Local institutions and Natural Resource Management

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Introduction

As researchers and policy-makers confront the challenges of and opportunities for improving natural resource management, increasing attention is being given to the dynamics of coupled natural-human systems (Liu et al. 2007). Interdisciplinary study of these coupled systems has generated considerable research and management innovations. Among these are more intensive research of the emergence and behavior of local institutions and consideration of the potential for voluntary and/or collaborative approaches to supplement conventional natural resource policy and management approaches. Front and center in this line of research are studies of local institutional responses to common pool resource management issues. Over time, this productive line of research is encouraging greater integration of insights across social science fields and identification of systematic patterns in research findings (e.g., Ostrom 1990, 1998, 2005, Lubell et al. 2002, Imperial 1999, Sabbatier et al. 2005, among others).

Local institutions have successfully addressed natural resource management issues, including management of fisheries, irrigation systems, forests and watersheds (Ostrom 1990, 2000, 2003, North 1990, Lubell et al. 2002, Imperial 1999, among others). Our examination builds on this past research of common pool resource (CPR) management and draws from theories from collective action theory, institutional rational choice, the Institutional Analysis and Development Framework, and transaction cost economics. We focus on lake associations and investigate the extent to which these theories explain the distribution of lake associations across Maine and the success of these lake associations in addressing five lake management issues. We explore the utility of jointly modeling the presence/absence of a local institution and the management success of these local institutions.

The primary research objective of this analysis is to develop an integrated empirical modeling framework of lake association presence (formation) and lake management success. To fulfill this objective, we examined the relative performance of empirical econometric models that ignore and address potential sample selection bias. Because we only observe measures of lake association management success on lakes that have a lake association, the sample is non-random. In our empirical work, entry into the lake association management success sample is further complicated by our reliance on survey data to describe management behavior and performance. A broad secondary research objective is to continue exploring the extent to which the Institutional Development Analysis (IAD) framework (Ostrom 1990, 1999, 2000, 2005 Lubell et al. 2002, Sabatier et al. 2005) can be used to study Maine lake associations (Snell 2009). We view this IAD framework as an inclusive theoretical and empirical framework, accommodating insights from institutional economics, rational choice, transaction cost economics, and collective action theory.

Using data from the lake-rich state of Maine, we used discrete regression analysis to examine empirically whether the distribution and management success of lake associations are consistent with the IAD framework. We collected data describing 2,602 lakes, including descriptions of resource, community, institutional, and lake association characteristics. We employed binary probit regression analysis to explain the presence/absence of lake associations as a function of resource, community, and institutional characteristics. We estimated ordered probit models to explain variation in management success for a subset of lake associations as a function of these characteristics as well as organization attributes; we consider water quality, invasive plant, recreation, development, and road management issues. The diversity of these five management issues allows us to compare and contrast patterns in success. We estimated a sample selection model that combines the binary probit model of presence and the ordered probit model of management and explicitly simulates entry into the lake management success sample (Greene 2002).

Our investigation of an integrated model of lake association presence and management success points to future research opportunities. Given our available data, we estimated the integrated model accounting for sample selection. At present, we find little evidence of empirical gain from this alternative modeling approach. Our empirical results suggest resource, community, and institutional factors explain the distribution of (presence/absence) lake associations consistent with expectations of the IAD framework. The empirical models of lake association management success are less robust. We are hesitant to generalize based on our current empirical findings. Our treatment of management success is constrained by our limited information describing management and organizational attributes (e.g., sample size < 150). This empirical challenge is guiding future data collection plans.

Lake Associations and Lake Management

Lake associations are an interesting class of resource-based organizations. These local, lake-centered institutions strive to address management issues using informal and voluntary strategies (Gabriel and Lancaster 2004, Kramer 2007, Kreutwiser 1986). Lake associations are most common in lake-rich states, including Minnesota, Michigan, Wisconsin, New York, New Hampshire and Maine. The objectives of these groups vary from narrow (private road maintenance) to broad (watershed health). Lake associations allow for lake-centered boundaries including multiple jurisdictions, provide a voice to seasonal property owners, and resolve some issues related to coordination, property rights, and transaction costs (Gabriel and Lancaster 2004, Kramer 2007, Kreutwiser 1986). Over the course of the last century, lakeshore residents in some communities have formed local organizations with lakes as the center of attention, while other communities have relied on more traditional top-down management to control nonpoint source pollution, protect water quality and regulate recreation. Though these local organizations do not often have regulatory power, they frequently work to protect ecological and social aspects of lake ecosystems through efforts in education, lobbying and collaboration with governments and stakeholders.

Lakes are valuable ecological, social, and economic assets (Carpenter and Brock 2004, Carpenter and Folke 2006, Wilson and Carpenter 1999, Bingham et al 1995, Boyle et al. 1997, Boyle et al. 1999, Burt and Brewer 1971, Carson and Mitchell 1993, Caulkins 1986, Loomis and Feldman 2003, Needleman and Kealy 1996, Kinnell et al. 2006, Lansford and Jones 1995). Maintenance and management of these assets have evolved over time in response to scientific advances in the understanding and changing of threats to lake ecosystems (Allan et al. 2008, Borre et al. 2001). For example, after decades of focus on point sources of water pollution, recent policies and research focus on managing nonpoint sources of water pollution (Borre et al. 2001, Carpenter et al. 1998, Dodds et al. 2009, Wamelink et al. 2007, Smith 2003). Threats posed by the introduction of non-native invasive plants and fish are also receiving increased attention by researchers, policy-makers, and citizens. Such introductions can disrupt lake ecosystems and prove extremely costly to manage (Halstead et al. 2003, Pimentel et al. 2000). Nonpoint source pollution and invasive plants and fish are difficult to regulate because pollution sources and dispersal mechanisms are difficult to isolate and monitor. Furthermore, contributions to ultimate pollutant loadings and invasions are complex, characterized by significant heterogeneity and uncertainty over time and space. Local level voluntary organizations, such as lake associations, may provide an opportunity to address these issues.

Nationally, lakes and ponds cover 16.45 million hectares. These lakes provide numerous services including drinking water, habitat and recreation. Sixty-four percent of monitored lakes are impaired so that they are not suitable for one or more of their designated uses (e.g. recreation, agriculture, drinking water)—most often due to nonpoint source pollution, with nutrients, metals, and siltation of primary concern (US EPA 2004). The inadvertent introduction of non-native plants and other organisms presents an additional threat to water quality by clogging channels and threatening biodiversity. Research estimates that aquatic weeds account for 10 million dollars of damages per year and cost an additional 100 million dollars annually to control. Invasive fish costs account for 54 million dollars each year (Pimentel et al. 2005, Knowler and Barbier 2004). These environmental problems have a number of economic implications including a decrease in property values as well as recreational revenues (Boyle et al. 1997, Boyle et al. 1998, Schuetz et al. 2001, Carson and Mitchell 1993, Halstead et al. 2003, Desvouges et al. 1983, Pimentel et al. 2005).

Federal, state and municipal regulations address, to some extent, the threats to ecological quality from nonpoint source pollution and non-native species. However, comprehensive lake management success may depend on greater changes in individual behaviors and consideration of interactions between ecological, social, and economic aspects of lake systems (Wooley and McGinniss 2002, Veda et al. 2008, Snavely and Tracy 2002, Pretty 2003). Local institutions, such as lake associations, are well suited to complement traditional regulatory approaches because the strong connections and relationships developed through these organizations allow for more detailed knowledge of the sources of potential problems as well as greater support for local monitoring and enforcement (Ostrom 2000, Wooley and McGinniss 2002, O'Neil 2005, Mullen and Allison 1999, Kramer 2007, Koehler and Koontz 2008, Klyza et al. 2006, Kellert et al. 2000, Evans 1996, Burger and Booyson 2006, Ballet et al. 2007). These relationships can aid in the spread of information and develop trust between community members. In addition, these organizations are able to address issues that state and local governments are not well suited to tackle. For example, issues that are difficult to quantify and track at a state scale, such as changes in lake character or loss of remoteness, are more easily observed at a local scale.

Arguably, the presence of lake associations throughout the U.S. suggests that federal, state, and municipal regulations are falling short in terms of meeting some management objectives. The management issues of lakes are interconnected and complex. Boundary issues, social dynamics, and properties of lake services account for much of this complexity. Lakes and their watersheds do not follow typical political boundaries. Management is complicated by the fact that many lakes are located in more than one jurisdiction. One part of a lake could be managed by one town, while another part is managed by a different town. This same lake could also cross a state or international border. Furthermore, lakes often serve as the anchor of seasonal communities. Seasonal residents who own lakeshore housing often do not have local political power but have strong feelings about lake management.

