environmental nonprofits in the United States consists of those focused on renewable energy and energy conservation, two themes that relate strongly

to transportation. The revenue for these groups increased fourteen fold between 1989 and 2006, suggesting that their ability to influence the policy process will also be enhanced. Many of these organizations are new organizations created after 2000, who have yet to build strong collaborations in the policy environment, but soak up 64% of all the funding allocated to environmental nonprofits ^[8].

MPOs (metropolitan planning organizations) and RPCs (regional planning commissions) are the second largest cohort in the study. They are key players in the sustainable transportation field because they have been tasked with developing regional transportation plans and prioritizing projects for funding since 1962 ^[9]. The regional arena is ground zero for the bulk of policy decisions affecting system sustainability within states ^[10], especially since the passage of ISTEA in 1991, when planning commissions were mandated to work more closely with state departments concerned with air quality, local governments, and public and private interest groups ^[10]. Therefore, MPOs and RPCs (regional planning commissions) have a unique power to carry out decision-making processes and facilitate or constrain collaboration between multiple interests.

State departments of air quality, environmental protection, public health, and transportation comprise the third largest cohort within the networks. State departments of transportation are often leaders in state-wide efforts to implement sustainable transportation programs, and they handle an average of 77.7% of the total funding pool for surface transportation. The departments concerned with transportation's impact on air quality also play an important role in sustainability efforts by developing MOUs with transit agencies and planning commissions on air quality plans for the Clean Air Act ^[10].

Transit providers are the smallest cohort in this study. Besides providing an alternative transportation service, they are also involved in air quality planning with MPOs and state agencies under the Clean Air Act ^[10].

2.2 Data Collection

Participants in each state were sent email surveys in the fall of 2010, which differed only in the names of the organizations listed. The survey was workshopped by a focus group of transportation professionals in August of 2010. It was designed in Survey Monkey with two major goals in mind. One was to collect information about all possible directional ties between organizations in a pre-determined population. Therefore, respondents were asked to indicate who they send information to and receive information from regarding sustainable transportation policy. They were given a list of all the organizations in their network and were asked to click a box indicating send or receive next to the name (See appendix for a sample of the survey layout).

The second major goal was to collect multiple attributes that could later be correlated with organizations' centrality scores, such as organization age, amount of time spent working on sustainable transportation, percentage of work devoted to sustainable transportation, number of ties with other organizations in New England, budget size, staff size, what role organizations play in the sustainable transportation field, what issues are most important to them, etc. Other attributes were collected through Likert scale questions in order to be able to analyze the strength of communication ties between organizations and how they perceive each other. For example, organizations were asked to rate the other organizations on how frequently they communicate with them, how influential they perceive them to be in the field of sustainable transportation, and how useful their information is regarding sustainable transportation.

Out of 122 organizations identified to participate, 121 responded to the survey, representing an over 99% response rate.

Beyond the communication networks, additional data was collected on hyperlinks between organizations and their appearance in the media. A tool called SocSciBot ^[11] was used to crawl organizations' websites and identify which organizations within the network were linking to each other. Data on organizations' appearance in the media was collected by searching the database Lexus Nexus for all Associated Press articles written on the topic of "sustainable transportation" in the years 2008-2010. The articles were then searched for organizations' names. An organization was noted as appearing in the media a maximum of one time per article.

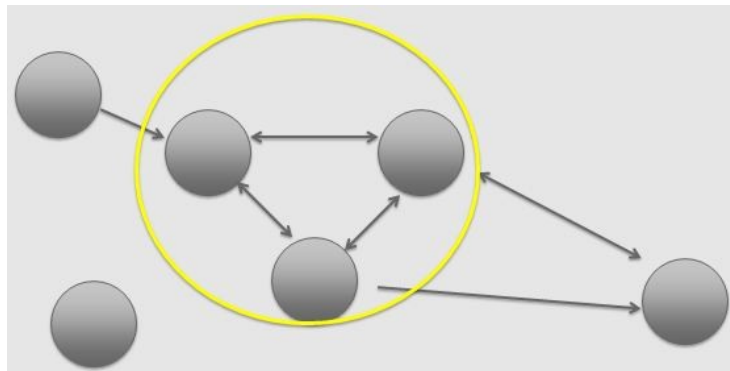
2.3 Data Analysis

Survey responses were then imported into UCINET ^[12], a social network analysis software, in order to build network models. The network models were analyzed to answer the first research question of what the networks look like and who is central within them. The models for each state were compared by running algorithms in the software, and the position of individual organizations in the networks were determined using algorithms.

Position algorithms measured centrality and number of cliques. Three common forms of centrality were calculated for each organization: indegree, betweenness, and closeness. Indegree is the simplest measure, consisting of a tally of the number of incoming ties an organization receives from others ^[13, 14, 15]. An organization with more ties is more central than an organization with less ties. Betweenness is a measure of the extent to which an organization is between other organizations who have limited communication with each other. In other words, an organization with high betweenness serves as a bridge or a broker between disparate parties ^[13, 14, 15, 16]. Closeness is a measure of the relative proximity of an organization to all other organizations in the network ^[13, 14, 15]. Organizations with higher closeness scores are closer, on average, to every organization in the network compared to organizations with lower closeness scores.

The number of cliques in each state was also calculated, as well as the number of cliques to which an organization belongs. Cliques are groups of three or more organizations who are all connected to each other ^[14]. In Figure 2-3 (below), the three nodes with full connection to each other comprise a clique. Organizations may belong to multiple cliques within the same network.

Figure 2-3. Example of a Clique



Statistical analysis was then conducted in SPSS, a statistical software, in order to answer research questions 2-4 on whether or not centrality matters to organizations. Analysis included Pearson correlations to test for relationships between network position and metrics of power such as influence and media coverage.

Table 2-3 (below) provides a snapshot of the characteristics of the organizations in the networks and the overall network sizes.

Table 2-3. Summary Statistics

	Maine	New Hampshire	Vermont
Organizations in Study	40	36	45
Mean Social Network Ties per Org (Mean indegree)	9.65	10	14.13
Mean Incoming Hyperlink Network Ties per Org (Mean Indegree)	2.33	5.67	6.27
Mean Incoming Hyperlinks per Org from World Wide Web	21.83	26.67	170.82
Total Relevant AP Articles (2008-2010)	82	56	131
Mean Article Appearances per Organization (2008-2010)	0.73	0.47	1.64

An interesting pattern emerges that may provide context for the research questions explored in this study. On average, Vermont has more communication network ties, more hyperlink network ties, and more hyperlink ties to the internet at large. Furthermore, Vermont has more Associated Press articles written on the topic of sustainable transportation and the organizations in Vermont appear more frequently in articles on the topic than in other states. This suggests that, as a state, Vermont may be more active at talking about the topic of sustainable transportation in the media or promoting it within its networks.

3. Results & Discussion

3.1. Research Question: What Do the Networks Look Like and Which Organizations Are Central in Them?

Network Maps & Central Organizations

The following graphs show the architecture of the communication links between organizations in the three states. Each line between two organizations indicates the exchange of information through face-to-face conversation, phone calls, emails, social networking sites, newsletters, and other means of communication.

