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Isomorphic Properties of Network Governance: Comparing Two Watershed Governance Initiatives in the Lake Champlain Basin Using Institutional Network Analysis

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In this paper a comparison of the two planned networks that appear in watershed planning documents for the Lake Champlain basin in 2010 One plan (2010 TMDL) was developed by a regulatory network initiated by the United States Environmental Protection Agency (USEPA) and state legislature. The second plan (2010 OFA) was developed by a watershed partnership network spanning the governmental, nonprofit, and business sectors. This paper asks if these two planning networks reify themselves in the plans they create? The extent to which the structural and functional properties of the networks in this study are mirrored in the plans that they produce is measured. Using textual data mining techniques and institutional network analysis the authors examine measures of network centrality, develop a visual analysis of network structures and clusters, and examine statistical comparisons of the task structures found across the two planned networks.

Institutional isomorphism theory is used to anticipate and explain any mirroring effects observed in the data. A comparison of policy tool identification, actor characteristics, and task structures for each plan is rendered. Findings suggest evidence of structural isomorphism, but not policy tool isomorphism occurring between the two planning regimes and possible explanations for these findings are given.

Key words: network governance, policy tools, partnership networks, regulatory networks, institutional isomorphism

Those who have charted the trajectory of environmental policy and governance in democratic societies have noted the growing role that multi-institutional networks have played in carrying out a wide range of policy functions (Durant, Fiorino, & O'Leary, 2004; Gerlak, 2006). The environmental network literature has included studies of networks

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that address certain collective action problems (Ostrom, 1990, 2007; Lubell, 2004), networks operating as advocacy coalitions (Sabatier, Leach, Lubell, & Pelkey, 2005; Sabatier, Weible, & Ficker, 2005), networks designed to regulate behavior through the execution of hierarchical, command and control ties (Fiorino, 2006; Coglianese, 2001), watershed governance networks (Imperial, 2005) and thick descriptions of environmental partnerships (Koontz et al., 2004; Imperial, 1999, 2005; Leach & Sabatier, 2005). Across this literature, at least two kinds of environmental networks have been said to persist: those kinds of environmental networks that carry out regulatory functions through command and control, hierarchically aligned ties that are used to *direct* collective action, and those environmental networks that tend to rely on partnership, collaborative and horizontal ties to *collaborate* for collective action (Fiorino, 2006).

To date, little has been done to advance the field's capacity to compare the properties of a regulatory network to a partnership network that are both charged with addressing the same environmental problem, covering the same geographic landscape, and encompassing similar jurisdictions during the same timeframe. In this study, the regulatory and partnership networks to be compared share a common policy function: the development of comprehensive plans that are designed to reduce the levels of phosphorus loading into Lake Champlain.

Furthermore, understanding how and why the structural and functional prosperities of different types of governance networks enable or temper experimentation and innovation has been noted as being of critical importance for practicing public administrators, researchers and theorists (Rhodes, 2007). In this study, the capacity of regulatory and partnership networks to experiment and innovate is observed through the comparison of policy plans generated by each network. Specifically, this study examines whether the regulatory and partnership networks responsible for the 2010 Total Maximum Daily Loading (TMDL) plan and 2010 Opportunities for Action (OFA) plan respectively replicate their internal governance structures into the planned networks that they create. This process of translation of process-based elements of organizational dynamics into static representations of organizational form and function is described here as "reification" (Wenger, 1998). The theory of institutional isomorphism (DiMaggio & Powell, 1983) is drawn on to anticipate and explain the transmission of the governance structures of planning networks into the plans they reproduce. Two hypotheses are proposed that examine the isomorphic properties of the planned network structures (H1) and the designation of policy tools in these two plans (H2).

To study the properties of the networks produced in the plans textual data mining techniques (Merkl, 2000) are used to render a comparative institutional network analysis of the two sets of networks. Methods for identifying policy tools, the actors designated for initiating and carrying out specific policy tasks, and the task structures themselves are advanced. Standard measures of network density, visual analysis of network structures and clusters, and statistical comparisons of the task structures found across the two planned networks are produced and used to provide basic descriptions of plan properties and to critically examine the two hypotheses.

This article begins with an articulation of the two governance network isomorphism hypothesis used in this study and introduce the conceptual framework used to study them.

The methods employed in this study are then discussed. The regulatory and partnership networks responsible for producing the two plans are presented, followed by a detailed account of each plan's properties. The paper concludes with an analysis of the two hypotheses and some implications for further theory development and research.

1. Governance Network Isomorphism Hypotheses Testing

Institutional isomorphism has been defined as, "a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions" (DiMaggio & Powell, 1983, p. 149). The use of institutional isomorphism theory in public administration and policy studies literature has been generally relegated to the studies of the organization serving as the unit of analysis (Ashworth, Boyne, & Delbridge, 2009; Frumkin & Galaskiewicz, 2004; Villadsen, 2013). These applications of isomorphism theory to public sector organizations add contextual richness, but do not explain isomorphic tendencies across institutional structures of a higher, more complex order of scale: the multi-organizational network.