Lastly, depending on the use of the lake, it can be viewed as either a public good or a common pool resource (CPR). A public good is both non-excludable and non-rival, meaning there is open access to the good, and use of the good by one person does not influence use by others. Lakes as scenery or part of an ecosystem could be considered a public good. A lake could also be considered a common pool resource. A common pool resource is non-excludable and rival, in that access is open and use of a resource decreases the amount of resource available or the quality available for others to use. Lakes used for drinking water or recreational resources fall in this category, as do fisheries and the elusive properties of remoteness and solitude found at lakes. Both public goods and CPRs are prone to market failure, because of poorly defined property rights, difficulty in enforcement, high transaction costs and imperfect information. Organizations and institutions, such as lake associations, can help overcome these problems by reducing transaction costs associated with management and aiding the spread of information (Ostrom 2000).

Conceptual and theoretical framework

The collective action theory/institutional economics literature offers the overarching framework and provides the theoretical context for our empirical research. Prior empirical research on the formation and distribution of institutions to protect natural resources presents valuable guidance on the design of our empirical analysis of lake associations. We give particular emphasis to empirical work focused on water-based institutions, including lake and watershed associations (Kramer 2007, Kruetwiser 1986, Gabriel and Lancaster 2004, Lubell et al. 2002, Lubell 2004a , Lubell 2004b, Sabatier et al. 2005, White et al. 1995, Sarker et al. 2008, Michaels et al. 2006, McGinnis et al 1999, Koehler and Koontz 2008, Leach 2006, Leach and Pelkey 2001, Bidwell et al. 2006, Blomquist and Schlager 2005, Bonnell and Koontz 2007, Chess and Gibson 2001, Clark et al. 2005, Cline and Collins 2003, Curtis et al. 2002, Duram and Brown 1999, Ferreyra et al. 2008, Ferreyra and Beard 2007, German and Hailemichael 2008, Hodge and McNally 2008, Impierial and Kaunekis 2003, Impierial 1999, Koontz and Johnson 2004, Leach et al. 2002, Low and Randhir 2005, Michaels 2001, O'Neil 2005, Oliver 2001, Wooley et al. 2002, Wooley and McGinnis 1999). These studies apply ideas related to institutional rational choice theory and the Institutional Analysis Development (IAD) Framework to explore factors relating to organizational formation and management success.

Collective action theory

Collective action theory, including the IAD framework, is applied extensively to explore systematic patterns in organizational formation and success (Ostrom 1990, Ostrom 2005, Lubell 2002, Sabatier et al 2005, among others). The IAD framework incorporates research from many disciplines in studying the formation and change of institutions and organizations (Ostrom, 1990). As noted previously, we take a broad view of this framework. The IAD framework's "action arena" both influences and is influenced by human interactions. Attributes of the natural resource, the community in which the resource is located in, the institutional setting, and attributes of these institutions and organizations are central to understanding the formation and success of institutions (Ostrom 1990, Ostrom 1999, Ostrom 2005, Lubell et al. 2002, Sabatier et al 2005, Kopelman et al. 2002).

Defining organizational success is challenging because associations address a number of issues, many of which are difficult to measure. Yet, the definition of success is central to management, organization, and institutional studies, determining which organizations are deemed successful and which organizations fall short of their goals (Koontz and Johnson 2004, Conley and Moote 2003, Ferreyra and Beard 2007, Leach 2002). Some researchers feel that improvement in measurable environmental outcomes, such as an improvement in water quality, should play a prominent role in the definition of success (Ferreyra and Beard 2007, Imperial 1999, Koontz and Thomas 2006, Kramer 2007, Mullen and Allison 1999). Others feel that emphasis should be placed on connections formed by the organization (Ballet et al. 2007, Bidwell et al. 2006, Borre et al. 2001, Ferreyra and Beard 2007, Goldman et al. 2007, Koontz and Thomas 2006, Leach 2002, Lubell 2004b, Michaels 2001, Mullen and Allison 1999, Rultan 2008). Organizations can be viewed as a success if they are enduring (Poteete and Ostrom 2008, Santos et al. 2008, Sethi and Somanathan 1996, Clark et al 2005, Ostrom 1990, 1999, 2005), or organizations can be considered successful if they are able to change attitudes or behavior (Conley and Moote 2003, Cline and Collins 2003, Leach 2006, Moore 2003). Several studies provide support for the argument that a combination of social and biological outcomes is necessary to create a more realistic picture of success (Allen 2008, Bidwell 2006, Woolley et al. 1999, Kellert et al. 2000, Koontz and Thomas 2006, 2004, Leach 2002, Mullen and Allison 1999, Lubell 2004a). Another challenge in defining success is determining measurable indicators of success. Surveys can capture information members' perception of organizational success. Perceived success can serve as an indicator of some types of success, especially social success, where data are lacking (Lubell et al. 2002, Ferreyra and Beard 2007, Leach et al. 2002, Conley and Moote 2003). Conley and Moote (2003) found that environmental success is best judged from an objective source outside the organization, while social success is best judged by members of the organization.

Collective action theory (Ostrom 1990, 2005, Lubell 2002b, 2004, Leach and Sabatier 2005) suggests four categories of factors influence the costs and benefits of management, and in turn, the returns to formation and the relative success of lake associations: resource characteristics, community characteristics, institutional characteristics and organizational characteristics.

Resource Characteristics

Natural resource attributes affect both the costs and benefits of management strategies. Different types of management responses to resource problems have varying probability of success, benefits, and costs. For example, problems that are easily identifiable with results that are easily measurable reinforce the formation of organizations (Chess and Gibson 2001). Dispersed resources that cover a larger area are more costly to manage (Ostrom 2005). Resources facing a serious environmental threat also encourage organization formation (Lubell et al. 2002). In order for the time and effort of organizations and institutional development to be beneficial, the resource must be perceived as scarce, limited or valuable, and community members must recognize at least the potential for problems (Ostrom 2005).

Resource or environmental conditions can encourage or discourage success by influencing the cost of management. Some environmental problems are easier to solve than others (Kellert et al. 2000, Ostrom 2008, Chess and Gibson 2001). In addition, smaller or more stationary resources are easier to manage, *ceteris paribus*. Situations where enforcement and monitoring costs are low encourage the success of collective management (Ostrom 1990, 2003). Empirical findings of lake studies are mixed: Kramer (2007) found the expected negative relationship between organization success and the size of the lake, while Gabriel and Lancaster (2004) found no significant relationship between size of the lake and success of the lake association.

Community Attributes

A number of community attributes may encourage local level resource management. Organization participation is more likely when individuals are: dependent on a resource, share a common understanding with other participants, have a low discount rate, and have experience with other local level organizations (Ostrom 1990, Ostrom 2005). Communities who depend on the resource for a large percentage of income have more motivation to successfully manage the resource (Ostrom 2005, Ostrom 1999, Ostrom 1990). These communities would receive more benefit from protecting a resource than communities who do not rely on the resource.

In contrast, some communities may face higher costs because of lake protection efforts. For example, Lubell et al. (2002) found that strong agricultural lobbies discourage the formation of watershed associations. Members of this lobby feared that the associations might encourage regulations that increase operating costs. Communities, who depend on forest and agricultural industries, frequent targets of water quality programs, may have similar concerns about lake management policies.

Homogeneity is a controversial subject within CPR research. Lubell et al. (2002) illustrated that partnerships are more likely to form in homogenous areas with high human, social and financial capital. Transaction costs are lower if members come from similar backgrounds and share common beliefs, values and attitudes. This relates to the concept of social feasibility (Chess and Gibson 2001, Allan and Curtis 2008, Sabattier et al. 2005). Ostrom (2005) conversely noted that homogeneity is not a necessary feature for collective management arrangements to occur. Moreover, organizations and institutions may be established precisely to overcome transaction costs caused by heterogeneities. Wagner and Fernandez-Gimenez (2008) found that the large number of community based resource management groups in their study area was due to a high degree of conflict between users. This suggests that though collaboration might be easier in homogeneous groups, it can be used to overcome problems caused by heterogeneity. Lake communities are made up of both year-round and seasonal residents. These groups have different interests and relationships, which could influence the success of the organization. Lake associations could include members from both groups, or be predominantly made up of one or another. There is debate as to the effect of group heterogeneity on the probability of success. As mentioned above, diverse stakeholder representation encourages success, but heterogeneity can increase transaction costs and decrease trust. Empirical evidence is mixed, with some research finding a significant negative relationship (Lubell 2004, Leach et al. 2002) and others finding no association (Poteee and Ostrom 2004, Ostrom 2005).