Figure 3-1-A. Maine's Communication Network

Many of the organizations on the periphery of the Maine network are environmental non-profit organizations who are generally interested in environmental issues, such as Environment Maine, Maine Conservation Voters Education Fund and the Conservation Law Foundation of Maine. The more central organizations tend to be ones that have a specific interest in sustainable transportation, such as the Bicycle Coalition of Maine, or transportation in general such as the Greater Portland Council of Governments.

Table 3-1-A (below) ranks the organizations in Maine by indegree centrality. The other centrality scores for each organization are also listed, as well as the number of cliques to which each organization belongs.

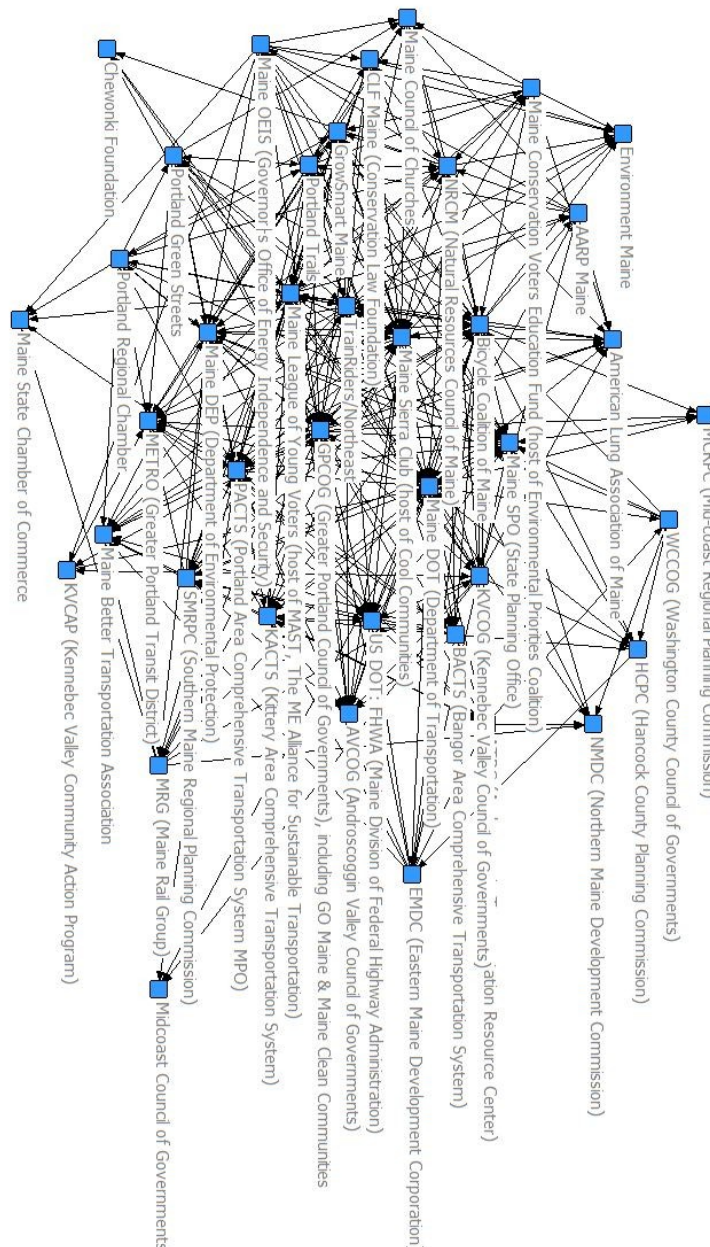


Table 3-1-A. Network Position of Maine Organizations

		Indegree	Closeness	Betweenness	Number of Cliques
1	Maine DOT (Department of Transportation)	71.795	14.029	16.249	6
2	GPCOG (Greater Portland Council of Governments), including GO Maine & Maine Clean Communities	53.846	13.684	11.322	24
3	Bicycle Coalition of Maine	46.154	13.495	10.753	7
4	Maine SPO (State Planning Office)	46.154	13.495	1.92	1
5	PACTS (Portland Area Comprehensive Transportation System MPO)	41.026	13.311	4.725	12
6	Maine DEP (Department of Environmental Protection)	38.462	13.265	1.467	3
7	Maine League of Young Voters (host of MAST, The ME Alliance for Sustainable Transportation)	35.897	13.22	3.892	8
8	METRO (Greater Portland Transit District)	35.897	13.356	1.264	3
9	Maine Better Transportation Association	33.333	14.943	0	0
10	NRCM (Natural Resources Council of Maine)	33.333	13.311	3.42	5
11	US DOT: FHWA (Maine Division of Federal Highway Administration)	33.333	13.265	0.721	7
12	AVCOG (Androscoggin Valley Council of Governments)	30.769	13.22	0	0
13	GrowSmart Maine	30.769	13.131	0.167	0
14	Maine Sierra Club (host of Cool Communities)	30.769	13.087	5.627	6
15	American Lung Association of Maine	25.641	15.058	0	0
16	ATRC (Androscoggin Transportation Resource Center)	25.641	13.087	0.838	6
17	CLF Maine (Conservation Law Foundation)	25.641	13	0.23	2
18	Maine Council of Churches	25.641	13	0.025	0
19	BACTS (Bangor Area Comprehensive Transportation System)	23.077	13.043	0.657	2
20	KACTS (Kittery Area Comprehensive Transportation System)	23.077	13.087	0.686	4
21	Portland Trails	23.077	12.957	2.934	2
22	TrainRiders/Northeast	23.077	12.957	1.392	3
23	Environment Maine	20.513	14.717	0	0
24	SMRPC (Southern Maine Regional Planning Commission)	20.513	13.043	0.538	3
25	Maine OEIS (Governor's Office of Energy Independence and Security)	17.949	12.829	0.945	1
26	Portland Green Streets	17.949	12.871	0.086	1
27	HCPC (Hancock County Planning Commission)	15.385	12.914	0.336	2
28	Maine Conservation Voters Education Fund (host of Environmental Priorities Coalition)	15.385	12.829	0.085	1
29	KVCOG (Kennebec Valley Council of Governments)	12.821	12.704	1.733	1
30	Maine State Chamber of Commerce	12.821	14.079	0	0
31	MRG (Maine Rail Group)	12.821	12.581	0.383	2
32	NMDC (Northern Maine Development Commission)	12.821	12.829	0.042	0
33	Portland Regional Chamber	12.821	12.581	0.353	3
34	AARP Maine	10.256	12.5	0.149	0
35	Chewonki Foundation	10.256	14.338	0	0
36	EMDC (Eastern Maine Development Corporation)	10.256	12.704	0.457	0
37	KVCAP (Kennebec Valley Community Action Program)	7.692	12.5	0.085	0
38	MCRPC (Mid-coast Regional Planning Commission)	7.692	12.787	0.017	0
39	Midcoast Council of Governments	7.692	14.552	0	0
40	WCCOG (Washington County Council of Governments)	7.692	12.662	0.186	1

In New Hampshire, many of the organizations on the periphery of the network are non-profit organizations, such as Environment New Hampshire or Seacoast Area Bicycle Routes (See Fig. 3-1-B below). The more central organizations tend to be state agencies such as the Department of Transportation, or planning commissions. An exception is the highly central New Hampshire Charitable Foundation, which works closely with planning commissions and organizations on funding projects.