This present study shifts the unit of analysis in isomorphism theory from the single institution to a multi-institutional, multi-sector network context. By expanding the unit of analysis to encompass actors spanning many levels of governmental, private and non-profit actors, an opportunity to capture the relationship between policy tool selection and governance structure is provided. In another study, Villadsen (2011) suggests that public governance networks are sources of isomorphic pressure unto themselves, and that network structures of particular form can either increase or decrease isomorphic tendencies. He pays particular attention to the role of elected officials as pollinators of network form and function. This study builds on this line of research. The central question to be asked in this study is: Do environmental planning networks tend to reify themselves in the plans they create?

Drawing on distinctions found within the environmental governance and environmental partnership literature, this study distinguishes between regulatory and partnership networks and treats these distinctions as dependent variables. Regulatory networks are predominantly shaped by hierarchical relationships between regulators and those that are regulated, be they industries, organizations and institutions, or individuals. Fiorino describes how these hierarchical ties function: "Regulatory agencies issue rules that are binding on defined classes of entities. Agencies create a system of inspections and reporting to monitor compliance with their rules. Entities that fail to comply are subject to penalties" (1999, p. 7).

Translating hierarchical ties into networks structures, we find *regulatory networks* dominated by hierarchical ties, appearing as mono-centric network structures, characterized by a singular network hub with the "regulator" at the center serving as the principal over its regulated agents. Within the context of environmental regulation of water quality, a regulatory network is established on principal-agent ties through which federal agencies set benchmarks and call on state agencies to adopt suitable management plans to address environmental problems. In the case of study undertaken here, regulation is carried out by the USEPA and the Vermont Agency for Natural Resources (VT ANR) under policy objectives and directives stated within the nonpoint source pollution amendments to the Clean Water Act in 1987. The USEPA is then obligated to require the State to plan and implement actions (usually through the form of a Total Maximum Daily Load [TMDL]) to achieve the state standard for that water body. The regulatory network in this study is responsible for developing, and ultimately implementing, federal level USEPA directed TMDL standards for the Vermont portion of the Lake Champlain Basin. The regulatory plan to be studied here is the 2010 Vermont Lake Champlain Basin TMDL Plan.

In contrast to the more top down regulatory framework, environmental partnership networks are collaboratively governed (Ansell & Gash, 2007) and structured through mostly voluntary ties built on reputation, trust, and norms of reciprocity. In this study, we refer to these as *partnership* networks that often appear as polycentric, and often times, less dense, network structures (Ostrom, 2010). In recent decades, watershed partnership approaches toward designing and implementing policy solutions have become more common (Lubell & Fulton, 2007; Sabatier, Leach, et al., 2005; Sabatier, Weible, et al., 2005). Empirical comparisons of watershed partnerships have tended to focus on the composition of partnership characteristics and their inferred relationship to performance goals (Koontz et al., 2004; Imperial, 2005). Partnership networks exist to carry out a broader range of policy functions: pooling resources, disseminating information, and otherwise aligning interests with public policy needs. In the case of the study undertaken here, these functions are carried out through the operations of the Lake Champlain Basin Program (LCBP, 2014) and its network of stakeholders. The LCBP serves as the network administrative organization (NAO) (Provan & Kenis, 2008) or backbone organization of a multi-jurisdictional watershed partnership that issues comprehensive watershed management plans for the entire basin every five years. The partnership plan to be studied here is the 2010 Opportunity for Action (OFA).

It is hypothesized that the structural characteristics of the two different planning networks in this study can serve as a predictor of their planned network characteristics. More specifically, this paper asks to what extent the more centralized structure of the regulatory network replicates this structure in the plan that it creates? The "network structure isomorphism" hypothesis for this study is stated below as:

H1: *The planned network designed by the TMDL regulatory network will exhibit more centralized and denser network properties than those designed by the LCBP partnership network.*

It has become widely accepted that the selection and use of a policy tool can shape the structure of a governance network by giving form to certain types of relational ties, and by determining the types of tasks to be undertaken up by specific network actors (Salamon, 2002; Bressers & O'Toole, 2005; Howlett, 2005; Koliba, Meek, & Zia, 2010). Regulatory tools give structure to principal-agent ties where a regulatory authority has some measure of *power over* others.

The regulatory policy tools identified in this study include: environmental and economic regulation, and permits. More collaboratively-oriented policy tools also persist.

Public information as a policy strategy ultimately relies on the diffusion of information through social networks (Weiss, 2002) that rely on a willingness to consume and distribute information. A range of other policy tools has been identified across the literature (Salamon, 2002; Howlett, 2005; Birkland, 2001) that tend to perpetuate some combination of principal-agent and collaborative ties. These "mixed tie" policy tools include: contracts, grants, loans and guarantees and tax incentives, all of which are coded for in this study.

Building on the relationship between policy tool structure and governance arrangements implied in this literature, a second hypothesis is posed that examines how regulatory authority is reified and passed on in the form of regulatory policy tools. It is expected that the regulatory network will recommend more regulatory policies (such as environmental and economic regulation, and permits) than the partnership network, which will tend to recommend policy tools that perpetuate the use of collaborative ties, (such as public information, as well as other "mixed ties" tools such as grants, contracts, and loans and guarantees). This "policy tool isomorphism" hypothesis is stated below as:

H2: *Planned networks designed by the TMDL network will recommend a higher percentage of regulatory tools than the LCBP network.*

To carry out this comparative analysis, a governance network analysis framework (Koliba et al., 2011) is used and is summarized in the table below (see Table 1). A "governance network" is defined as *a relatively stable pattern of coordinated action and resource exchanges involving policy actors crossing different social scales, which are drawn from the public, private, or non-profit sectors and across geographic levels. These actors interact through a variety of competitive, command and control, cooperative, and negotiated arrangements for purposes anchored in one or more facets of the policy stream* (p. 53). Key elements of governance network analysis framework to be explained here include: 1) the policy functions that the network takes (problem formation, policy design, policy implementation, policy evaluation) (Bovaird, 2005); 2) the policy tools that shape the design process and appear in policy plans (Salamon, 2002); 3) the sectoral and jurisdictional composition of the actors in the network; and 4) the task structures that are assigned to actors in these plans. Table 1 (below) lays out these parameters along with highlighted notes.