Traits of the local community can influence the success of the organization (Chess and Gibson 2001, Lubell 2004b, McGinnis et al. 1999, Ostrom 2003). Research indicates that the size of the community strongly influences the viability of organizations (Olson 1965 Lubell 2004a, Ostrom 1999 Gabriel and Lancater 2004). Though coordination is more difficult in larger groups and benefits of the actions must be spread among more people, larger groups also bring greater resources to address problems. In addition, greater participation can imply the development of greater social capital, which can reduce transaction costs associated more people (Kramer 2007).

Education and income levels have also been shown to influence positively the success of organizations (Leach and Pelkey 2001, Koehler 2008, Cline and Collins 2002). Those with higher income may have more resources to commit to the organization. Education has been shown to positively influence the participation in volunteer organizations (Koehler 2008). However, Kramer (2007) did not find a significant relationship for either factor in his analysis of lake association success.

Institutional Factors

Institutions are referred to as the rules society members follow (North 1990, Ostrom 1990). These can be both formal and informal and are included within the concept of social capital or the shared ideas, norms and beliefs of a community. Social capital reduces transaction costs associated with resource management. Olson (1965) noted that social sanctions and rewards can act as the necessary incentives to encourage collective action, though these are more important in larger organizations. Like other forms of capital, social capital can be used to obtain necessary resources (Coleman 1986, Woolcock 1998, Woolcock and Narayan 2000, Wagner and Fernandez-Gimenez 2008). Social capital is recursive: it encourages group participation and group participation encourages social capital (Kramer 2007, Coleman 1988, Woolcook 1998, Ostrom 1990, 1999, 2005). Communities with a history of local level organizations or clubs may be more likely to form additional organizations.

Lubell et al. (2002) argued that though traditional “command and control” or top-down systems work well in some communities, other strategies would be more attractive in areas where these approaches have been less successful. Support from state and local government encourages such activity (Leach and Pelkey 2001). Local associations that form around a resource instead of along political lines reduce transaction costs caused by coordinating across multiple jurisdictions. As a result, organizations may be more likely to form around resources that cross multiple jurisdictions. Organizations may form in areas where no clear, consistent or effective management exists (Ostrom 1990, 2005, Lubell 2004, North 1990).

Research has found that social capital encourages success in local level natural resource management (Kramer 2007, Klyza 2006, Leach 2006, 2001, Lubell 2004, Wagner, McGinnis 1999, Ostrom 1990, 2003, 2005, Michaels 2001). Ostrom (1990, 2003) noted that shared norms and values encourages collective action and allows organizations to persist. If a community has a history of collaboration, new endeavors are more likely to succeed (Michaels 2001). Social capital encourages a sense of community in which members are more willing to work together (Woolcook 2000). In their comparative study, McGinnis et al (1999) noted that a lack of a sense of community could have contributed to the failure of the San Ynez Watershed Association.
Broad stakeholder participation has been identified as a key to organizational success. Stakeholders should represent all interested parties (Koontz and Johnson 2004, Imperial 1999, Michales 2001, Lubell 2004b, O'Neil 2005, Veda et al. 2008, Leach 2001, Mullen and Allison 1999). This can include government officials, local residents, or those who use a resource. Stability within the group of participants increases the chances for success (Ostrom 2003).

Organizational factors

Attributes of the organization can also influence the likelihood of success (Kellert et al. 2000). Successful organizations have strong, motivational leaders who are accountable to the membership of the organization (Leach 2001, O'Neil 2005). An organization's leadership and legitimacy are reinforced if both the leaders and members are accountable, and the decision making process is viewed as fair (McGinnis et al. 1999, O'Neil 2005). Social capital literature suggests that older lake associations are more likely to be successful because they may be more accepted within the community (Leach and Sabatier 2005, Leach and Pelkey 2001, Kramer 2007). These organizations may have established trust and other relationships between community members. Empirical evidence is mixed as to the role organizational size plays in the level of success obtained. Transaction costs are greater when more people are evolved (Ostrom 1990, Barker et al 1984). However other research has found larger organizations are more successful (Leach and Pelkey 2001). With a larger membership, personal costs could be lower. This could reduce member fatigue.

Successful groups also have a clear scope of focus (Chess and Gibson 2001, O'Neil 2005). This focus can lead to a more efficient allocation of resources and more targeted fundraising. Research has shown that an organization is more likely to be successful if it pays more attention to an issue (Chess and Gibson 2001, Leach 2001). Research has found that reliable funding and resources encourages success of local organizations (Leach 2001, Mullen and Allison 1999, O'Neil 2005 Coleman 2009).

Water-based Institutions

Our analysis benefits from prior research of lake and watershed associations (e.g., Kramer 2007, Kreutwiser 1986, Gabriel and Lancaster 2004, Lubell et al. 2002, Lubell 2004, Lubell 2004, Sabatier et al. 2005, White et al. 1995, Sarker et al. 2008, Michaels et al. 2006, McGinnis et al. 1999, Koehler and Koontz 2008, Leach 2006, Leach and Pelkey 2001, Bidwell et al. 2006, Blomquist and Schlager 2005, Bonnell and Koontz 2007, Chess and Gibson 2001, Clark et al. 2005, Cline and Collins 2003, Curtis et al. 2002, Duram and Brown 1999, Ferreyra et al. 2008, Ferreyra and Beard 2007, German and Hailemichael 2008, Hodge and McNally 2008, Imperial and Kaunekis 2003, Koontz and Johnson 2004, Leach et al. 2002, Low and Randhir 2005, Michaels 2001, O'Neil 2005, Oliver 2001, Wooley et al. 2002, Wooley and McGinnis 1999). These prior studies apply ideas consistent with the IAD framework to explore different aspects of these organizations.

Lake and watershed associations have much in common: they are concerned primarily with water quality, and a lake association may also be a watershed association or eventually evolve into a watershed association. More research has focused on formation of watershed organizations than lake associations (Lubell 2004, Sabatier et al. 2005, White et al 1995, Sarker et al. 2008, Michaels et al. 2006, McGinnis et al 1999, Koehler and Koontz 2008). Research of watershed organizations has focused on research questions addressing formation (Lubell et al. 2002, Lubell 2005, Sabitier et al 2005, Santos et al. 2008), organization (Leach and Pelkey 2001, Bidwell et al. 2006, Clark et al. 2006, Curtis et al. 2002, Duram and Brown 1999, Ferreyra and Beard 2007, Koehler and Koontz 2008, Koontz et al. 2004, Lubell et al. 2002, McGinnis et al. 1999, Michaels 1999, Wooley and McGinnis 1999) and success (Lubell et al. 2002, Lubell 2004, Lubell 2005, Sabitier et al 2005, Bonnell and Koontz 2007, Chess and Gibson 2001, Cine and Collins 2003, Curtis et al. 2002, German and Hailmichael 2008, Koontz and Thomas 2006, Koontz et al. 2004, Leach and Pelkey 2001, Michaels 2001, Michaels et al. 2006, Santos et al. 2008, Wagner and Fernandez-Gimenez 2008, Wakefield et al. 2007, Woolley and McGinnis 1999). These studies have highlighted the importance of the context in which the organizations emerge. Studies of lake associations address similar themes, examining formation (Kramer 2007, Kruetwiser 1986) and success (Kramer 2007, Kruetwiser 1986, Gabriel and Lancaster 2004).

Methods and Data

Guided by theoretical expectations reviewed in the previous section, we employed regression approaches to investigate the current distribution (presence/absence) and management success of Maine lake associations. We considered the influences of resource, community, institutional, and organizational characteristics on organizations' presence, management behavior, and management success. We evaluated success by gauging institutional responses to distinct lake management issues: water quality, invasive plants, recreation, development, and road maintenance.

We employed binary probit regression analysis to explain the presence/absence of lake associations as a function of resource, community, and institutional characteristics. We estimated ordered probit models to explain variation in management success for a subset of lake associations as a function of these characteristics as well as organization attributes; we consider water quality, invasive plant, recreation, development, and road management issues. The diversity of these five management issues allows us to compare and contrast patterns in management success.