Figure 3-1-B. New Hampshire's Communication Network

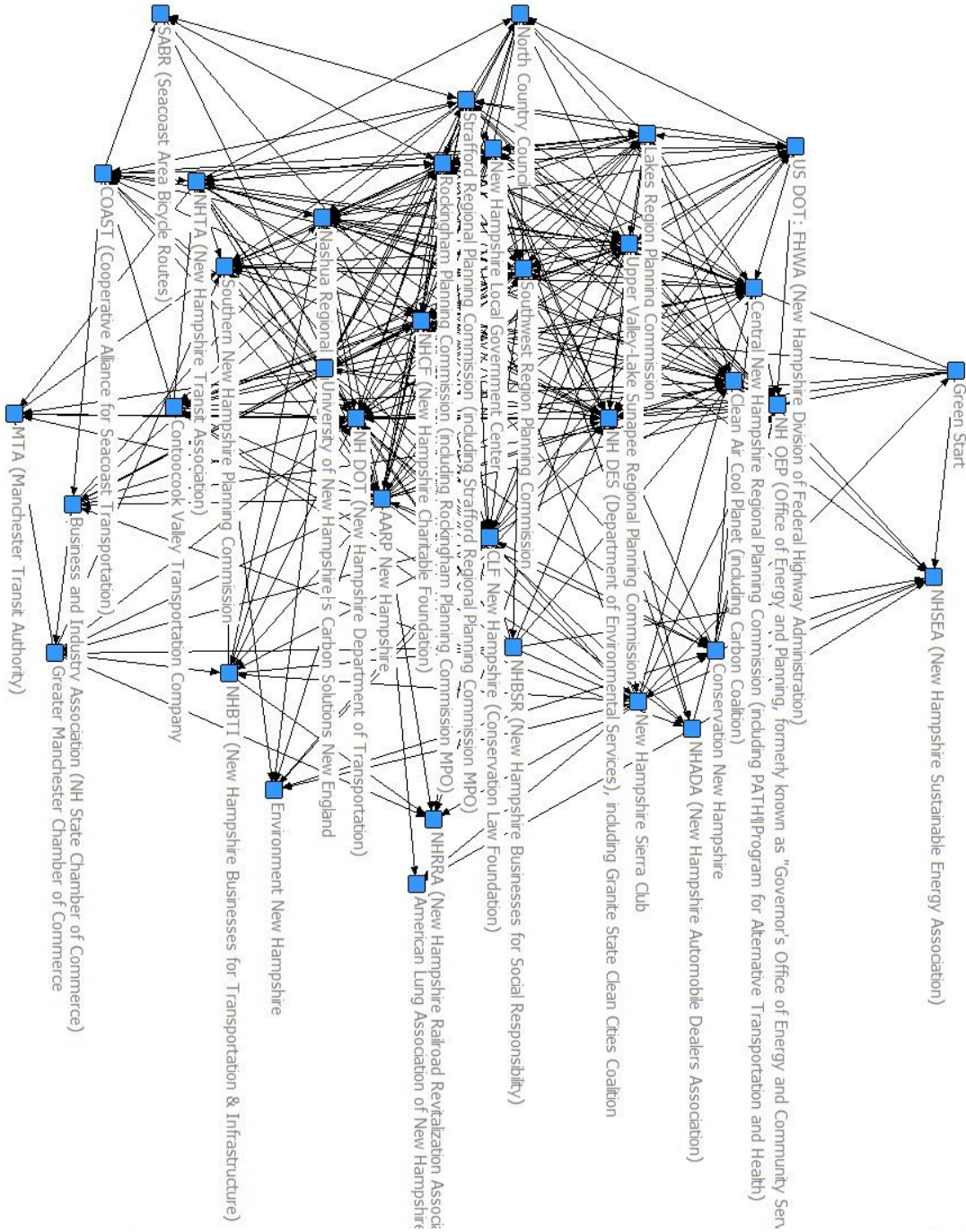


Table 3-1-B below ranks the organizations in New Hampshire by indegree centrality. The other centrality scores for each organization are also listed, as well as the number of cliques to which each organization belongs.

Table 3-1-B. Network Position of New Hampshire Organizations

		Indegree	Closeness	Betweenness	Number of Cliques
1	NH DOT (New Hampshire Department of Transportation)	77.143	16.432	0	0
2	NH DES (Department of Environmental Services), including Granite State Clean Cities Coalition	65.714	13.944	13.615	5
3	NH OEP (Office of Energy and Planning, formerly known as "Governor's Office of Energy and Community Services (ECS)")	54.286	13.725	0.049	0
4	Rockingham Planning Commission (including Rockingham Planning Commission MPO)	51.429	13.672	6.329	12
5	NHCF (New Hampshire Charitable Foundation)	45.714	13.566	4.607	6
6	Southern New Hampshire Planning Commission	45.714	15.625	0	0
7	Nashua Regional Planning Commission	42.857	13.41	0.616	0
8	Strafford Regional Planning Commission (including Strafford Regional Planning Commission MPO)	40	13.308	2.459	8
9	Central New Hampshire Regional Planning Commission (including PATH—Program for Alternative Transportation and Health)	37.143	13.308	1.59	2
10	CLF New Hampshire (Conservation Law Foundation)	37.143	13.258	6.146	5
11	New Hampshire Local Government Center	37.143	13.208	1.6	1
12	Southwest Region Planning Commission	37.143	13.258	4.164	10
13	Clean Air Cool Planet (including Carbon Coalition)	34.286	13.359	1.485	3
14	North Country Council	34.286	15.086	0	0
15	Upper Valley-Lake Sunapee Regional Planning Commission	34.286	13.158	2.051	6
16	COAST (Cooperative Alliance for Seacoast Transportation)	28.571	13.208	1.314	3
17	Lakes Region Planning Commission	28.571	13.06	0.526	4
18	AARP New Hampshire	25.714	13.109	6.865	9
19	NHSEA (New Hampshire Sustainable Energy Association)	22.857	14.706	0	0
20	NHTA (New Hampshire Transit Association)	22.857	12.821	0.923	4
21	US DOT: FHWA (New Hampshire Division of Federal Highway Administration)	22.857	13.109	0.654	2
22	Business and Industry Association (NH State Chamber of Commerce)	20	12.868	1.334	3
23	University of New Hampshire's Carbon Solutions New England	20	13.109	3.728	4
24	Conservation New Hampshire	17.143	12.774	0.655	2
25	Environment New Hampshire	17.143	12.727	0.2	1
26	New Hampshire Sierra Club	17.143	12.915	6.267	1
27	NHRA (New Hampshire Railroad Revitalization Association)	17.143	14.644	0	0
28	Contoocook Valley Transportation Company	14.286	12.821	0.7	2
29	Greater Manchester Chamber of Commerce	14.286	12.5	0.902	1
30	MTA (Manchester Transit Authority)	14.286	12.963	0.042	0
31	NHBTI (New Hampshire Businesses for Transportation & Infrastructure)	14.286	12.59	0.955	0
32	American Lung Association of New Hampshire	8.571	14	0	0
33	NHADA (New Hampshire Automobile Dealers Association)	8.571	12.821	0.767	0
34	NHBSR (New Hampshire Businesses for Social Responsibility)	8.571	12.281	0.939	0
35	SABR (Seacoast Area Bicycle Routes)	8.571	12.456	0.014	1
36	Green Start	2.857	11.745	0.018	0

Many of the peripheral organizations in Vermont's network are non-profit organizations that are generally interested in environmental issues, but not specifically focused on transportation, such as Vermonters for a Clean Environment and Preservation Trust of Vermont (See Fig. 3-1-C below). The more central organizations tend to be nonprofits with a strong focus on transportation such as Smart Growth Vermont and Local Motion. Other central organizations are state agencies or planning commissions.