These governance network variables and parameters are used to describe the patterns of interaction of both plans, and examine the two isomorphism hypotheses introduced at the beginning of the article. The next section describes the methods used to undertake this analysis.

2. Methods

This study integrates institutional network analysis, text data mining, and qualitative case study research, along with elements of the governance network framework described above. Comparative case study analysis methods were used to compare the two planning networks. A combination of stakeholder interviews, source document analysis, and

Table 1
Governance Network Variables and Parameters Employed

Variable	Parameters applied in this study	Notes	
Policy Functions	Policy design	Draws on the major assumption made in the network governance literature that multi-institutional networks exist across all policy functions: problem definition, policy design, policy implementation and policy evaluation stages (Bovaird, 2005; KOLIBA ET AL., 2010).	
Dominant Pattern of Network Interaction	Regulatory Partnership	Monocentric network Polycentric network	Draws on the articulation of networks as a series of nodes and ties. Regulatory networks are most often characterized by their monocentric, more densely clustered structures. Partnership networks are more often characterized by their polycentric, less densely clustered structures.
Policy Tools	Economic Regulation Environmental Regulation Permits Public Information Grants Contracts Loan guarantee Tax incentives	Principal-agent ties Collaborative ties Mixed ties	Draws on a commonly excepted framework for differentiating policy tools (Salamon, 2002) and articulates the relationship between policy tool and network tie.
Type of Network Actors	International Governing Body Federal Government State/Province Government Regional Government Local Government Private Enterprise NGO/Non-Profit Citizen Researcher	Draws on current appreciation that network governance unfolds within networks of institutional actors that span the public, private and nonprofit sectors, as well as different social scales (individual to organizational).	
Task structure	Initiating Implementing	Applies principal-agent theory to the level of task structure. Initiating actors are principals ascribed responsibility for carrying out a task to be undertaken by an agent responding actor.	

participant observation were triangulated to discern the network governance structures of the two planning networks. These qualitative data were coded for critical events that informed the design of each of the two plans under study. Visualizations of these policy design networks were rendered from these qualitative assessments (see Figures 1 and 2).

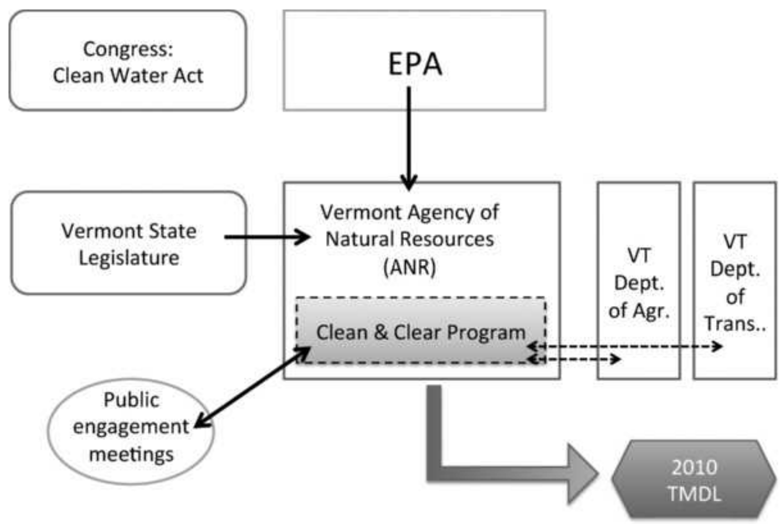

Figure 1. TMDL Policy Design Network Governance Structure for the 2010 Vermont TMDL