We estimated a sample selection model that combines the binary probit model of presence and the ordered probit model of management and explicitly simulates entry into the lake management success sample. We examined the relative performance of empirical econometric models that ignore and address potential sample selection bias. Because we only observe measures of lake association management success on lakes that have a lake association, the sample is non-random. In our empirical work, entry into the lake association management success sample is further complicated by our reliance on survey data to describe management behavior and performance. When estimating the integrated model, we had to drop some lake association presence observations from our sample because we did not have management success information for these lakes. By relying on a survey of VLMP monitors, we influenced the process of entry into our success sample. Unmeasured characteristics may be explaining entry into the success sample and the stated level of success.

Following the notation of Greene (2002, p. E18-24), the integrated model can be represented as follows:

Ordered probit model of lake management success

$$y_i^* = \beta' x_i + \varepsilon_i$$

$$SUC_i = 0 \; if \; SUC_i > \mu_1$$

$$SUC_i = 1 \; if \; SUC_i \leq \mu_1$$

$$SUC_i = 2 \; if \; SUC_i \leq \mu_2$$

$$SUC_i = 3 \; if \; SUC_i < \mu_2$$

where y_i* is an unobserved latent measure of the lake association's "true" management success on lake i, β are k parameters to be estimated, x_i represents k resource (R), community (C), institutional (I), and organizational (O) characteristics for lake i , y_i is the perceived categorical level of management success, and ε is a random error term.

Binary probit model of lake association presence (sample selection equation)

$$LA_i^* = \alpha' z_i + u_i$$

$$LA_i = 1 \; if \; LA_i^* > 0 \; and = 0 \; otherwise$$

where LA_i* is an unobserved latent measure of the return from having a lake association present on lake i, α are l parameters to be estimated, z_i represents l resource (R), community (C), and institutional (I) characteristics for lake i, LA_i is our binary description of lake association presence, and u is a random error term.

We only observe success data (SUC) when lake associations are present (LA=1). This specification of sample selection assumes ε and u are random error terms having a bivariate standard normal distribution with correlation ρ. We estimated the integrated model using full information maximization likelihood (FIML) techniques. When the estimate of ρ is significantly different from 0, there is support for "selectivity".

These same expressions can be used to motivate the stand-alone binary probit and ordered probit models that overlook sample selection issues.

Study Area

The State of Maine is an appropriate area to study lake associations. Maine's landscape is rich in lakes and ponds, with more than 2,000 Great Ponds (10 acres/40.05 hectares or more in area) and countless smaller or seasonal ponds. The State of Maine holds all Great Ponds in trust. The Great Ponds Law, a colonial ordinance, guarantees public access to Great Ponds for fishing and fowling across unimproved lands (Maine Revised Statute Title 17 § 3860). The Maine Department of Environmental Protection (DEP) estimates lakes and ponds cover six percent of Maine's landscape (Maine Department of Environmental Protection, 1998). In addition to providing habitat for plants and animals, Maine's lakes and ponds provide drinking water and are a major recreation attraction for both residents and visitors to the state. Research in the late 1990s established that both residents and visitors spend a total of $1.087 billion on lake recreation annually (Boyle et al., 1997). This research also estimated the net economic value of Maine's Great Ponds to be $6.7 billion dollars (Boyle et al., 1997). In addition, lakes attract residential development. Nearly $350 million is spent on lakefront properties per year (Boyle et al., 1997). Maine's Land Use Regulation Commission (LURC) notes that, within the unorganized territories, 46 percent of all building permits are for structures within 500 feet of a water body (ME LURC, 2007).

Data

We assembled an extensive spatial database describing natural and human features of 2,602 Maine lakes (Maine's great ponds; > 10 acres in size) to support this analysis. Data describing the distribution and success of lake associations were drawn from non-government organization, federal and state agency databases and primary survey data collected to describe social and economic characteristics of Maine lakes. We captured additional lake and association attributes by manipulating various state and federal GIS databases and creating primary spatial databases.

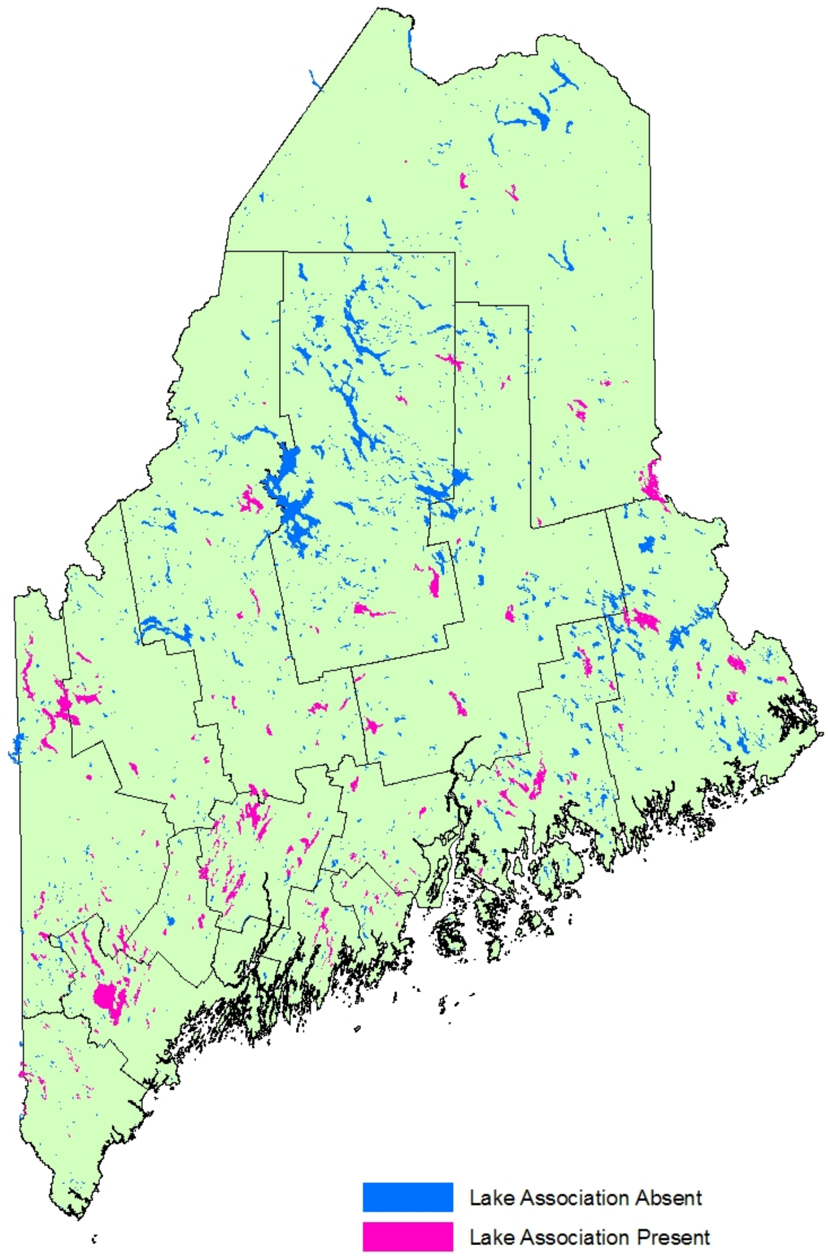
We view the current distribution of lake associations as indicative of past cumulative decisions made by communities, where the return from organizational formation is a function of physical attributes of the lake resource, community attributes and institutional attributes. Our research of lake association presence (LA) emphasizes several lake attributes: lake size (SHORE), threatened environmental quality (IMP), surrounding land cover (PAG, PFOR), public recreation access via boat launches (BL); recreational fish

(FISH); housing density and housing value (HU and HV); the number of jurisdictions bordering a lake (JUR); local employment (NREMP, RECEMP), presence of other lake institutions (VLMP), whether or not the lake serves as a drinking water source (DWAT), the number of jurisdictions surrounding the lake (JUR), and whether or not the lake is located in the unorganized or organized area of Maine (INLURC). We also examine five organizational issues: organization age (AGE), membership size (MEMB), membership mix (MYR, MSE), collaborative relationships (CGOV, CSTATE, CNGO) and issue attention (ATT).

