

INSTITUTIONAL DESIGN AND ADAPTATION IN REGIONAL-SCALE COMMON-POOL  
RESOURCE INSTITUTIONS: SECURING ACCESS TO HIGH-QUALITY DRINKING  
WATER IN BOSTON, NEW YORK, PORTLAND, AND SAN FRANCISCO

by

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Tomás Olivier

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## **Dedication**

*This dissertation is dedicated to my brother Mariano Olivier and to the memory of my grandfather Eduardo Enrique Olivier. Both of them have been pillars of support from the beginning, providing comfort during hard times and sharing the joy with me during the good days.*

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## **Abstract**

This dissertation develops and assesses hypotheses regarding the design and adaptation of institutions for maintaining the quality of a shared natural resource at regional scales. The analysis is centered on arrangements created by governmental actors for deciding how to jointly govern a resource producing high-quality drinking water. The cases studied are Boston (Massachusetts), New York City (New York), Portland (Oregon), and San Francisco (California). Drinking water in each of these cities is provided unfiltered, and it is sourced from lands located in other jurisdictions. To maintain water quality, both providers and landowners in the watersheds have reached agreements defining how to jointly govern the resource. This dissertation studies the design of these arrangements. Studying these dynamics, particularly in a federal regime, highlights the limits that governmental actors face in making decisions with other governments at different levels.

The dissertation contains three empirical papers addressing aspects of design in these arrangements. The empirical chapters are structured as separate papers that follow a common theme. Throughout the dissertation, insights from various research traditions are brought in to complement the analysis of institutional design. The studies in this dissertation combine arguments from the Institutional Analysis and Development Framework, Common-Pool Resource Theory, Transaction Cost Economics, social network analysis, Adaptive Governance, and theories of information processing stemming from the Punctuated Equilibrium literature in public policy.

## **Chapter 1: Introduction**

The study of institutions has attracted the attention of researchers for decades. Although the corpus of literature on this matter is enormous, we still observe developments that help us better understand issues of design, implementation, effectiveness, and failure. Furthermore, as the complexity of social interactions and issues increases, new questions arise. New theoretical and analytical methods help us address these questions and develop solutions that affect the way we guide and constrain behavior to achieve common goals.

A particular example of this evolution takes place in the study of institutions for the governance of shared natural resources. Nowadays, the challenges posed by Climate Change, growing populations, social, political, and economic tensions demand effective mechanisms to address new socio-ecological dynamics. These challenges require more and innovative research on how to design institutions that are flexible to deal with their social and ecological environments, as well as able to monitor and enforce the rules so that no major deviant behavior goes unpunished.

Complexity further increases when issues transcend local boundaries. Today's environmental problems go beyond the individual level, demanding the involvement of multiple government actors at different levels, along with private and non-governmental organizations. Coordinating such a variety of actors requires structures that are attentive of each actor's rights and responsibilities, as well as with enough 'teeth' to put them back in line whenever any form of defection occurs.

The purpose of this dissertation is to develop and assess hypotheses regarding the design and adaptation of institutions created by governments for maintaining the quality of a shared natural resource. Studying these dynamics, particularly in a federal regime, highlights the limits that governmental actors face in making decisions with other governments at different levels.

Throughout the dissertation, insights from various research traditions are brought in to complement analyses of institutional design. The studies in this dissertation combine arguments from the Institutional Analysis and Development Framework, Common-Pool Resource Theory, Transaction Cost Economics, social network analysis, Adaptive Governance, and the theory of information processing stemming from the Punctuated Equilibrium literature in public policy. Applying these approaches to the study of regional-scale natural resource governance will improve our understanding of institutional design and adaptation in intergovernmental agreements.

Rather than developing a single theoretical argument and testing it throughout, this dissertation is structured as three distinct but related empirical papers. All empirical chapters develop and analyze new hypotheses for understanding institutional design in the governance of shared natural resources at regional scales. Each paper will address a specific aspect of institutional design, developing and testing hypotheses regarding the sources of institutional variation (Chapters 4 and 5) and the effects of such variation (Chapter 6). Each chapter is intended to advance new hypotheses, and as such, the papers serve as plausibility probes to assess the validity of the hypotheses and methods used.