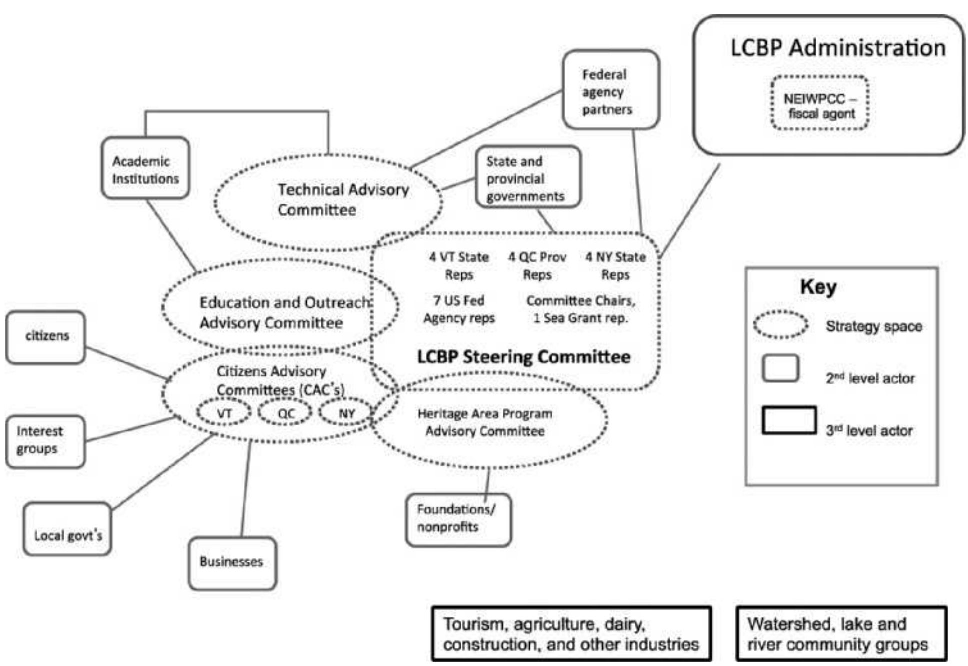

Figure 2. Lake Champlain Basin Program Governance Structure

Instititional network analysis techniques are used to describe and evaluate the networks of institutions found in the planning documents created by the TMDL and OFA planning networks. The application of instititional network analysis techniques to the study of governance networks has become widely adopted following the pioneering application of social network analysis to emergency management by Comfort (2002, 2007) and Kapucu (2006a, b). These applications have been used to study the jurisdictional and sectoral composition of institutional actors. In at least one case, institutional network analysis has been used to study the fidelity of implemented emergency management responses to those found in national emergency management plans (Kapucu & Demiroz, 2011). This study builds on Comfort and Kapucu's approaches to textual data mining to code for actors, but we deepen this methodology by adding a network layer of "task structures" that appear in planning documents and contain a significant level of detail in them.

A task structure is defined here as those bimodal relationships between two or more actors united around a common task. The combination of these bimodal relationships form patterns of network structure that may be described, compared, and contrasted. In highly structured planning documents like the ones studied here, policy recommendations may be accompanied by more detailed implementation strategies that identify who is to intiate a given task and who is to respond to the intiation to carry out the task. In strategies where actors are explicitly identified, a network structure is inferred to represent the planned relationships among these actors. *ORA software (Carley, 2001–2011) was used for matrix algebra and metric calculation. The network visuals were generated in UCINET (Borgatti, Everett, & Freeman, 2002). Measures of network density, nodal centrality, betweenness and eigenvector values are generated.

3. The Governance of Phosphorus Loading in Lake Champlain

The networks studied here share a common policy aim and geographic context: to protect and manage water quality in the Lake Champlain Basin, located on the boarder of Vermont, New York and Quebec. Both sets of networks rely on the same shared data regarding the scope, scale and causes of nutrient loading into Lake Champlain. Both sets of networks were born from a shared concern for the impacts of this nutrient loading on water quality in the lake, particularly the significant algae blooms that comprise water quality for drinking, swimming and other forms of recreation.

Although land use contributors to phosphorus loading in the Lake Champlain Basin vary across the region, Vermont contributes the majority of phosphorus loads to Lake Champlain (LCBP, 2008). This variation in loading responsibility between land use types, as well as the cross-jurisdictional complexity of two state (VT and NY) regions and one province (Quebec) region, prevents the use of blanket regulatory approaches, making the situation ripe for collaborative watershed management. In the sections to follow, a description of the regulatory and partnership networks that have been established to mitigate the flow of phosphorus pollution into the lake is provided.

3.1. 2010 TMDL Regulatory Planning Network

The regulatory authority of the USEPA dominates the regulatory network (see Figure 1). In section 303(d) of the Clean Water Act, the USEPA requires all states to identify waters that are "impaired," that is, which do not meet the state water quality standards. Once identified, states must analyze and set Total Maximum Daily Load (TMDL) targets for each pollutant to the water body. TMDLs must include: (1) an estimate of pollutant loads from all significant point and non-point sources; (2) a link between pollutant sources and their impacts on water quality; (3) allocation of allowable pollutant loads among sources; (4) actions for achieving Water Quality Standards; and (5) opportunities for public participation (USEPA, 1991). In this way, the USEPA establishes limits for pollutant levels and places a burden on the state to reduce those levels. Vermont was issued a TMDL directed at nonpoint source pollution into Lake Champlain in 2002. Following a lawsuit filed by the Conservation Law Foundation in 2008, the 2002 TMDL was pressured to be withdrawn and replaced with a more robust plan. The 2002 TMDL was officially rejected by the USEPA in 2011.

The 2010 TMDL plan was developed under the assumption that the 2002 TMDL may be rejected by the USEPA. Catalyzed into action as a result of the lawsuit, the Vermont State Legislature directed the VT ANR to work with the Vermont Agency of Agriculture, Food, and Markets (AAFM) and other state agencies to design this implementation plan as a way to stave off a rejection of the 2002 TMDL. Figure 1 provides a visualization for the multi-institutional context for the creation of the 2010 TMDL plan, with the ANR serving as a lead organization in a collaborative planning process that included extensive consultation with the public at large, special interest groups and other state agencies. This network catalyzed as a result of mandate derived directly through the VT State Legislature and indirectly through the regulatory authority of the USEPA. These regulatory pressures held the lead organization, the ANR, as chiefly responsible for devising a suitable plan. The extent to which these coercive pressures were translated in the plan chiefly devised by the ANR is the subject of this particular study.