We employed data collected by the Maine Congress of Lake Associations (COLA) and Maine Bureau of Corporations, Elections and Commissions to identify which communities have formed lake associations (ME COLA 2009, Computer file available online, Maine Bureau of Corporations, Elections and Commissions, Department of the Secretary of State. Computer file available online). The distribution of lake associations throughout the state of Maine shows a mixed spatial pattern with more lake associations in the populated southern portions of Maine as well as in Maine's "rim" counties (Figure 1). As of January 2009, about ten percent of these lakes host some form of local lake management organization. A variety of state and federal data resources provided information describing resource, community, and institutional characteristics (see Table 1 for descriptive statistics). University of Maine's PEARL database (Senator George J. Mitchell Center for Environmental and Watershed Research, University of Maine, 2008, PEARL. Computer file available online) and Maine’s Department of Inland Fisheries and Wildlife (IF&W) lake data files (Maine Department of Inland Fisheries and Wildlife, 2008. Computer file.) were invaluable sources of information about physical resource characteristics. We calculated the percentage of urban, agricultural and forest land cover for each Great Pond’s direct drainage area using the 2001 USGS National Land Cover data layer (NLCD 2001). The US Census Bureau's Census of Population and Housing (United States Census Bureau 1990 and 2000 Census. Computer file available online) served as the key source of information for community characteristics. Due to data availability, we opted to measure these characteristics at the county subdivision level; data reflect values for all county subdivisions bordering the water body. We measured numerous characteristics using ESRI's ArcMap GIS software and opted to organize and store our database in GIS format.

We derived our measures of perceived management success using survey data collected by our research team in Spring of 2009. The survey, designed and implemented using Dillman's (2000) tailored design method, was sent to members of Maine's Volunteer Lake Monitor Program (VLMP). Members of this program collect water quality data for more than 350 lakes in Maine and are well trained in scientific protocols. We opportunistically included a number of questions about local organizations and lake associations that exist around the lakes these volunteers actively monitor. We pre-tested the survey with members of the VLMP before distributing the survey. The survey was sent to 417 lake monitors. The monitors were sent a reminder postcard one week following the survey. Another reminder along with a replacement survey was sent several weeks later. This resulted in the response rate of 76 percent. Of those responding, more than 80 percent (N) reported some sort lake association activity. Merging these organizational data with the Great Ponds data on presence/absence of lake associations(n=2,602), we identified about 170 lakes in common. Management success on five issues (WQSUC, IPSUC, RECSUC, DEVSUC, RDSUC) is described using an ordinal measure of success; values range from 0 to 3, with 3 representing the highest level of management success.

Figure 1. Distribution of Maine Lake Associations



Resource Characteristics(R)

Physical characteristics of lakes influence the benefits and costs of lake association formation and management for community members. Larger lakes, with more complicated shorelines (SHORE) may be more difficult to manage because of increased transaction costs associated with management. Separate intra-communities may form in coves, and a lake association may help coordinate the lake management among these groups. Hence, we expect SHORE to be correlated positively with lake association presence and negatively with lake association management success.

Natural resource threats, such as an infestation of non-native invasive plants or an impaired lake (US EPA 303 d list), can influence the return to local organization formation as well as management success. Community members may have a strong incentive to control the growth of an invasive plant infestation because the presence of invasive plants has a negative effect on property values and can detract from recreation and scenery (Halstead et al. 2003). Controlling invasive plants is an expensive process and property owner groups help share the effort and costs. In addition, an infestation may serve as a "crisis" that spurs action. The risk of infestation increases if a nearby lake is a known infestation site. Inclusion on the 303 d list is another indication of an environmental problem. This is a list required by the Clean Water Act to report lakes that are impaired such that they are not meeting their designated use. We expect these natural impairments (IMP) to be correlated positively with lake association presence.

The surrounding land cover in the direct drainage may influence the lake's water quality. Agricultural (PAG) land cover is typically associated with decreases in water quality because of nonpoint source pollution (US EPA 305 b report 2000). Accordingly, we expect PAG to be correlated positively with lake association presence. While forest harvesting can also cause nonpoint source pollution, we have mixed expectations about forest land cover (PFOR) because forests also act as natural buffers. The knowledge that a lake is impaired or at risk may motivate citizens to work to improve the water quality (Lubell 2004). In this context, lake association formation can be viewed as responding to a gap in existing and past lake management approaches.

Popular recreation lakes are a valuable resource that the community may want to preserve (Boyle et al. 1997, Schuetz et al. 2001). Boat launches (BL) ease public access to a lake for boating, fishing and other recreational activities. Fishing for bass or cold-water species such as trout and land locked salmon is a popular pass time in Maine. Lakes with strong fisheries (FISH) may be valued by a community as a recreational resource. Lake associations may form to protect water quality, habitat or lobby for stocking. Communities may form lake associations to protect a popular recreation site. Accordingly, we expect BL and FISH to be correlated positively with lake association presence. We have mixed expectations about the correlation between BL and FISH and management success because public access and values of a lake resource can complicate local management of lake management issues.

Community Characteristics(C)

Community Characteristics, including demographic and geographic factors, may encourage or discourage the formation and success of lake associations. Increased population and more frequent use can increase transaction costs by slowing the spread of information and contribute to the heterogeneity of the community. Such a lake may also be valued by a larger group of people who may work to protect its water quality. Due to the large population of seasonal residents, we use housing unit density (HUD), instead of population density, as a measure of community size. We have uncertain expectations regarding the correlations between HUD and lake association presence and success. The median housing value (HUV) in a community could contribute to lake association formation and success because a lakeside home is a significant asset. Property owners are motivated to protect the value of their homes by protecting the water quality of a lake and the recreational experiences it supports. Therefore, we expect HUV to be correlated positively with lake association presence and management success.

Lake-based recreation plays an important role in the economy lakeside communities (Boyle et al 1997, Schuetz et al 2001). If the quality of the lake declined to a point that discouraged visitors, these communities would experience an economic decline. Therefore, community members have an incentive to maintain the quality of recreation opportunities. US Census data allowed us to calculate the percentage of the population employed in recreation accommodation or food service industries (RECEMP), and measure the town's economic dependence on recreation. We also include the natural resource employment (NREMP) to test the hypothesis about a resistance to increased environmental regulation. Areas dependent on agriculture, forestry or other natural resource-based industries may be resistant to increased regulation or policy changes designed to protect water quality, which may be costly to implement. Accordingly, we expect these employment measures to be correlated negatively with association presence.

Institutional Characteristics

Laws, beliefs and a community's culture also influence the formation of organizations. A past history of local level organization is a strong predictor of subsequent organization formation because these organizations increase social capital, connections and similar beliefs between community members (Coleman 1988, Woolcook 1998, Ostrom 1990, Ostrom 1999 Ostrom 2005). Maine's Volunteer Lake Monitoring Program (VLMP) has collected water quality data for Maine's lakes since the 1970s. Participation in the volunteer lake monitoring program may indicate that the community has a tradition of local level management.

Lakes often cross a number of jurisdictional boundaries, which may increases transaction costs associated with lake management because management must be coordinated across boundaries and at a number of levels. Lake associations may reduce these transaction costs by aiding communication. If a lake is surrounded by more than 1 jurisdiction (JUR), we expect a higher chance of lake association presence. In contrast because of transaction costs, we expect JUR to be correlated negatively with lake management success.

The Land Use Regulation Commission (LURC) is responsible for land use planning in the unorganized territories of Maine. LURC has defined a number of restrictive zones around Great Ponds (LURC) that limit access, development and uses of lands. As a result, lake associations may be viewed as unnecessary on Great Ponds regulated by these policies (INLURC) because LURC's zoning and regulations are sufficient to protect lake quality. Statewide, more than 100 Great Ponds serve as a community's drinking water source (DWAT). These lakes are especially valuable resources and towns may have taken additional measures to protect the water quality. As a result, community members may feel that this resource is adequately protected and may be less likely to form a lake association.

Organizational (O)

Research shows that organizations that collaborate with other organizations create social capital and are more likely to successfully address lake management issues (Gabriel and Lancaster 2004, Lubell 2004, Kramer 2007). Agencies can provide professional support

(CSTATE, CGOV) and other organizations, including land trusts and sporting groups (CNGO), often have similar goals, which could benefit from collaboration. We expect these binary measures of successful collaboration to be correlated positively with lake management success.

Membership size of an organization (MEMB) is associated with success of an organization (Kramer 2007, Ostrom 1990). Work is divided among more people, which prevents the fatigue of volunteers. In addition more social capital is created when more people work together for a common goal. The age (AGE) of an organization can be an indicator of how established the organization is in the community. The longer an organization has existed, the greater a chance it has developed social capital within the community. Social capital is a key element in the success of associations (Leach and Sabitier 2005). The makeup of the organization can also influence the success of the organization (Lubell et al. 2002, Sabatier 2005). A lake association made up of mostly seasonal residents may have difficulty integrating into the larger community and changing behaviors of nonmembers. A heterogeneous group may face more challenges than a group made up of mostly seasonal residents or mostly year-round residents in addressing road issues because the needs of the two groups are drastically different. MSE and MYR are dummy variables that indicate if the lake association is made up of mostly seasonal or mostly year-round residents. This is compared to an even mix of both groups, the left-out category in the regression analysis.