This chapter serves as an introduction for the dissertation by providing a discussion of the two key themes of this project: institutional design and adaptation. The chapter will describe how the abovementioned theories are applied to the three papers in the dissertation. The chapter will then situate the research questions of each empirical chapter and will provide a justification for the development and testing of hypotheses. The chapter will conclude by outlining the remainder of this dissertation.

### **Why study regional arrangements?**

Institutions are generally defined as “the rules of the game” (North, 1990), as such, they provide “prescriptions that humans use to organize all forms of repetitive and structured interactions” (Ostrom, 2005:3). Institutions emerge because actors realize of the benefits of collective action. For institutions to work effectively, actors need to accept those rules as legitimate and abide by them. Notwithstanding, since institutions are human creations, they are far from perfect: they require mechanisms for ensuring

compliance while making sure that everyone agrees on the legitimacy of the rules. Additionally, institutional arrangements need to adapt to their environments by adjusting to changes in their social and biophysical contexts.

Over the past decades, an extensive literature has focused on the design of institutions for governing natural resources. This literature has analyzed the design characteristics that make institutions robust (see, for instance, Anderies et al, 2004).<sup>1</sup> After a careful study of successful and failed cases in the governance of different small-scale shared natural resources, Elinor Ostrom developed eight “design principles” (Ostrom, 1990, 2005) capturing the main commonalities across these cases. The principles highlight the conditions under which collective action can be maintained (Cox et al, 2010). Although these principles are empirical regularities present in successful cases of small-scale common-pool resource (CPR) governance, the specific ways in which they are implemented vary greatly depending on the characteristics of the resource.

The design principles were originally developed for situations where a group of individuals jointly govern a common-pool resource (CPRs). CPRs are characterized for being difficult (although not impossible) to exclude potential users, and where every resource unit (a fish in a river, for instance) that is removed from the resource will no longer be available to others. The study of these goods became notorious after Garret Hardin’s classical piece “The Tragedy of the Commons” (1968), where he stated that due to the economic and demographic pressures on shared natural resources, and in the absence of any type of mechanism to regulate human activity, users following their self-interest would end up depleting these resources.

But, why is the study of these goods relevant? CPRs provide an excellent setting to analyze how individuals devise governing arrangements to achieve a common set of goals. As such, CPRs are the perfect setting to observe collective-action dilemmas where groups of individuals must collaborate to avoid depleting the resource through the development of “small-scale social contracts”. In addition, many examples of successful CPR governance have challenged Hardin’s prediction: they are stable and enduring governing arrangements guided neither by a Leviathan nor through the invisible hand of the market. Ostrom’s design principles highlight some of the design characteristics of institutions that have successfully managed a CPR over time.

The design principles originated after Elinor Ostrom’s attempt to identify the specific rules associated with long-lasting CPR institutional arrangements. The failure to identify such rules led Ostrom to focus on broader empirical regularities present among successful cases (Ostrom, 2008). As a result of this, eight design features present in successful cases of CPR governance were identified by Ostrom (1990, 2005). These principles include: clearly defined boundaries; congruence between appropriation and provision rules with local conditions; the individuals affected by operational-level rules can participate in modifying those rules; monitors are accountable to the appropriators or are the appropriators; appropriators who violate the rules are likely to be assessed graduated sanctions; appropriators have rapid access to low-cost local arenas to resolve conflicts; the rights of appropriators to devise their own institutions are not challenged by external governmental authorities; appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Simultaneously with the discussion of the design principles, Ostrom (1990, 2005, 2007) warned researchers and practitioners about the dangers of considering these as blueprints for guaranteeing an institution’s good performance. The presence of these principles is not sufficient for creating robust institutions, and no single design principle is necessary and sufficient for the good governance of a CPR (Schlager, 2016; Baggio et al, 2016). Moreover, the principles do not present an exhaustive list of all potential factors affecting good governance of CPRs. In recent years, authors have attempted to expand the design principles by identifying other important factors and by providing conceptual and empirical

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<sup>1</sup> The simplest definition of robustness is “adaptability to disturbances” (Ostrom, 2005: 258) in the behavior of the components of an institution or its environment (Anderies et al, 2004).

clarifications (Agrawal, 2002; Cox et al, 2010). Overall, the principles highlight the importance of monitoring, enforcement of the rules, and conflict resolution mechanisms as ways of developing credible commitments and for maintaining rule compliant behavior over time. However, the ways in which they are implemented vary greatly depending on the characteristics of the CPR.