3.2. 2010 OFA Partnership Planning Network

The LCBP is designed along the "management conference" model of watershed management (Koontz et al., 2004), in which a network administrative organization is created to generate and manage knowledge about watershed health for adaptive management purposes. An act of Congress led to the passage of the Lake Champlain Special Designation Act of 1990 (Public Law 101–596, 1990), sponsored by US Senators from both New York and Vermont, created the LCBP.[1] The governments of Vermont, New York and Quebec entered into a partnership facilitated through the LCBP Steering Committee (LCSC) and citizens' advisory committees to craft a science-based action plan entitled "Opportunities for Action" (OFA) (LCBP, 2010). The LCBP does not have regulatory

[1] The LCBP is also known as the Lake Champlain Management Conference (LCMC).

authority, but rather sponsors research, manages grant programs, provides educational outreach, convenes public meetings, and compiles watershed data and maps into a comprehensive atlas (LCBP, 2014).

By design, the LCBP is an organization deeply involved in the coordination of a partnership network and serves as a classic network administrative organization (Provan & Kenis, 2008). The LCBP is administered jointly by several agencies: USEPA Regions I and II; New York State Department of Environmental Conservation (NYS DEC); VT ANR; Quebec Ministry of Environment; and New England Interstate Water Pollution Control Commission (NEIWPCC). Administration is carried out by a professional staff, some of whom have shared reporting roles with state, provincial, and federal agencies. The LCSC guides the program's policy and planning activities and serves an executive role in a network of committees that includes a CAC from each jurisdiction (Vermont, New York and Quebec), as well as a technical advisory committee (TAC), an education and outreach committee, and a cultural heritage and recreation advisory committee. This network of committees, shown in Figure 2 below, creates a management structure that is not centrally administered, but rather built on collaboration between many actors that participate in both decision-making and implementation.

Every seven years, a new OFA report is issued by the LCBP, which offers policy recommendations designed to improve water quality in the basin. Topical foci in the OFA extend beyond nutrient loading to include control of invasive species, management of fisheries, and so on. For the purposes of this analysis, only the portions of the OFA addressing nutrient management in the lake are included in the analysis. Drafts of plans are vetted in open committee meetings and public hearings along with other citizen engagement activities. The OFA plan is informed by a broad range of actors who have repeated opportunities to inform its final version.

It is important to note that the USEPA mandates the institution of approved TMDL plans for all impaired watersheds. USEPA is responsible for assuring some form of regulatory compliance over state and local jurisdictions. While the LCBP watershed partnership OFA plans have no legal authority per se, and carry the weight of recommendations and research funding authority. These are two distinctions that we are to return to later.

4. Comparing the 2010 TMDL Plan and the 2010 OFA Plan

The comparative analysis of the two planned networks begins with an analysis of the suite of policy tools assigned to mitigate different land use behaviors contributing to phosphorus runoff. A description of the network actors by sector and jurisdiction found in each plan is then rendered. Task structures in both plans are then described as patterns of initiating and implementing actor assignments. The section concludes with a comparative analysis of both planned networks, comparing both node-level and whole network properties.

4.1. Policy Tool Ascription by Land Use

Phosphorus loading levels into Lake Champlain are strongly tied to the composition of agricultural, development (residential and commercial), and forestry land uses in the region (Troy et al., 2007). Table 2 (below) demonstrates how the TMDL plan identifies 249 tasks, roughly 87% of which indicate a policy tool to be used. The OFA plan identifies 192 tasks, 99% of which indicate a policy tool. While this represents a greater detail in planning in the OFA than the TMDL plan, the OFA applies a smaller range of tools. The OFA identifies five different policy tools, while the TMDL plan identifies eight. Public information is the most dominant tool in both plans, accounting for more than half of the identified tools in each plan, with environmental regulation and grants recommendations the next most prevalent policy tools in both plans. Both plans apply permits and contracts, but only to a lesser extent. Three tools appear only in the TMDL plan: economic regulation, loans and guarantees, and tax incentives.

Comparison of these results suggests that the mix of policy tools is similar in both plans.

In reviewing the dominant policy tool selection, public information is the most used tool in all the land-use domains. The second most identified policy tool is environmental regulation, mostly used to address agriculture and development land use issues.

4.2. Actor Characteristics

The composition of actors within both plans is shown in Table 3 and 4, differentiated by actor jurisdiction and sector. The patterns found in Table 3 (below) should come as no surprise, as they reflect the differences in geographic scope of the regulatory (Vermont) and partnership (Vermont, New York and Quebec) networks.