The amount of attention (ATT) an association places on an issue can have a strong influence on the amount of success the association has addressing that issue because the association commits time and resources to the problem (Lubell et al. 2002, Leach and Pelkey 2001). We expect these binary measures of focus (WQATT, IPATT, RECATT, DEVATT, RDATT) to be correlated postively with lake management success.

Methods

We tested the relevancy of the IAD framework to explain the distribution and success of lake associations on Maine's Great Ponds using discrete regression analyses. We began by estimating a binary probit model of lake association presence/absence (Table 2). We also estimated ordered probit models of lake management success (Table 3). To explore the utility of the integrated model incorporating selection, we also estimated the selection model that integrates the two previous models (Table 4). We used LIMDEP software to estimate these models. Parameters (β and α) were estimated using maximum likelihood methods.

We evaluated different specifications of the models by comparing goodness of fit measures across specifications, including the likelihood value, information criteria (AIC and BIC) and McFadden Pseudo R^2. We examined the data to detect multicollinearity problems. Pair-wise correlation tests and variance inflation factors were used to identify possible multicollinearity problems. We dropped some potential explanatory variables from our analysis in response to these problems (e.g., seasonal housing and percent urban land cover in the drainage).

Results

Overall, the results of our proposed empirical modeling are encouraging (Tables 2-4). As noted in the introduction, we are most optimistic about the presence/absence formation findings (Table 2). By employing data describing Maine's Great Ponds (n=2,602), we were able to work with a diverse set of lake resources and lake associations. Examined separately, parameters associated with the variables describing resource characteristics and institutional characteristics are significant at the 0.10 level (these parameters are shaded in light blue in Table 2).

Of the factors associated with *resource* characteristics, the presence of a natural impairment (IMP), percent of drainage in agricultural and forest land cover (PAG, PFOR), number of public boat launches (BL), and presence of a bass or cold-water fishery (FISH) have parameters that are significant at the 0.10 level. IMP, BL, and FISH are positively correlated with lake association presence, suggesting lake associations are responsive to crises and form to protect valued recreational assets. PAG and PFOR are negatively correlated with lake association presence relative to other land covers. These results may indicate a lesser need for lake associations in more remote areas with less development. These are consistent with our expectations and past research (Lubell 2002, Kramer 2007).

Parameters associated with three of the *institutional* factors are significant at the 0.10 level. The parameters associated with VLMP and JUR have the expected positive sign. Theory suggests that areas with a history of local level organizations are more likely to form other organizations. In this case lake associations and volunteer lake monitoring (VLMP) seem to be correlated. The positive sign of JUR suggests that lake associations can help reduce transaction costs associated with managing a resource that crosses multiple political jurisdictions. Lake associations might help coordinate between government officials. The parameter associated with INLURC is significant at the 0.10 level also with a negative sign. In this case, the negative correlation with lake association presence suggests lake associations are less relevant in the unorganized region of Maine. This could be explained by successful regional lake management plans in place by LURC or be a function of the more remote characteristics of this region.

None of the *community* characteristics are correlated with lake association presence at the 0.10 significance level. We remain concerned about correlations across these characteristics and other independent variables.

Our empirical findings regarding lake management success are less encouraging (Tables 3 and 4). We view these as preliminary findings because of the small sample size and general statistical performance of these models. The strongest result of the stand-alone ordered probit models is the consistent positive correlation between a lake association's focus (or level of attention; ATT) on an issue and its management success.

Resource characteristics explain some variation in management success. A more extensive shoreline (SHORE) is negatively correlated with recreation management success. This finding is consistent with prior research showing larger, more dispersed resources are more difficult to manage. Hosting key recreational fish species (FISH) is negatively correlated with successful management of road issues. Excessive public use of local lake roads could explain this finding.

Community characteristics also explain some variation in management success. Higher median housing values (HV) are positively correlated with successful management of invasive plants; higher housing unit densities (HUD) are positively correlated with successful management of road issues. Communities with higher housing values have more to lose from an invasive plant infestation. Similarly, communities with greater housing densities have more to gain from maintained roads and may be more likely to have public roads near lakes; more densely settled communities on private lake roads would face higher transaction costs and greater free-riding.

Organizational/institutional characteristics help explain variation in management success. Membership dominated by seasonal residents (MSE), relative to an equal balance of seasonal and year-round residents, is correlated negatively with water quality management success. Water quality problems may demand year-round attention or water quality be more highly valued by year-round residents. Successful collaboration is positively associated with lake management success - successful collaboration with local town government or LURC (CGOV) is positively correlated with successful management of recreation and road maintenance issues; successful collaboration with state government agencies (CSTATE) is positively correlated with management of water quality issues; and successful collaboration with land trusts or sporting groups (CNGO) is positively correlated with management of development-related lake management issues. These findings are somewhat consistent with the focus of these respective groups. As noted above, the clearest pattern (Table 3) across the 5 distinct management issues is the positive correlation between attention/focus and management success.

The results of our joint modeling (Greene 2002) treating presence as a form of selection into the management success sample (Tables 4A-4E) offer no support for this integrated modeling approach. In all cases, the selection parameter (ρ) is not significantly different from 0. Because of the small sample size and source of the success data, we remain interested in testing this joint modeling approach. Having worked through this model, we are now open to collecting improved, comprehensive data and conducting additional empirical testing in the future.

Limitations

There are several key limitations of this research, mostly related to regression analysis and data availability. These can be broken down into three categories: regression analysis, issues of timing, and issues of scale.

The usual caveats of regression analysis apply. Correlation does not imply causation. In addition, factors associated with the existence of lake associations are not necessarily correlated with the formation of an association. These data are a snapshot of lake associations as of 2009. We know little about the individual histories of the associations, and this data would be difficult to incorporate in this model. We rely on surveys of citizen science monitors to characterize lake association behavior and attributes. These data represent the view of a single individual and do not capture all Great Ponds with a lake association. As a result, we were not able to make full use of the lake data; only 170 lakes were in both the presence/absence and success databases. Approximately, 269 lake associations are present on Maine's Great Ponds; our analysis missed 100 lake associations.

Temporal data could better capture whether a lake association formed after a particular environmental crisis, for example a particularly bad algae bloom or the discovery of an invasive species outbreak, or the extent to which management success varies over time.
Many community variables were measured at the county subdivision scale. Anecdotal evidence suggests that lakeside property owners make up much of the lake association membership, which suggests that ideally a smaller level of analysis would be more accurate. This limitation may account for the small number of significant parameters associated with community variables. Furthermore, this research does not address the importance of a strong individual community leader.

Conclusions

We find little support for our integrated model incorporating selection, where lake association presence determines entry into a model of lake management success. Yet, we hope to do additional testing of this approach and other alternatives for integrating these models using an improved dataset in the future.

We find Ostrom's IAD theoretical framework to be a useful means of describing factors influencing the formation (presence/absence) of lake associations.

Constrained by limited data on the management success of lake associations, we advance only preliminary findings. However, we remain interested in our joint modeling approach and look forward to further research of the behavior of these local institutions.

Our research of Maine lake associations strives to offer guidance on how to better integrate the informal approaches of local institutions with more formal, regional government-based management approaches. Our findings related to the presence of lake associations have several policy implications. First, understanding where and why lake associations form is an important step to understanding what makes lake associations successful. In addition, these associations could play a greater role in lake management if there were stronger ties between local-, state-, and regional- scale organizations. Formal and informal organizations are well suited to complement each other. While state and local governments are better able to address enforcement, informal organizations are well suited to develop personal relationships, spread information, and change behaviors. By understanding where lake associations are likely to form, government agencies and other stakeholder groups are likely to form stronger relationships with lake associations, and even delegate some management tasks to lake associations.

This research extended recent thesis research at University of Maine (Snell 2009). Together, these studies offer guidance for future research. Future work will include gathering additional data on lake association success and management activities, testing of spatial aspects of local institutions include potential network effects from nearby associations and interactive effects due to the spread of risks and problems over space (e.g., invasive plants and fish), and consideration of more advanced econometric approaches.