When natural resources cross political boundaries and other actors (such as governments and governmental agencies) get involved, managing them becomes more complex. In particular, the literature on CPRs has recently started to pay attention to the issue of scale (Young, 2002; Dietz et al, 2003). Managing large-scale natural resources like Ozone (Epstein et al, 2014) requires of creative governance structures that can foster collaboration among dissimilar actors such as nation states or multi-national corporations. In these circumstances, the principles guiding institutional design vary from those designed for managing small-scale systems among a group of individuals (Fleischman et al, 2014).

At these scales, the issue of how to coordinate actions among multiple and varied actors becomes central. One way is by developing “linkages” between them (Young, 2002, Berkes, 2002, Heikkila et al, 2011). Linkages, for instance, connect the decisions made by local units with their national or state counterparts, facilitating the implementation at the national level of global goals (Young, 2002). These linkages can be present in formal institutional arrangements or through more informal regular interactions. In these cases, linkages create interdependencies between two or more actors involved in the management of a shared natural resource. The characteristics of these linkages can vary, especially when more than one geographical and political scale is involved. In addition, the formal features of these linkages can affect how actors interact over time, addressing sources of conflict and often creating new ones (Young, 2006).

Issues of scale are also common within the borders of a single nation, any time two or more polities must figure out how to govern a transboundary resource. This occurs often in federal regimes, where it is difficult for a government to monitor or enforce rules to other governments. Situations like these require of agreements that can foster collaboration, yet respecting the authority of each actor.

Given the variety of forms in which linkages can occur, it becomes difficult to analyze how specific institutional arrangements incorporate the elements identified by the CPR literature. The design principles highlight which factors ought to be present when devising robust institutions. However, it remains difficult to “scale up” principles that were developed considering small-scale institutions where the participants are individuals (Cox et al, 2010; Fleischman et al 2014). Heikkila et al (2011), for instance, studied how interstate river compacts in the Western US create horizontal or vertical linkages among its members, and how the linkages incorporate features of the design principles. The authors found that some linkages were more common than others, particularly those related to allocation of the resource, collective-choice decision-making, and monitoring.

The study by Heikkila et al (2011) provides a way of incorporating the design principles to the study of arrangements that cross multiple scales. However, as Berkes (2002) points out, institutional arrangements may adopt multiple forms, and thus there is still room for understanding how different types of institutions assign formal responsibilities among actors at different scales. When CPRs increase in scale, some of these principles need to adapt to the larger scale, quantity, and types of actors involved. Actors may divide up responsibilities regarding monitoring and enforcement of the rules, or rely on a single actor specially created for this purpose (Young, 2002; Berkes, 2002). The design decisions made in these circumstances resemble those made in the creation of new polities for the provision of public goods (Oakerson and Parks, 1989).

### **Institutional design and intergovernmental agreements**

Chapters 4 and 5 analyze how institutions are designed to address collective-action problems between governments. In those chapters, the literature and methods of Common-Pool Resource Theory and the Institutional Analysis and Development Framework are combined with insights from Transaction Cost Economics, contracting theory, and the Institutional Collective Action Approach to better

understand variations in the design of intergovernmental agreements. The common root shared by these approaches allows for cross-fertilization between them.

A fundamental assumption of these approaches is that context plays an important role in affecting the possibility of collective action. Rather than predicting that individuals (or organizations or governments) will not collaborate in the absence of external forces (the state or the market), these literatures argue that actors can self-organize and engage in collective action. This literature identifies multiple variables that can have an effect on a group's ability to collaborate (Ostrom, 2009a). For instance, Ostrom's Design Principles (Ostrom 1990, 2005) provide a set of features that can lead to the maintenance of institutions fostering collective action in the case of Common-Pool Resources governance. A key contribution of the CPR literature is in highlighting the possibility that resource users themselves can address social dilemmas through the creation of self-governing arrangements, without relying neither in the market nor the state.