Table 2
Strategic Profile by Use of Policy Tools

	OFA (192 tasks)		TMDL (249 tasks)	
	Count	Percent	Count	Percent
Economic Regulation	0	0.0	1	0.4
Environmental Regulation	42	21.9	48	19.3
Permits	9	4.7	14	5.6
Public Information	100	52.1	135	54.2
Contracts	6	3.1	6	2.4
Grants	35	18.2	36	14.5
Loan Guarantees	0	0.0	7	2.8
Tax Incentives	0	0.0	2	0.8
Policy Tools Utilized	192	100.0	249	100.0

Table 3
Frequency of Jurisdiction Attribute Values

	TMDL		OFA	
Category	Count	Percentage	Count	Percentage
Vermont	12	25.53	15	21.13%
New York	0	0.00%	9	12.68%
Quebec	0	0.00%	4	5.63%
U.S.	8	17.02%	12	16.90%
Canada	0	0.00%	0	0.00%
International	1	2.13%	3	4.23%
Multiple or Indeterminate	26	55.32%	28	39.44%
Total	47	100%	71	100%

Table 4
Frequency of Sector Attribute Values

	TMDL		OFA	
Category	Count	Percentage	Count	Percentage
Federal Government	8	17.02%	9	12.68%
State/Province Government	9	19.15%	10	14.08%
Regional Government	4	8.51%	1	1.41%
Local Government	6	12.77%	21	29.58%
Private Enterprise	7	14.89%	11	15.49%
NGO/Non-Profit	5	10.64%	10	14.08%
Citizen	6	12.77%	5	7.04%
Researcher	2	4.26%	3	4.23%
International Governing Body	0	0.00%	1	1.41%
Total	47	100%	71	100%

A review of the distribution of actors by sector (table 4 below) reveals some differences in plan composition. Overall, government actors dominate both plans, representing 56.25% of actors in the TMDL and 55.55% of actors in the OFA. However, while the TMDL plan demonstrates a preponderance of state-level agencies, the OFA shows a stronger emphasis on local government. Reliance on the remaining sectors is remarkably similar in both plans.

4.3. Network Properties and Structural Patterns

The networks extracted from these two reified plans demonstrate structures that emerge from formal planning processes. Measures of node relationships and network connectivity help to illuminate patterns seen in Figures 3 and 4. A visual review of these

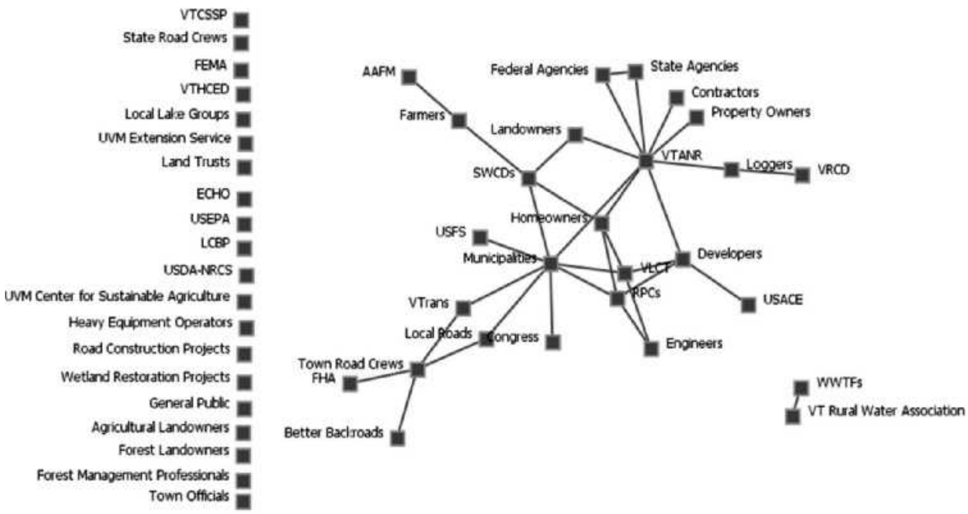

Figure 3. Designed network for a phosphorus reduction network found in the TMDL plan

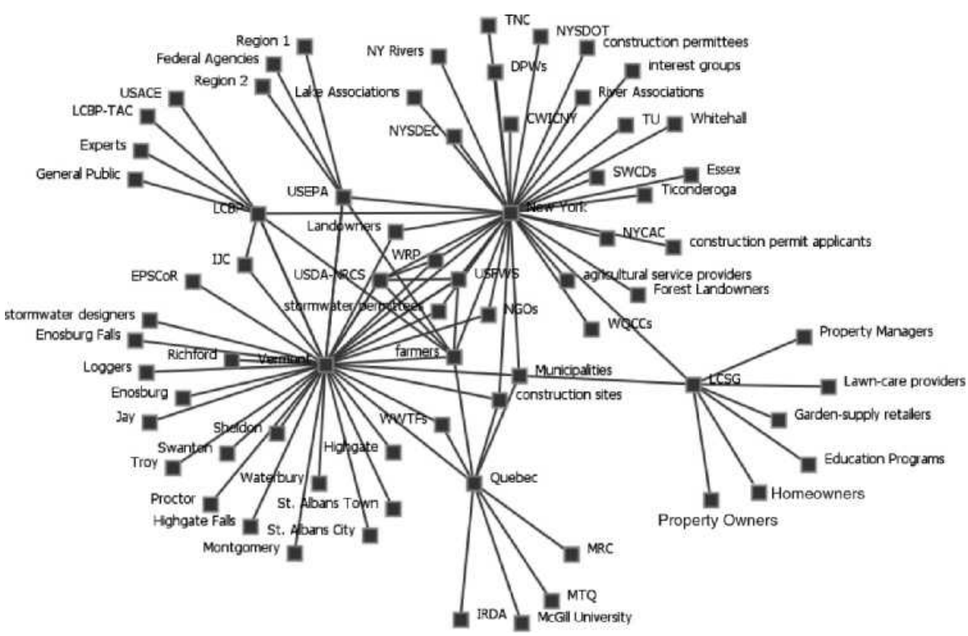

Figure 4. Designed network for a phosphorus reduction network found in the OFA plan

two figures shows the TMDL planned network is distributed as a star network organized around the VT ANR and municipalities (a class node), along with several isolate actors that have no ties. The OFA planned network exhibits a more distributed structure with a series of bridging organizations that link jurisdictional clusters of actors, notably the ridge of federal agencies connecting the states of New York and Vermont.