Figure 3-1-C. Vermont's Communication Network

Table 3-1-B below ranks the organizations in Vermont by indegree centrality. The other centrality scores for each organization are also listed, as well as the number of cliques to which each organization belongs.

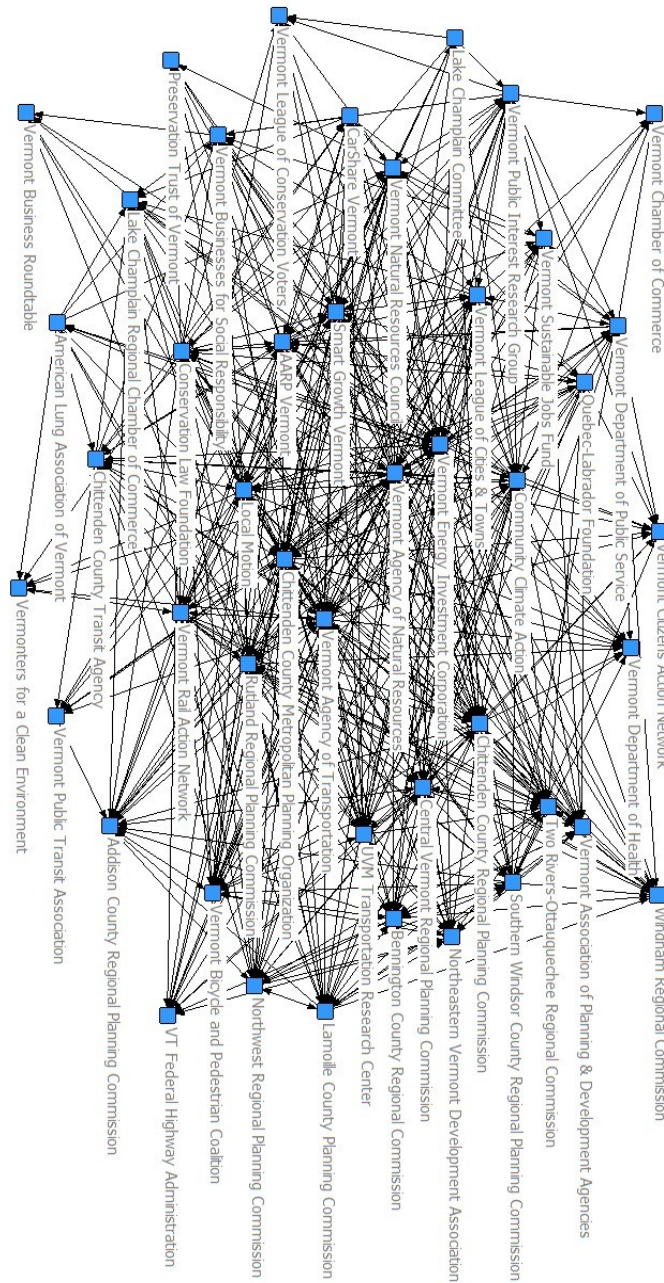


Table 3-1-C. Network Position of Vermont Organizations

	Indegree	Closeness	Betweenness	Number of Cliques	
1	VTTrans (Vermont Agency of Transportation)	68.182	10.945	8.235	22
2	CCMPO (Chittenden County Metropolitan Planning Organization)	56.818	10.784	6.426	30
3	Chittenden County Regional Planning Commission	50	10.706	2.242	18
4	Two Rivers-Ottawaquechee Regional Commission	47.727	10.706	1.208	2
5	Local Motion	45.455	10.68	4.207	26
6	Smart Growth Vermont	45.455	10.68	5.825	7
7	VEIC (Vermont Energy Investment Corporation)	45.455	10.654	5.743	28
8	VNRC (Vermont Natural Resources Council)	45.455	10.68	1.703	13
9	Addison County Regional Planning Commission	43.182	10.602	0.395	4
10	TRC (UVM Transportation Research Center)	43.182	10.654	0.985	3
11	VAPDA (Vermont Association of Planning & Development Agencies)	43.182	10.654	0.143	0
12	Vermont Bicycle and Pedestrian Coalition	43.182	10.654	0.488	3
13	Northwest Regional Planning Commission	40.909	10.628	0.44	4
14	AARP Vermont	38.636	10.552	1.667	13
15	ANR (Vermont Agency of Natural Resources)	38.636	10.552	4.782	17
16	VLCT (Vermont League of Cities & Towns)	38.636	10.602	0.969	8
17	Central Vermont Regional Planning Commission	36.364	10.552	1.255	14
18	Lake Champlain Regional Chamber of Commerce	36.364	13.293	0	0
19	Lamoille County Planning Commission	36.364	10.552	0.187	3
20	Rutland Regional Planning Commission	36.364	10.577	1.691	6
21	Windham Regional Commission	36.364	11.796	0	0
22	CCTA (Chittenden County Transit Agency)	34.091	10.501	0.721	8
23	VBSR (Vermont Businesses for Social Responsibility)	34.091	11.702	0.17	0
24	Bennington County Regional Commission	29.545	10.476	0.284	1
25	Northeastern Vermont Development Association	29.545	10.501	0.137	0
26	Vermont Department of Health	29.545	11.702	0	0
27	Southern Windsor County Regional Planning Commission	27.273	10.451	0.406	3
28	US DOT: FHWA VT (VT Federal Highway Administration)	27.273	10.427	0.052	1
29	Vermont Department of Public Service	27.273	10.427	0.656	4
30	Alliance for Climate Action / 10 Percent Challenge (Now known as Community Climate Action)	25	10.304	1.604	5
31	VCAN (Vermont Citizens Action Network)	25	11.579	0	0
32	Vermont Rail Action Network	25	10.451	2.115	8
33	VPIRG (Vermont Public Interest Research Group)	25	10.377	0.671	7
34	CarShare Vermont	22.727	10.377	0.106	3
35	CLF Vermont (Conservation Law Foundation)	20.455	10.304	0.81	7
36	Vermont Sustainable Jobs Fund	20.455	10.353	0.201	4
37	Preservation Trust of Vermont	18.182	10.377	0	0
38	Vermont League of Conservation Voters	18.182	11.429	0	0
39	VPTA (Vermont Public Transit Association)	15.909	10.304	0.008	1
40	Lake Champlain Committee	13.636	10.209	0.103	2
41	Quebec/Labrador Foundation: Atlantic Center for the Environment	13.636	10.209	0.183	3
42	Vermont Business Roundtable	13.636	12.828	0	0
43	Vermont Chamber of Commerce	13.636	11.253	0	0
44	Vermonters for a Clean Environment	11.364	10.138	0.022	0
45	American Lung Association of Vermont	9.091	10.092	0.083	1

Centrality across Types of Organizations

Particular types of organizations emerge as central in these networks. For example, the tables below show the relative centrality of different cohorts of organizations in each state: government agencies; planning commissions such as regional planning commissions and metropolitan organizations; nonprofit organizations; and transit providers. Although the standard deviations overlap, the most central organizations tend to be government agencies, followed by planning commissions, and finally, nonprofits. The transit providers in this study are a relatively small sample size so it is difficult to predict what their general patterns are.