A characteristic of regional CPR arrangements is that participants are not only individual appropriators; instead, they are governments, NGOs, and individuals, among others. In the cases studied in this dissertation, agreements are between governmental actors, sometimes at the same level (municipal government with other municipal governments, or state agency with another state agency), and other times between actors at different levels (municipal governments and federal agencies). The involvement of different actors leads to an increase in second-order collective action dilemmas.<sup>2</sup>

Just as the CPR literature focused on self-organizing institutional arrangements for the governance of common-pool resources, other literatures have focused on different types of social dilemmas. Parallel to Common Pool Resource theory and the Institutional Analysis and Development Framework, a corpus of literature was developed analyzing government interactions in metropolitan settings. Unlike CPR theory and the IAD framework, the Local Public Economies literature (Oakerson and Parks, 2011) focuses on how systems of organizations help governments produce and provide public goods. The focus here centers on how governmental entities, producers, and providers organize the production and provision of labor-intensive goods (police, fire, education), and how the structure of these industries affect their performance (Oakerson and Parks, 2011). This literature introduces a useful set of concepts to understand the contexts in which governments, especially in metropolitan areas, make decisions regarding the production and provision of public goods. Of particular interest for this project is the notion of "local government constitutions" (Oakerson and Parks, 1989; Oakerson, 1999). Local government constitutions provide the frameworks for government action and define how governments will make decisions for the production or provision of public goods. The institutional arrangements studied in this dissertation resemble those "local government constitutions" in that they are arrangements created by government actors defining how the good of water quality will be produced.

Chapters 4 and 5 focus on the effects of contextual factors in the design of such arrangements. Chapter 4 utilizes insights from the Institutional Collective Action (ICA) approach (Feiock, 2013) to understand the effect of different types of collective action dilemmas on the formal relationships mandated by intergovernmental arrangements.

The Institutional Collective Action approach focuses on the collective action dilemmas that occur between governments addressing regional problems in metropolitan areas (Feiock, 2007). Unlike the CPR literature that focuses on how individuals (more specifically, resource users) can cooperate to obtain outcomes that benefit the collective, the ICA centers on how composite actors (e.g. governments) (Scharpf, 1997) can coordinate to obtain mutually beneficial outcomes. The issues of interest for this literature arise from the division of authority between governmental units, where the decisions of one government have an impact in other governments (Feiock, 2013). Rather than relying on centralization or

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<sup>2</sup> A first-order collective-action dilemma would be to ensure that everyone contributes to the maintenance of the good in question. According to Ostrom (1990:42), the provision and implementation of rules is the equivalent to providing another public good, decisions regarding the supply of a new set of rules constitutes a *second-order* collective dilemma.

decentralization as the only mechanisms for addressing institutional collective action problems, the ICA approach argues that governments can also develop self-organizing responses to these problems (Feiock and Scholz, 2010).

The ICA builds on the Local Public Economies literature (Oakerson and Parks, 1999). Both approaches share an interest in understanding decisions regarding the provision and provision of public goods. However, the ICA also incorporates notions from transaction cost economics (Williamson, 1981) and the contracting literature (Brown and Potoski, 2003) to assess how the transaction costs of different coordination mechanisms affect the possibility of addressing institutional collective action dilemmas (Feiock 2009, 2013). The ICA takes a step forward in analyzing decisions regarding the production or provision of public goods by paying attention to the role that contextual variables have in facilitating different mechanisms for collaboration. In that sense, this approach draws and extends directly from the Ostromian literature in general, and on the IAD framework and Local Public Economies in particular.