Centralization measures the extent to which a network approaches a perfect star structure. Table 5 shows greater degree of centralization in the TMDL network than in the OFA network. This is shown visually in Figures 3 and 4 in which there are several hub nodes in the OFA, while in the TMDL network there is but a single central node. Greater fragmentation in the TMDL is witnessed as a subset of highly connected actors that are centralized into one component while several others remain isolated. This is quite different from the OFA, which incorporates all of the actors into the connected component through a set of regional hubs. These characteristics are quantified in the comparison of isolate count, fragmentation scores, and levels of degree, betweenness, and eigenvector centralization (see Table 5). These patterns all point to a more centralized, but also more fragmented, TMDL network.

A review of the top nodal actors by centrality measures (table 6) of the 2010 TMDL plan shows that the VT ANR possesses the greatest number of ties (degree centrality) and has the most relationships to other highly-connected nodes (eigenvector centrality). According to this design, ANR will broker with many other actors directly to carry out plan functions. In contrast, the OFA relies on several nodes for brokering (Vermont, New York, Quebec, LCSG, LCBP, USEPA) (see table 7).

Table 5
Network characteristics

	TMDL	OFA
Node Count	47	71
Component Count	22	1
Isolate Count	20	0
Fragmentation	0.722	0.00
Degree Centralization	0.084	0.244
Eigenvector Centralization	0.548	0.593

Table 6
Ten Most Central Organizations in the TMDL Network

Degree Centrality		Eigenvector Centrality	
VT ANR	0.097	VTANR	0.646
Municipalities	0.097	Municipalities	0.610
VLCT	0.043	Homeowners	0.448
Homeowners	0.043	RPCs	0.408
Developers	0.043	VLCT	0.408
RPCs	0.043	Developers	0.386
SWCDs	0.043	SWCDs	0.346
Town Road Crews	0.043	Landowners	0.246
Federal Agencies	0.032	Federal Agencies	0.213
VTrans	0.022	State Agencies	0.213

Table 7
Ten Most Central Organizations in the OFA Network

Degree Centrality		Eigenvector Centrality	
Vermont	0.257	Vermont	0.694
New York	0.243	New York	0.683
Quebec	0.064	Farmers	0.348
LCBP	0.064	USDA-NRCS	0.289
LCSG	0.057	USFWS	0.264
USEPA	0.050	LCBP	0.260
Farmers	0.050	USEPA	0.238
USDA-NRCS	0.043	Municipalities	0.227
USFWS	0.043	Quebec	0.225
Municipalities	0.029	WRPs	0.218

Several actors are present in both tables, indicating their centrality to both plans. An example is the "municipalities" class node that is primarily identified as an implementing actor. Its centrality indicates that the node is targeted by a range of interventions in both plans. A similar node, "farmers," is highly central in the OFA, but does not appear as a top node in the TMDL plan. This reflects the TMDL plan's reliance on AAFM as a bureaucratic channel to address agriculture, while the OFA utilized a more varied approach.

5. Network and Policy Tool Isomorphism

This analysis suggests some mixed results regarding the two network isomorphism hypotheses. In the 2010 TMDL planned network (Figure 5), the largest assemblage of the network is a highly dense cluster of actors with relatively high number of connections, while the remainder of the graph is highly fragmented, including many isolates. As noted, the design of the 2010 TMDL plan was led primarily by the VT ANR. The evidence presented here suggests that the same monocentric structure that shaped the planning network appears in the planned network, with ANR as the central locus of initiating activity. While a visual inspection of the 2010 OFA (Figure 6) reveals a spine of federal agencies linked to two main hubs—Vermont and New York—with four smaller hubs: Quebec, the LCBP, the USEPA, and Lake Champlain Sea Grant (LCSG). Given the visual evidence and the comparative centrality scores found in Table 6, it appears that there is sufficient reason to affirm the H1 presented earlier: *the regulatory network embodied in the regulatory network produced a more centralized planned network structure*.

Interestingly, in follow up conversations with the lead author of the 2010 TMDL plan, there was a concerted effort to decenter ANR as the center piece of the plan. Although ANR serves as the most central hub in the planned network, its centrality is tempered somewhat by the intentional efforts of the lead author (the then head of the Clean and Clear Program) to collectivize responsibility for phosphorus reduction.

Looking at the distribution of policy tools found in each plan (see Table 2), a more complex picture of policy tool distribution is painted. The more coercive regulatory policy tools that were coded for (economic regulation, environmental regulation, and permitting) accounted for 21.91% of the policy tools identified in the 2010 OFA and just 19.3% of the policy tools identified in the 2010 TMDL plan. This distribution suggests that H2 is not proven and that, in fact, *the overall distribution of policy tools within each of the two plans is remarkably similar, suggesting here that a predisposition toward some policy tools over others prevails across both networks*. We provide some possible explanations for this below.