Table 3-1-D. Mean Indegree by Cohort in Maine

Organization Type	Mean Indegree Ties	Standard Deviation	N
Government	16.2	7.727	5
MPO/RPC	8.14	5.318	14
Non-profit	8.85	4.017	20
Transit Provider	14	N/A	1

Table 3-1-E. Mean Indegree by Cohort in New Hampshire

Organization Type	Mean Indegree Ties	Standard Deviation	N
Government	19.25	8.18	4
MPO/RPC	13.67	2.398	9
Non-profit	6.95	4.048	19
Transit Provider	7	2.449	4

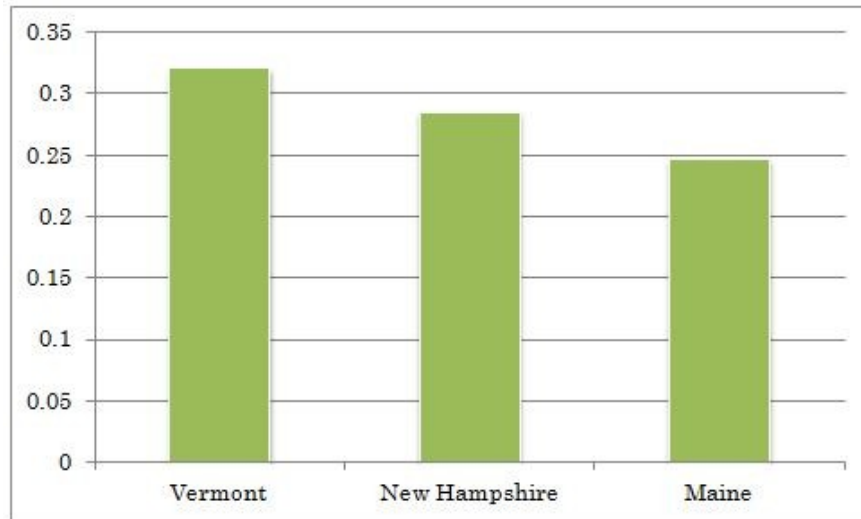
Table 3-1-F. Mean Indegree by Cohort in Vermont

Organization Type	Mean Indegree Ties	Standard Deviation	N
Government	16.8	7.662	5
MPO/RPC	17.38	3.798	13
Non-profit	12.16	5.565	25
Transit Provider	11	5.657	2

These patterns suggest that government agencies and planning commissions occupy strategic positions in the sustainable transportation networks. If these organizations are not already aware of their central position, this study may provide justification for them to take advantage of their situation. They could play a more significant role as mediators or disseminators of information. Government agencies or planning commissions that are not central to their networks may especially be under-utilizing their potential to benefit from a central location. The benefits of centrality will be discussed in more detail in the following section (3.2).

Comparison of Networks

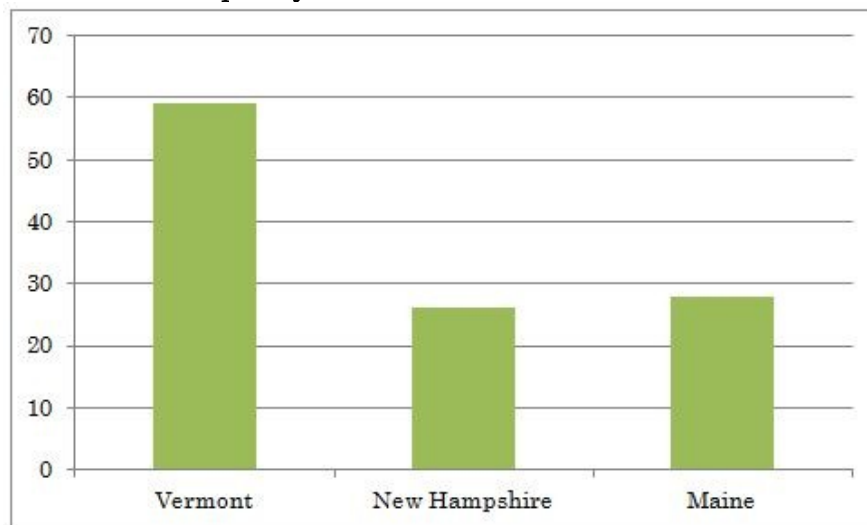
Network graphs can be compared by densities or numbers of cliques in order to highlight potential opportunities offered by the networks or constraints imposed by them. Vermont has the densest of the three networks (See Fig. 3-1-D below). The y-axis shows the percentage of connectedness between all organizations. A “1.0” would represent 100% connectedness where every organization communicates with every other organization. In this case, Vermont is the most dense at just over 30% connected.

Figure 3-1-D. Group Density by State

According to some researchers ^[17], organizations have different relative power depending on whether their network is more dense or less dense. For example, central organizations in less dense networks like Maine may enjoy the role of commander, whereas central organizations in more dense networks like Vermont may be forced to play a compromiser role.

Organizations on the periphery of networks like Maine may be allowed to play a solitary role, striking off on their own, while organizations in networks like Vermont may be limited to the role of subordinate, having less autonomy to make their own decisions.

A closely related concept to density is the number of cliques in a network. Recall that cliques are groups of three or more organizations who are all connected to each other. In less dense networks, cliques may represent exclusivity in the flow of information. But, in dense networks like the ones in this study, cliques may represent even more communication sharing. The existence of numerous cliques within these dense networks may suggest a high number of coalitions or the quick spread of information. Figure 3-1-E (below) shows the number of cliques in each state.