The main contribution of the ICA is in showing that competition between governments is not the only way for coordination in local public economies. Rather, self-organizing arrangements can also emerge between governmental authorities. The goal of the ICA is to predict the adoption of specific forms of integration (Feiock, 2007, 2013). For the ICA, the goal of any arrangement is to match the scale and coerciveness of the rules created with the nature of the collective-action problem (Feiock, 2013). The decision of which design alternative to choose will be based on two issues: the risks involved in collaboration and the transaction costs of implementing a set of rules. By collaboration risk, Feiock (2013) refers to the nature of the collective-action dilemma faced by the actors, which could be: coordination problems (how to coordinate in achieving a specific goal), division problems (how to select an alternative to achieve the agreed upon goal), and defection problems (the risk that other actors will not fulfill their promises). Collaboration risk is largely determined by the nature of the problem to be addressed, the preferences of the actors involved, and the role of existing institutions.

Chapter 4 analyzes how collaboration risk affects the design of agreements created to address similar CPR dilemmas at regional scales. By combining institutional analysis tools developed from the IAD framework (Ostrom, 2005) with social network analysis tools, Chapter 4 takes a novel approach to measure institutional design as a “Network of Prescribed Interactions” (NPIs). These networks capture the interactions mandated by the rules of a given institutional arrangement. Using the NPI approach, Chapter 4 focuses on the effects that different types of collective action dilemmas have on institutional design.

Chapter 5 addresses another aspect of institutions: the design of mechanisms for monitoring behavior, providing conflict resolution, and sanctioning noncompliant behavior. The choice of analyzing these aspects is guided by a theoretical need: in CPR theory, the design principles have provided and thoroughly assessed what makes small-scale CPR institutions robust. Unfortunately, as discussed above, the efficacy of the design principles as analytical tools becomes unclear when scale increases. In the study of larger scale institutions for governing natural resources, Dietz et al (2003) argue that monitoring, conflict resolution, and enforcement are three aspects that are worthy of attention. Chapter 5 builds on that discussion to understand how contextual factors may affect variations in the design of these aspects at regional scales.

To understand the effect of contextual variables, Chapter 5 combines arguments from a suite of second generation rational choice approaches<sup>3</sup>: the literatures on Transaction Cost Economics (Williamson, 1981), property rights (Libecap, 1989) theories of government contracting (Brown and Potoski, 2003; Brown et al, 2016), and the ICA approach (Feiock, 2013) to understand how variations in levels of transaction costs may affect design choices. In particular, the chapter looks at how characteristics of the resource being produced, the number of actors involved in decision-making around

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<sup>3</sup> Ostrom (2005) distinguishes between “first generation” rational choice models based exclusively on assumptions of rational egoist assumptions, and “second generation” models that relax some of the rationality assumptions and incorporate the role of contextual factors in shaping an actor’s actions (Feiock, 2007).

the shared natural resource, and the existence of information asymmetries may collectively affect the design of monitoring, conflict resolution, and consequence aspects of a governing arrangement. These factors have been identified as some of the structural variables affecting the likelihood of collective action (Ostrom, 2009a), and also as “protective safeguards” in contracting interactions (Williamson, 1996).

### **Institutional design and adaptation**

The second theme of this project focuses on how regional governing arrangements adapt to their environments. To do this, features from the theory of information processing stemming out of the Punctuated Equilibrium Theory literature are incorporated to assess how the design of different agreements adapts to their socio-ecological environments.

Institutional change may occur for myriad reasons. In the field of policy studies, institutional change is often understood as a product of small incremental steps (Lindblom, 1959), because of shifting coalitions establishing new policy demands (Sabatier and Jenkins Smith, 1999), the result of unexpected events highlighting failures of preexistence policies (Birkland, 2006), or because of changes in the attention paid to a given topic (Baumgartner and Jones, 1993). None of these approaches deny the others. In fact, most of these perspectives of institutional change rest on the assumption of fallible individuals who are boundedly rational at best. They differ, however, in that they highlight different aspects of the cognition of boundedly rational individuals (Jones and Baumgartner, 2012).

One of such approaches, emerging out of the Punctuated Equilibrium Theory literature (Baumgartner and Jones, 1993), combines the notion of boundedly rational individuals with the limitations imposed by institutional arrangements created to aggregate decisions, and develops an overarching theory of policy change (Jones and Baumgartner, 2005). This approach takes the dynamics of change observed in specific policy subsystems (Baumgartner and Jones, 1993) and extends it to understand the broader logic of decision-making in a policymaking system. The main focus of the theory of information processing is on the flows of information that enter the policymaking system and the friction caused by the system itself, to explain patterns of policy stability and change (Jones and Baumgartner, 2012).