DiMaggio and Powell (1983) distinguish between three types of institutional isomorphism. Coercive isomorphism is associated with pressures bought on by regulation, legal sanction, or mandate, whereby organizations adopt certain structures and functions to accommodate regulatory, legal, or bureaucratic compliance. Mimetic isomorphism is said to arise under uncertainty when risk may be reduced by copying pre-existing, presumably successful, organizational forms. Normative isomorphism is driven by professional standards and expectations regarding best practices and high performance. All three drivers of isomorphic behavior may be in play here to explain both observed phenomena: evidence of network structure isomorphism at the level of perpetuation of regulatory and partnership network structure; and, the lack of evidence to assert that policy tool isomorphism persists across partnership or regulatory network forms.

The origins of the 2010 TMDL planning networks originated through legislative mandate, a source of coercive isomorphic pressure. Existing federal level TMDL legislation (appearing in the 1987 amendment to the Clean Water Act) outlines a centralized design model in which states are required to draft management plans to be approved by the USEPA. Designees of each state are then presumed to assume a central role. Greater coercive pressure is at play in the TMDL network. The Clean and Clear Program of the VT ANR at the time was mandated by the Vermont State Legislature to develop an implementation plan for the original 2002 TMDL. USEPA pressures to achieve benchmarks for phosphorous loading may have encouraged the use of a lead organization network structure, where a clear line of accountably can be drawn to ANR. Coercive isomorphism appears in planned networks when and where formal or informal expectations are laid out by principals and provided to agents to carry out plans.

However, the expectations of the principals overseeing the planning networks' activities (USEPA, Vermont State Legislature, and the principal parties to the governance of the LCBP) over the selection of policy tools used to address the problem of phosphorus loading into Lake Champlain appear to be very similar. It may suggest that other network ties are at work across the region that have been not accounted for in the current study. It may also arise out of a common set of interest groups and network actors appearing in both the regulatory and partnership networks. For example, municipalities, which are the main locus of land use zoning in Vermont and New York, play a prominent feature in both plans. Local control over land use decision making may be a tacit assumption driving the homogeneity of policy tool choice. Deeper examination of these factors is called for.

It is likely that some form of mimicry is at work to explain the isomorphism present. Mimicry occurs when best practices are proffered by planners, policy makers and thought leaders within a given field. These best practices strategies may be drawn from other watershed regions, practices thought to be most effective, and/or practices that have been undertaken in the past. It should also be noted that nonpoint source pollution, whether it is focused on mitigating agricultural runoff or storm water runoff from development, is said to be best addressed through a professionally determined set of best management practices (BMPs). These BMPs are promulgated through professional networks that have evolved among environmental engineers, agronomists, and watershed management professionals. These same professionals staff the committees and programs charged with drafting these plans. The dissemination of BMPs may be described as a form of mimicry. Thus, mimicry appears to be in place in the standard accepted practices established for watershed management and governance, and may be a major factor in explaining the homogeneity in the selection of policy tools in both plans. In the context of plan development phases in both networks, best management practices for stormwater and agriculture run-off were widely shared and examined among water quality experts drawn from the public, private, and nonprofit sectors.

Normative isomorphism may be found in the translation of common norms, values, and beliefs between key stakeholders. The implementation plans that were created and vetted through both networks were subject to substantial dialogue and debate. Both planning processes preferred to rely on a consensus of a core group of stakeholders whose perspectives were informed through lengthy public input, peer review, and negotiation.

It has been noted how recent environmental governance and management approaches have tended to avoid the utilization of command and control regulatory approaches (Gerlak, 2006) and instead rely on more reflexive strategies (Fiorino, 1999). These reflexive strategies surface in the stronger deference to the use of incentives and market-based mechanisms in both plans.

Several key actors in the Lake Champlain Basin were participants in both planning networks. In follow up discussions with the lead author of the 2010 TMDL plan sheds particular light on this subject. When asked about the apparent similarities between the 2010 TMDL plan and the 2010 OFA she remarked that the overlaps in the plans were likely the result of having some of the same lead actors in designing the plans participating in the same planning meetings. In other words, there was an intentional effort to align the plans together. This observation demonstrates the role of that individual network managers may take, when positioned right, in steering the overall composition of an implementation plan.

6. Conclusions

This study presents the first time that a regulatory network and a partnership planning network focusing on the same environmental problem—operating within similar jurisdictional regions, and functioning at the same point in time—have been studied. Institutional network analysis was used to compare the two plans resulting from these two planning networks. The results of this study suggest that institutional isomorphism theory can be applied to the study of multi-institutional networks and that it may be useful to explain how networks evolve from one stage of development to another.

In order to deepen our understanding of network isomorphism it will be essential to render a more robust comparative analysis of a network's evolution over time using consistent institutional network analysis methods for comparative purposes. In the present study, the informational asymmetry between the qualitative description of the planning networks and a statistical description of the planned networks is acknowledged.

The methods of institutional network analysis advanced here allow for the mapping of networks reified in formal plans in a manner that accounts for initiating and implementing actors. Our methods advance the field's capacity to measure plan characteristics, including ways that document sectors and jurisdictions, policy tools for achieving outcome goals, and task structures. The task structure framework found in Figures 1 can be applied to other types of plans, reports, and detailed descriptions of implementation tasks that offer significant details about actors and policy tools. *When used as a decision support, these measures can clarify the structural needs of proposed actions and indicate plan weaknesses prior to implementation.* In this way it can help align policy structures with contextual constraints and provide insight into the role that plans play in policy implementation.

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