Figure 3-1-E. Number of Cliques by State

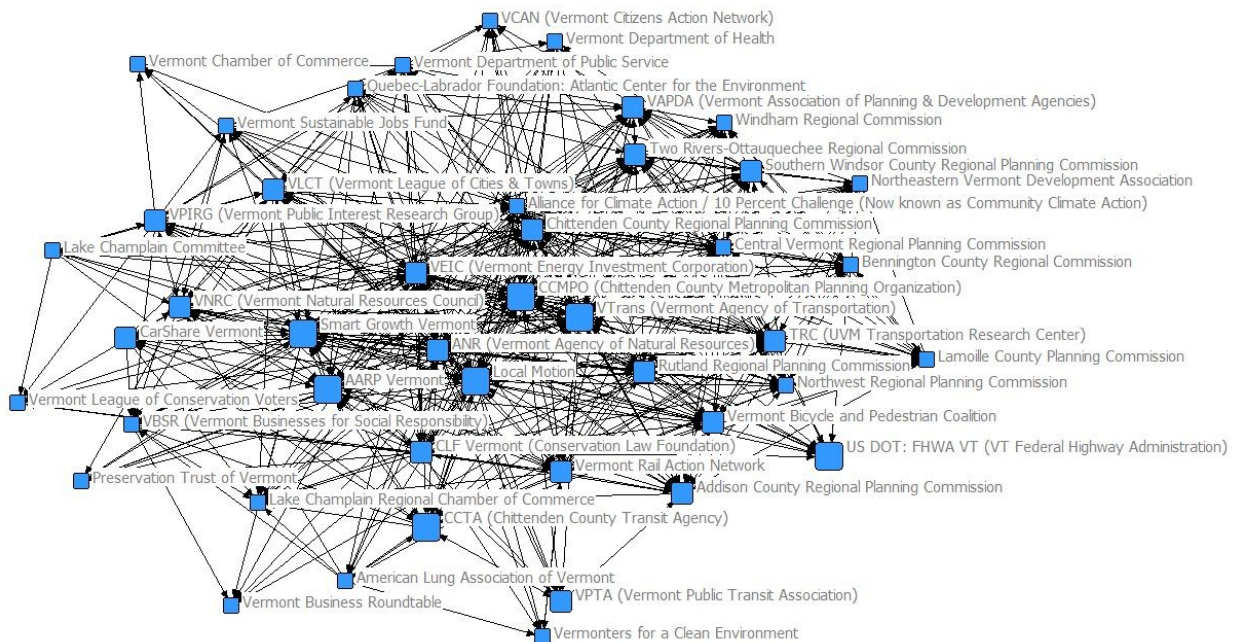
From the visual representations of the networks, the comparisons of density, and the comparisons of cliques, it is clear that Vermont is the most well connected state. New Hampshire and Maine have half the number of cliques and slightly lower densities, suggesting more modest communication patterns. Is this because Vermont has less than half the population of the other states, forcing organizations to work more closely with each other because of fewer alternatives to acquire resources? Or, perhaps the sustainable transportation network of Vermont is more active at working for the goal of sustainable transportation. The exact reason is beyond the scope of this study. However, organizations in these networks may benefit from exploring the possibility of increasing communication in Maine and New Hampshire in order to spur collaboration and the sharing of resources. But, organizations will have to weigh the benefits of increased collaboration with the drawbacks of having to play more compromising roles in denser networks.

3.2 Research Question: Does Network Position Relate to Perceived Influence?

Perceived influence is a score the researchers assigned to organizations based on how other organizations in the network rate a given organization’s influence over the policy process. In the survey, organizations were given a list of all the organizations in the network and asked to rate them on a 5-point scale with 1= “not influential at all” and 5= “very influential.” The mean of these ratings became the perceived influence score for an organization.

Figure 3-2 (below) depicts the size of organizations’ nodes in the Vermont network according to their level of perceived influence. Larger nodes represent organizations that are deemed more influential by their peers. Many of the central organizations in this network appear larger, suggesting that centrality correlates with higher perceived influence.

Figure 3-2. Vermont’s Communication Network with Node Size Corresponding to Influence



To test this theory statistically, Pearson correlations were run to compare network centrality to perceived influence. Table 3-2-A (below) shows Pearson correlations between each of the centrality metrics and perceived influence.

Table 3-2-A. Correlations between Centrality & Perceived Influence

		Indegree	Betweenness	Closeness
Maine	Pearson Correlation	.749**	.574**	.338*
	Sig. (2-tailed)	0.000	0.000	0.033
New Hampshire	Pearson Correlation	.592**	0.270	0.183
	Sig. (2-tailed)	0.000	0.112	0.286
Vermont	Pearson Correlation	.666**	.539**	.388**
	Sig. (2-tailed)	0.000	0.000	0.008

** Correlations significant below the .01 level

* Correlations Significant below the .05 level

All centrality measures correlate significantly with perceived influence in Maine and Vermont. In New Hampshire, only indegree correlates significantly. These results suggest that having a central position in a network usually does matter to organizations who strive to be influential in the arena of sustainable transportation policy. But, even though organizations on the periphery may not have a high level of influence within this network, they may offer important links to other networks such as energy or public health networks. Therefore, they may have high betweenness scores when broader networks are considered and could provide valuable networking with other networks.

Each type of centrality reflects different sources of power. Organizations with high indegree may be a hub of information, an authority figure, or have the most prestige [14, 15, 18]. Recall that indegree consists of the total number of direct ties an organization has to others in the network. Organizations with high betweenness may be in the best position for acquiring diverse resources, for controlling the flow of information and coordinating the network's actions [13, 15, 19, 20, 21, 22]. Recall that betweenness is calculated based on the extent to which an organization lies between other organizations who have few ties to each other. Finally, organizations with high closeness may be more "in the loop" than organizations who are farther away from others, thus avoiding dependencies on others for information, and they are in a better position for disseminating information quickly to the entire network [15, 24, 25].

Organizations planning to capitalize on a central network position should ask themselves which type of central position would benefit them most. Those wanting to gain popularity or become a spokesperson for the sustainable transportation movement may be best served by increasing their degree score. Those wanting to access diverse resources and build broad coalitions may accomplish their goals most efficiently by increasing their betweenness score. For example, if an organization wants to pass a sustainable transportation bill that requires broad public support, they might find it useful to bridge the divide between rail and bicycle groups who often compete for rail beds. Finally, organizations that wish to call others to action in time sensitive scenarios to oppose or promote transportation legislation may be best served by a high closeness score.

Another network position that matters is the number of cliques to which an organization belongs. The Pearson correlations in table 3-2-B (below) suggest that being in multiple cliques relates significantly with perceived influence in both Maine and Vermont, but not New Hampshire. The power associated with being in cliques includes an increased chance

that an organization will form useful alliances and more immediate access to information circulating through the network [26, 27].

Table 3-2-B. Correlations between Number of Cliques & Perceived Influence

Maine	Pearson Correlation	.529**
	Sig. (2-tailed)	0.000
New Hampshire	Pearson Correlation	0.272
	Sig. (2-tailed)	0.109
Vermont	Pearson Correlation	.535**
	Sig. (2-tailed)	0.000

** Correlations significant below the .01 level

* Correlations Significant below the .05 level

3.3 Research Question: What Network-derived Characteristics Relate to Nonprofits' Perceived Influence?

For this research question, the researchers pooled the nonprofit organizations from all three networks into one population. Since centrality scores depend on the size of the network, normalized centrality scores were used for statistical analysis.

The interest in nonprofits, specifically, stems from previous research that argues nonprofits are especially dependent on and susceptible to network dynamics. Nonprofits may depend even more on their network ties than organizations in the for-profit sector because multiple organizations are required to work together in order to implement most programs [28]. Organizations' centrality within networks has also been linked to success building organizational capacity [28]. The researchers tested this theory of nonprofits' network dependency by examining whether network position relates to perceived influence among the nonprofit sub-populations of the three states. Following the convention established in the other parts of this study, the three centrality scores of indegree, betweenness, and closeness were tested, as well as the number of cliques to which an organization belongs.

The researchers also tested other organizational characteristics to see if they too were correlated with perceived influence. These characteristics included number of partnerships, and number of ties organizations have to government agencies. Nonprofits often build strategic coalitions to stay competitive and secure funding, suggesting that partnerships may be a critical determinant of their level of influence [29, 30, 31]. Nonprofits are also disadvantaged by having limited resources and competencies for addressing environmental issues, forcing them to turn to partnerships that expand their capacity beyond their own limited resource bases and access to information [32, 33]. One of the most popular partners for nonprofit organizations seeking substantial resources is government agencies. Many nonprofits also rely on government agencies for funding, a reliance that has increased since the 1960s [29].

The results of Pearson correlations between organizational characteristics and perceived influence suggest that all characteristics listed here relate to perceived influence, with the exception of the centrality score, closeness (See Table 3-3 below). This is not surprising, given that closeness is also the weakest correlate of influence among the larger networks examined earlier. The lack of significance may also be attributed to the abstract nature of the metric when compared to degree and betweenness, which are more obviously associated with a

visibly central position in these networks. The strongest of all the Pearson correlations was the relationship between perceived influence and the betweenness measure of centrality.