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Table 1: Descriptive Statistics (Maine Lake Associations; 2009)

Variable	Category	N	Mean	Std Dev	Minimum	Maximum
Formation(Presence or Absence)						
LA		2602	0.103	0.305	0.000	1.000
SHORE	R	2602	22.973	58.050	2.476	1482.590
IMPAIR	R	2602	0.043	0.204	0.000	1.000
PAG	R	2602	2.594	7.219	0.000	90.431
PFOR	R	2602	75.162	15.056	0.000	100.000
BL	R	2602	0.088	0.327	0.000	6.000
FISH	R	2602	0.553	0.497	0.000	1.000
HUD	C	2602	17.415	30.968	0.118	468.363
HUV	C	2602	8.193	3.668	0.000	32.500
NREMP	C	2602	0.527	0.830	0.000	18.077
RECEMP	C	2602	0.866	1.206	0.000	18.556
VLMP	I	2602	0.146	0.353	0.000	1.000
DWAT	I	2602	0.041	0.199	0.000	1.000
JUR	I	2602	0.147	0.354	0.000	1.000
INLURC	I	2602	0.473	0.499	0.000	1.000
Management Success						
WQSUC		133	2.022556	0.891595	0	3
IPSUC		130	1.984615	0.923296	0	3
RECSUC		132	1.409091	0.80033	0	3
DEVSUC		123	1.235772	0.820649	0	3
RDSUC		137	1.394161	0.834528	0	3
SHORE	R	172	72.60023	99.24162	5.164861	691.3834
BL	R	172	0.523256	0.65296	0	3
FISH	R	172	0.947674	0.223333	0	1
HUD	C	172	35.93446	43.97558	0.601511	468.363
HUV	C	172	9.568701	2.406642	2.375	20.54
JUR	I	172	0.540698	0.499796	0	1
AGE	O	172	34.32025	17.10884	2	101
MEMB	O	163	37.29908	29.49218	1	250
MYR	O	172	0.185078	0.378281	0	1
MSE	O	172	0.449128	0.48503	0	1
CGOV	O	172	0.80814	0.394914	0	1
CSTATE	O	172	0.581395	0.494771	0	1
CNGO	O	172	0.482558	0.501155	0	1
WQATT	O	172	0.906977	0.291313	0	1
IPATT	O	172	0.80814	0.394914	0	1
RECATT	O	170	0.670588	0.471388	0	1
DEVLATT	O	170	0.617647	0.487398	0	1
RDATT	O	172	0.697674	0.460607	0	1

Table 2: Binary Probit Model of Maine Lake Association Formation (Presence or Absence of Lake Association 2009)

Variable	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	-1.7651	0.3509	-2.4529	<.0001
SHORE	-0.0001	0.0007	-0.0013	0.9278
IMPAIR	0.6348	0.1621	0.3171	<.0001
PAG	-0.0254	0.011	-0.047	0.0214
PFOR	-0.008	0.0039	-0.0157	0.0419
BL	0.2675	0.1158	0.0405	0.0209
FISH	0.5935	0.1202	0.358	<.0001
HUD	0.0008	0.0015	-0.0022	0.586
HUV	0.0162	0.014	-0.0113	0.2491
NREMP	0.0484	0.0564	-0.0622	0.3909
RECEMP	0.0225	0.0365	-0.0491	0.5386
VLMP	1.494	0.1049	1.2885	<.0001
DWAT	-0.2847	0.1938	-0.6645	0.1417
JUR	0.3951	0.1165	0.1668	0.0007
INLURC	-0.4438	0.1199	-0.6787	0.0002

N=2,602; LnL=-456.4505; Restricted LnL=-865.0378
AIC=0.3631; BIC=0.3992; McFadden R^2=0.4723;
Global Chi-square (817.1745) and Pr (<0.0001)

Table 3: Ordered Probit Models of Lake Association Success (SUC=3,2,1, and 0)

	WQSUC		IPSUC		RECSUC		DEVSUC		RDSUC	
Parameter	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq
Constant	-0.200	0.781	-0.811	0.273	-0.038	0.954	-0.315	0.654	0.887	0.203
SHOR	0.001	0.509	-0.001	0.538	-0.004	0.009	0.000	0.859	-0.001	0.348
BL	-0.105	0.523	0.092	0.622	0.271	0.142	0.038	0.847	-0.051	0.785
FISH	0.301	0.553	0.008	0.989	-0.140	0.761	-0.163	0.742	-1.227	0.009
HUD	0.000	0.954	0.000	0.916	-0.001	0.584	0.001	0.740	0.004	0.068
HUV	0.033	0.466	0.098	0.051	0.073	0.110	0.076	0.112	-0.037	0.464
JUR	-0.024	0.918	-0.108	0.641	0.046	0.833	-0.055	0.814	0.227	0.286
AGE	0.007	0.281	0.002	0.772	-0.003	0.690	-0.005	0.409	0.009	0.160
MEMB	0.001	0.259	0.000	0.574	-0.001	0.133	-.00008	0.867	0.000	0.591
MYR	-0.464	0.130	-0.307	0.322	0.092	0.769	0.106	0.733	-0.178	0.565
MSE	-0.415	0.086	-0.019	0.936	0.191	0.421	-0.042	0.861	0.208	0.392
CGOV	0.389	0.151	0.408	0.152	0.556	0.047	0.176	0.545	0.603	0.028
CSTATE	0.506	0.026	0.302	0.180	0.095	0.667	0.216	0.362	0.119	0.588
CNGO	-0.008	0.970	0.279	0.216	0.218	0.308	0.421	0.059	-0.136	0.529
ATT	0.773	0.063	1.333	<.0001	0.658	0.004	0.642	0.008	1.163	<.0001
Mu(1)	0.764	<.0001	1.245	<.0001	1.678	<.0001	1.480	<.0001	1.335	<.0001
Mu(2)	2.189	<.0001	2.379	<.0001	2.932	<.0001	2.719	<.0001	2.936	<.0001
	N=133	LnL=	N=130	LnL=	N=132	LnL=	N=123	LnL=	N=137	LnL=
	AIC=2.41	-143.089	AIC=2.43	-141.17	AIC=2.39	-140.86	AIC=2.47	-135.03	AIC=2.37	-145.48
	BIC=2.78	RLnL=	BIC=2.81	RLnL=	BIC=2.76	RLnL=	BIC=2.86	RLnL=	BIC=2.73	RLnL=
		-159.518		-163.10		-155.38		-147.32		-166.15
								1		

Table 4A: FIML Selection Model (Probit and Ordered Probit) - Lake Association Formation and Association Success at Managing Water Quality Issues

Variable	Estimate	Standard Error	b/St.Er.	Pr[Z>z]
Constant	0.330	0.999	0.331	0.741
SHORE	0.001	0.001	0.505	0.614
BL	-0.154	0.205	-0.751	0.453
FISH	0.201	0.684	0.295	0.768
HUD	0.000	0.004	-0.066	0.947
HUV	0.032	0.038	0.825	0.409
JUR	-0.068	0.241	-0.283	0.777
AGE	0.005	0.007	0.651	0.515
MEMB	0.000	0.001	0.959	0.338
MYR	-0.450	0.348	-1.292	0.197
MSE	-0.368	0.263	-1.396	0.163
CGOV	0.414	0.319	1.299	0.194
CSTATE	0.497	0.256	1.944	0.052
CNGO	-0.027	0.288	-0.095	0.924
ATT	0.641	0.391	1.637	0.102
Mu(1)	0.755	0.197	3.832	<0.0001
Mu(2)	2.161	0.240	8.988	<0.0001
Constant	-2.184	0.677	-3.224	0.001
SHORE	-0.001	0.001	-1.268	0.205
IMPAIR	0.439	0.243	1.809	0.070
PAG	-0.043	0.024	-1.779	0.075
PFOR	-0.016	0.007	-2.333	0.020
BL	0.428	0.171	2.498	0.013
FISH	0.852	0.278	3.069	0.002
HUD	0.001	0.002	0.369	0.712
HUV	0.022	0.033	0.666	0.506
NREMP	0.175	0.127	1.378	0.168
RECEMP	-0.021	0.070	-0.294	0.769
VLMP	1.977	0.182	10.868	<0.0001
DWAT	-0.494	0.255	-1.937	0.053
JUR	0.322	0.180	1.788	0.074
INLURC	-0.829	0.260	-3.184	0.002
ρ(u,e)	-0.249	0.308	-0.808	0.419