Table 3-3. Correlations between Network Characteristics & Perceived Influence (Among Nonprofits)

Indicator	Pearson Correlation	Significance	N
Degree	.406**	0.001	68
Betweenness	.438**	0.000	68
Closeness	-0.03	0.807	68
Partnerships	.370**	0.013	44
Ties to Government	.337**	0.005	68
Number of Cliques	.333**	0.006	68

** Correlations significant below the .01 level

* Correlations Significant below the .05 level

Overall, the results of this examination of nonprofit organizations mirrors those of the whole networks examined earlier. Network position does appear to matter to nonprofit organizations trying to exert their influence over the policy process.

3.4 Research Question: Does Network Position Also Relate to Appearance in the Media?

This research question examines the relationship between media prominence and the network position of organizations. Media prominence, like perceived influence, is used here as a metric for network-derived power. The researchers do not claim that media coverage is a type of power that every organization desires. Rather, it is offered as one of many possible metrics for power that can be tested.

To test if there is a relationship between prominence and position, the position of the organizations (measured by their connectedness to others through web hyperlinks and survey-reported social networks) is compared to their media coverage. Other characteristics that could potentially influence the level of media coverage are also statistically tested for correlations to compare the relative strength of network-characteristics to other organizational characteristics.

The level of media coverage was determined by counting the number of times an organization appeared in Associated Press articles on the topic of sustainable transportation through the three year period of 2008-2010. The hyperlink network data was collected using a webcrawler called SocSciBot on the organizations' websites. Hyperlinks within the network of organizations were used to build social network models similar to the communication models. Hyperlinks to all other organizations external to the networks were also tallied for an additional layer of analysis.

Table 3-4 (below) shows the results of whether network position relates to media coverage and what other correlates might explain media coverage (See table 2-3 for descriptive statistics on the media coverage of sustainable transportation in each state).

Table 3-4. Correlations between Organizational Characteristics & Media Coverage

Organizational Characteristics	Maine		New Hampshire		Vermont	
	Correlation	Sig.	Correlation	Sig.	Correlation	Sig.
Perceived Influence Score	.418*	0.007	.390*	0.019	.405**	0.006
Budget	0.129	0.475	0.317	0.107	-0.016	0.929
Paid Staff	0.124	0.492	.967**	0	-0.146	0.396
Unpaid Staff	.607**	0	-0.113	0.559	-0.051	0.762
Total Number of Incoming Hyperlinks	.726**	0	.390*	0.019	.581**	0
Communication Network Degree	.608**	0	.504**	0.002	.405**	0.006
Hyperlink Network Degree	.706**	0	.390*	0.019	.344*	0.02

** Correlations significant below the .01 level

* Correlations Significant below the .05 level

Results show that organizations with higher centrality (as measured by degree) are more likely to appear in the media in all three states. This is true of both types of networks: communication and hyperlink. Degree, perceived influence, and the total number of incoming hyperlinks an organization has from other organizations across the internet all correlated positively and significantly across all states.

These findings support the ongoing theme that network position matters to organizations. In this case, the relationship between position and media coverage may be explained by issues of accessibility and credibility. Journalists have limited time and resources to identify, reach and engage sources. Organizations that are central to hyperlink networks and have higher levels of general hyperlinks appear higher in web searches, especially in the context of topics that define their hyperlink network, such as “sustainable transportation.” For example, PageRank is the algorithm at the heart of Google elevating the importance of pages dependent upon how much they are pointed to from other pages ^[34]. Another example is the HITS algorithm, which uses link structures as one method for identifying the most applicable pages to a specific query topic ^[35].

If an organization appears higher in a web search, then it is more accessible to journalists conducting research on a policy issue. The same logic may apply to central organizations in communication networks. If they are more central and influential, then they are likely to be more visible to journalists seeking sources for their stories. In both hyperlink networks and communication networks, central organizations are also seen as more credible ^[36, 37]. Journalists may be more willing to cite organizations that are perceived as more credible.

4. Conclusion

The results of this study suggest that networks matter to organizations aiming to influence sustainable transportation policy. Not only is a central position in communication networks strongly correlated with perceived influence and more media coverage, but a central position in hyperlink networks also correlates with these benefits. This illustrates that personal interactions with other people as well as internet connections have a bearing on influence.

Different types of centrality were found to have stronger relations to influence, such as degree and betweenness, rather than closeness. This means that organizations are likely to gain influence by increasing their total number of connections to others in a network or by placing themselves between groups that do not frequently communicate with each other. This suggests special power in bridging the divide between isolated groups. Many government agencies and planning commissions already occupy central positions and may be able to harness the power associated with their position.

These trends also hold up among the sub-population of non-profit organizations in this study, suggesting that nonprofits are also highly dependent on network connections. Additionally, it was revealed that the number of partnerships nonprofits have is a strong predictor of their level of influence, as well as the number of cliques an organization belongs to, and the number of ties an organization has to state government agencies or departments. This suggests that nonprofits derive power from multiple types of relationships that offer tangible resources in an environment where they are often marginalized because of their small budgets, limited technical expertise, and lack of authority.

As organizations attempt to use networks strategically, they should take note of the difference in the state networks. Maine has the least dense network, and therefore, the most opportunity for increased collaboration and sharing of information. Vermont has the most dense network, suggesting less opportunity for additional collaboration, and more pressure to compromise goals. Vermont's network also seems more active at discussing and promoting the concept of sustainable transportation. Perhaps the Vermont network is more ripe for coalitions that can successfully pass sustainable transportation policy. Central organizations in Vermont may have the opportunity to call the network to action. Organizations in Maine and New Hampshire, on the other hand, may have to work harder to ripen the network by educating the public and creating more partnerships between organizations. Networks provide many different roles for organizations inspiring to be influential, so organizations should carefully consider which role they want to play and how to position themselves appropriately in the context of their network. For more information about this research, please see Aaron Witham's Master's thesis on the networks of sustainable transportation policy organizations ^[38].

Appendix

PAGE 3 [Edit Page](#) [Add Page Logic](#) [Move](#) [Copy](#) [Delete](#) [Show this page only](#)

Sending and Receiving Information

[+ Add Question](#)

Q1 [Edit Question](#) [Move](#) [Copy](#) [Delete](#)

This question has three parts:
First, identify which organization you represent. Organizations are alphabetized and your organization might appear on a following page.

Second, indicate whether your organization has sent out any information regarding sustainable transportation (e.g., via emails, phone calls, regular mail or other means) to the other organizations on the list.

Third, indicate whether your organization has received any information regarding sustainable transportation from the other organizations on the list.