N=2,466; LnL=-351.3057; Restricted LnL=-351.3340
AIC=0.3117; BIC=0.3894

Table 4B: FIML Selection Model (Probit and Ordered Probit) - Lake Association Formation and Association Success at Managing Invasive Plants

Variable	Estimate	Standard Error	b/St.Er.	Pr[Z>z]
Constant	-0.452	1.503	-0.300	0.764
SHORE	-0.001	0.002	-0.481	0.631
BL	0.044	0.254	0.174	0.862
FISH	-0.085	0.942	-0.090	0.928
HUD	0.000	0.005	-0.086	0.931
HUV	0.095	0.066	1.436	0.151
JUR	-0.140	0.244	-0.574	0.566
AGE	0.001	0.007	0.143	0.887
MEMB	0.000	0.001	0.487	0.626
MYR	-0.304	0.328	-0.926	0.354
MSE	-0.002	0.248	-0.008	0.994
CGOV	0.412	0.340	1.213	0.225
CSTATE	0.291	0.253	1.150	0.250
CNGO	0.266	0.249	1.071	0.284
ATT	1.277	0.441	2.894	0.004
Mu(1)	1.238	0.275	4.505	<0.0001
Mu(2)	2.369	0.315	7.509	<0.0001
Constant	-2.276	0.715	-3.183	0.002
SHORE	-0.001	0.001	-1.504	0.133
IMPAIR	0.426	0.249	1.708	0.088
PAG	-0.035	0.024	-1.432	0.152
PFOR	-0.015	0.007	-2.273	0.023
BL	0.495	0.178	2.775	0.006
FISH	0.875	0.276	3.166	0.002
HUD	0.001	0.002	0.638	0.524
HUV	0.024	0.037	0.641	0.521
NREMP	0.155	0.129	1.200	0.230
RECEMP	0.003	0.066	0.052	0.959
VLMP	1.867	0.185	10.076	<0.0001
DWAT	-0.397	0.248	-1.599	0.110
JUR	0.399	0.185	2.157	0.031
INLURC	-0.757	0.265	-2.854	0.004
ρ(u,e)	-0.137	0.303	-0.452	0.651

N=2,463; LnL=-347.5554; Restricted LnL=-347.7213;
AIC=0.3090; BIC=0.3869

Table 4C: FIML Selection Model (Probit and Ordered Probit) - Lake Association Formation and Association Success at Managing Recreation Issues

Variable	Estimate	Standard Error	b/St.Er.	Pr[Z>z]
Constant	-0.116	1.008	-0.116	0.908
SHORE	-0.004	0.002	-1.990	0.047
BL	0.282	0.264	1.069	0.285
FISH	-0.122	0.557	-0.219	0.827
HUD	-0.001	0.006	-0.194	0.846
HUV	0.073	0.059	1.249	0.212
JUR	0.057	0.265	0.215	0.830
AGE	-0.002	0.008	-0.307	0.759
MEMB	-0.001	0.001	-0.787	0.431
MYR	0.091	0.461	0.198	0.843
MSE	0.185	0.261	0.709	0.479
CGOV	0.554	0.322	1.719	0.086
CSTATE	0.099	0.233	0.425	0.671
CNGO	0.222	0.251	0.886	0.376
ATT	0.660	0.274	2.413	0.016
Mu(1)	1.678	0.203	8.276	<.0001
Mu(2)	2.931	0.239	12.272	<.0001
Constant	-2.481	0.712	-3.485	0.001
SHORE	-0.001	0.001	-0.991	0.322
IMPAIR	0.503	0.241	2.087	0.037
PAG	-0.032	0.024	-1.335	0.182
PFOR	-0.011	0.007	-1.630	0.103
BL	0.391	0.170	2.302	0.021
FISH	0.738	0.288	2.558	0.011
HUD	0.001	0.002	0.340	0.734
HUV	0.029	0.035	0.812	0.417
NREMP	0.189	0.113	1.678	0.093
RECEMP	-0.015	0.064	-0.231	0.817
VLMP	1.944	0.184	10.591	<.0001
DWAT	-0.384	0.249	-1.546	0.122
JUR	0.363	0.176	2.057	0.040
INLURC	-0.855	0.255	-3.357	0.001
ρ(u,e)	0.038	0.331	0.115	0.909

N=2,465; LnL=-350.2783; Restricted LnL=-350.2928;
AIC=0.3109; BIC=0.3888

Table 4D: FIML Selection Model (Probit and Ordered Probit) - Lake Association Formation and Association Success at Managing Development Issues

Variable	Estimate	Standard Error	b/St.Er.	Pr[Z>z]
Constant	-0.719	1.272	-0.565	0.572
SHORE	0.000	0.002	-0.199	0.842
BL	0.098	0.235	0.417	0.677
FISH	-0.056	0.928	-0.060	0.952
HUD	0.001	0.006	0.167	0.867
HUV	0.080	0.052	1.524	0.127
JUR	-0.011	0.272	-0.041	0.967
AGE	-0.004	0.007	-0.638	0.523
MEMB	-0.00006	0.001	-0.110	0.913
MYR	0.093	0.361	0.258	0.796
MSE	-0.064	0.312	-0.205	0.838
CGOV	0.174	0.343	0.507	0.612
CSTATE	0.246	0.275	0.896	0.370
CNGO	0.437	0.279	1.563	0.118
ATT	0.651	0.296	2.198	0.028
Mu(1)	1.473	0.197	7.470	<.0001
Mu(2)	2.701	0.304	8.896	<.0001
Constant	-2.360	0.732	-3.224	0.001
SHORE	-0.001	0.001	-1.081	0.280
IMPAIR	0.534	0.249	2.143	0.032
PAG	-0.034	0.024	-1.427	0.154
PFOR	-0.012	0.007	-1.717	0.086
BL	0.416	0.178	2.338	0.019
FISH	0.752	0.279	2.698	0.007
HUD	0.001	0.002	0.451	0.652
HUV	0.014	0.036	0.392	0.695
NREMP	0.209	0.127	1.651	0.099
RECEMP	-0.013	0.068	-0.197	0.844
VLMP	1.922	0.189	10.159	<0.001
DWAT	-0.345	0.249	-1.383	0.167
JUR	0.339	0.194	1.747	0.081
INLURC	-0.835	0.282	-2.962	0.003
ρ(u,e)	0.171	0.298	0.575	0.565

N=2,456; LnL=-335.6834; Restricted LnL=-335.9222; AIC=0.3002; BIC=0.3783

Table 4E: FIML Selection Model (Probit and Ordered Probit) - Lake Association Formation and Association Success at Managing Road Issues

Variable	Estimate	Standard Error	b/St.Er.	Pr[Z>z]
Constant	0.743	0.979	0.759	0.448
SHORE	-0.001	0.002	-0.858	0.391
BL	-0.031	0.256	-0.119	0.905
FISH	-1.195	0.568	-2.103	0.036
HUD	0.004	0.005	0.940	0.347
HUV	-0.036	0.076	-0.468	0.640
JUR	0.245	0.258	0.951	0.341
AGE	0.009	0.007	1.227	0.220
MEMB	-0.0002	0.0004	-0.560	0.575
MYR	-0.183	0.407	-0.449	0.653
MSE	0.196	0.326	0.603	0.547
CGOV	0.605	0.296	2.045	0.041
CSTATE	0.124	0.219	0.568	0.570
CNGO	-0.129	0.263	-0.492	0.623
ATT	1.166	0.258	4.523	<.0001
Mu(1)	1.333	0.190	7.002	<.0001
Mu(2)	2.932	0.249	11.775	<.0001
Constant	-2.210	0.683	-3.236	0.001
SHORE	-0.001	0.001	-1.257	0.209
IMPAIR	0.477	0.253	1.889	0.059
PAG	-0.044	0.025	-1.729	0.084
PFOR	-0.014	0.007	-2.110	0.035
BL	0.367	0.163	2.254	0.024
FISH	0.774	0.267	2.903	0.004
HUD	0.001	0.003	0.441	0.659
HUV	0.018	0.034	0.530	0.596
NREMP	0.187	0.129	1.444	0.149
RECEMP	-0.011	0.067	-0.165	0.869
VLMP	1.961	0.170	11.531	<.0001
DWAT	-0.389	0.252	-1.542	0.123
JUR	0.391	0.181	2.161	0.031
INLURC	-0.727	0.243	-2.995	0.003
ρ(u,e)	0.066	0.325	0.205	0.838

N=2,470; LnL=-362.5185; Restricted LnL=-362.5657;
AIC=0.3203; BIC=0.3979