	I represent this organization	Send information	Receive information
AARP New Hampshire	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
American Lung Association of New Hampshire	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Business and Industry Association (NH State Chamber of Commerce)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Central New Hampshire Regional Planning Commission (including PATH—Program for Alternative Transportation and Health)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Clean Air Cool Planet (including Carbon Coalition)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CLF New Hampshire (Conservation Law Foundation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

References

- [1] U.S. Environmental Protection Agency (EPA), *U.S. Greenhouse Gas Inventory* (2010). <http://www.epa.gov/climatechange/emissions/usgginventory.html> (accessed July 13, 2012).
- [2] Samet, J.M., Zeger, S.L., Dominici, F., Curriero, F., Coursac, I., Dockery, D.W., Schwartz, J., and Zanobetti, A., *The National Morbidity, Mortality, and Air Pollution Study Part II: Morbidity and Mortality from Air Pollution in the United States* (2010). Health Effects Institute. <http://www.cabq.gov/airquality/pdf/samet2.pdf> (accessed July 13, 2012).
- [3] Spellerberg, I.F., "Ecological Effects of Roads and Traffic: A Literature Review." *Global Ecology and Biogeography Letters*, Vol. 7, No. 5 (1998) pp. 317-333.
- [4] Lopez-Zetina, J., Lee, H. and Friis, R., "The Link between Obesity and the Built Environment. Evidence from an Ecological Analysis of Obesity and Vehicle Miles of Travel in California." *Health & Place*, Vol. 12, No. 4 (2006) pp. 656-664.
- [5] American Lung Association, *State of the air*. American Lung Association National Headquarters (2011).
- [6] Brundtland, G.H., *Report of the World Commission on Environment and Development: Our common future* (1987). <http://www.un-documents.net/ocf-cf.htm> (accessed July 13, 2012).
- [7] Kenyan, J., Glitman, K., and McRae, G., *Future Surface Transportation Financing Options: Challenges and Opportunities for Rural States* (Report no. 09-003). Transportation Research Center (2009).
- [8] Straughan, B. and Pollak, T., *The Broader Movement: Nonprofit Environmental and Conservation Organizations, 1989-2005*. National Center for Charitable Statistics at the Urban Institute (2008).
- [9] Goetz, A.R., Dempsey, P.S., and Larson, C., "Metropolitan Planning Organizations: Findings and Recommendations for Improving Transportation Planning." *Publius: The Journal of Federalism*, Vol. 32, No. 1 (2002) pp. 87-105.
- [10] Goldman, T. and Deakin, E., "Regionalism Through Partnerships? Metropolitan Planning since ISTEA." *Berkeley Planning Journal*, Vol. 14 (2000) pp. 46-75.
- [11] Thelwall, M., *Link Analysis: An Information Science Approach*. Academic Press (2004).
- [12] Borgatti, S.P., Everett, M.G. and Freeman, L.C., *Ucinet for Windows: Software for Social Network Analysis*. Analytic Technologies (2002).
- [13] Scott, J., *Social Network Analysis: A Handbook*. Sage (2009).
- [14] Knoke, D. and Yang, S., *Social network analysis*. Sage Publications (2008).
- [15] Freeman, L.C., "Centrality in Social Networks Conceptual Clarification." *Social Networks*, Vol. 1 (1978/79) pp. 215-239.
- [16] Anthonisse, J.M., *The Rush in a Graph*. *Mathematisch Centrum (mimeo)*. Amsterdam (1971).

- [17] Rowley, T.J. "Moving Beyond Dyadic Ties: A Network Theory of Stakeholder Influences." *Academy of Management Review*, Vol. 22, No. 4 (1997) pp. 887-910.
- [18] Knoke, D., and Burt, R. S., "Prominence." In R.S. Burt and Minor M.J. (Eds.) *Applied Network Analysis*. Sage (1983) pp. 195-222.
- [19] Fernandez, R.M. and Gould, R.V., "A Dilemma of State Power: Brokerage and Influence in the National Health Policy Domain." *American Journal of Sociology*, Vol. 99, No. 6 (1994) pp. 1455-1491.
- [20] Haythornthwaite, C., "Social Network Analysis: An Approach and Technique for the Study of Information Exchange." *Library & Information Science Research*, Vol. 18, No. 4 (1996) pp. 323-342.
- [21] Zaheer, A. and Bell, G.G., "Benefiting from Network Position: Firm Capabilities, Structural Holes, and Performance." *Strategic Management Journal*, Vol. 26: (2005) pp. 809-825.
- [22] Burt, R.S. *Structural Holes: The Social Structure of Competition*. Harvard University Press (1992).
- [24] Bavelas, A., "A Mathematical Model for Group Structures." *Human Organization*, Vol. 7 (1948) pp. 16-30.
- [25] Beauchamp, M.A., "An Improved Index of Centrality." *Behavioral Science*, Vol. 10, No. 2 (1965) pp. 161-163.
- [26] Gulati, R., "Network Location and Learning: The Influence of Network Resources and Firm Capabilities on Alliance Formation." *Strategic Management Journal*, Vol. 20, No. 5 (1999) pp. 397-416.
- [27] Burt, R.S., "Structural Holes versus Network Closure as Social Capital." In N. Lin, K. Cook, & R.S. Burt (Eds.), *Social Capital, Theory, and Research*. Aldine de Gruyter (2001) pp. 31-56.
- [28] Johnson, J.A., Rooks, L., and Brown, W., "A Social Network Analysis of Non-profits in Southside, Virginia: A Pre-test of the Impact of Connect Southside." (March 2008). http://www.connectsouthside.org/Portals/2/Outside%20Reports/SNA_Connect%20Southside_PreTest_Final%20Report.pdf (accessed July 13, 2012).
- [29] Smith, S.R., "Governments and Nonprofits in the Modern Age." *Society* (May/June 2003) pp. 36-45.
- [30] Cho, S. and Gillespie, D., "A Conceptual Model Exploring the Dynamics of Government-Nonprofit Service Delivery." *Nonprofit & Voluntary Sector Quarterly*, Vol. 35, No. 3 (2006) pp. 493-509.
- [31] Saidel, J.R., "Resource Interdependence: The Relationship Between State Agencies and Nonprofit Organizations." *Public Administration Review*, Vol. 51, No. 6 (1991) pp. 543-553.
- [32] Polonsky, M.J., Garma, R., and Chia, N., "Australian Environmental Alliances from an Environmental NGOs Perspective." *Journal of Marketing Theory and Practice*, Vol. 12, No. 2 (2004) pp. 73-86.

- [33] Vyas, N.M., Shelburn, W.L., and Rogers, D.C., "An Analysis of Strategic Alliances: Forms, Functions and Framework." *The Journal of Business & Industrial Marketing*, Vol.10, No. 3 (1995) pp. 47-60.
- [34] Langville, A.N. and Meyer, C.D., "The Use of Linear Algebra by Web Search Engines," *IMAGE*, Vol. 33 (October 2004) pp. 2-5.
- [35] Kleinberg, J.M., "Authoritative Sources in a Hyperlinked Environment". *Journal of ACM*, Vol. 46, No. 5 (September 1999) pp. 604-632.
- [36] Park, H.W. and Thelwall, M., "Hyperlink Analyses of the World Wide Web." *Journal of Computer-Mediated Communication*, Vol. 8, No. 4 (July 2003).
- [37] Park, H.W, Barnett, G.A. and Nam, I.Y., "Interorganizational Hyperlink Networks Among Websites in South Korea," *NETCOM: Networks and communications studies*, Vol. 16 (2002) p. 155-173.
- [38] Witham, A.Z., "Inter-organizational Issue Networks Concerned with Sustainable Transportation Policy: An Examination of Maine, New Hampshire, and Vermont." Master's Thesis. Rubenstein School of Environment & Natural Resources, University of Vermont (2012).