The theory of information processing argues that if boundedly rational individuals are placed within a decision-making system created by them (and therefore also prone to the limits of human information processing abilities) that impose decision costs (i.e. supermajority requirements), the pattern of outputs produced should favor stability but should also be characterized by short periods of substantial change. This is defined as the *general punctuation hypothesis* (Jones and Baumgartner, 2005, 2012; Baumgartner et al 2014). In other words, in studying policymaking, two sources of friction must be considered: those caused by the cognitive limits of boundedly rational individuals and their organizations, and institutional constraints (Jones and Baumgartner, 2012).

For this theory it is not only that boundedly-rational individuals are making decisions, but also that the institutional context in which those decisions are made matters. Institutions matter in that they help decision-makers to process large amounts of information. In this context, information processing is defined as the “collecting, assembling, interpreting, and prioritizing signals from the environment” (Jones and Baumgartner, 2005: 7). By aiding in the processing of information, institutions help translate signals from the outside by controlling the supply of information and prioritizing it as it enters the system. In doing so, however, institutions impose frictions, overreacting to some signals and underreacting to others. The way organizations manage information flows will affect the ability of individuals to respond to policy problems. Too much information can cause overloads hindering any possibility of action. On the contrary, not enough information may lead to erroneous policy responses that do not address the real causes of a problem. Therefore, it is important to access plenty of information so that nothing is left aside, while at the same time prioritizing it properly so that it does not prevent any decisions from happening.

Studies within this tradition have embarked in teasing out the different ways in which institutional complexity around the supply and prioritization of information affects patterns of policy decisions (see, for instance Robinson, 2004; Robinson et al, 2011; Jones and Baumgartner, 2005; Baumgartner and Jones, 2015). Recently, in an effort to clarify the consequences of different mechanisms for decision making, May et al (2012) analyzed how the design of public bureaucracies affects their responses to emerging demands. The authors studied how bureaucratic agencies structure attention: on one hand, the bureaucratic model posits that agencies should rely on delegation of authority and streamlined routines, whereas the other alternative is of centralized decision-making at the top of the agency, where leaders maintain a high degree of discretion in their decisions. May et al (2012) showed how changes in decision-making structures can affect the type, quantity, and quality of responses produced by bureaucratic agencies to demands from their environments.

Baumgartner and Jones (2015) studied the consequences of accessing to information in decision-making. The authors argued that adaptation, understood as government responses to issues demanding action, depends heavily on the amount of attention paid to multiple issues. The way in which organizations focus attention and their openness to new sources of information will affect their outputs. The authors argue that since 1947, the US Government has experienced a process of issue expansion by acquiring new roles and addressing new issues. However, this expansion process halted in the late 70's, giving room to a process of "thickening" through which multiple agencies involved more on issues they were already addressing. The authors attribute these changes to variations in the way information was incorporated in decision-making processes.

For Baumgartner and Jones (2015), there is a tradeoff between how governments balance the complexity of searching for new sources of information and the clarity and control required to make and implement clear-cut decisions. The more complex a decision-making system is, the more information it will receive, and its outputs will tend to expand its agenda of action, a response that the authors call "broadening". Simpler decision-making structures with fixed (non-overlapping) hierarchical boundaries will tend to be more expediting in their decisions, but run the risk of not incorporating relevant sources of information. In these cases, the response should be one of "thickening", through which actors will become more involved in areas where they have been traditionally involved. The authors define complexity as the way in which a given decision-making process incorporates a variety of viewpoints. Complex decision-making systems are not only capable of allowing a multiplicity of voices, but also grant them a say in the process of making decisions.

The literature on punctuated equilibrium theory and its theory of information processing have provided insights to how different institutional structures affect processes of policy change. Spearheaded by the joint work of multiple researchers across the globe, through the *Comparative Agendas Project*,<sup>4</sup> a large number of studies have been published in the last decade analyzing varying aspects of the policymaking process (for a detailed account of these studies, see Baumgartner et al, 2014). However, no studies have yet focused on comparative analyses on how the design of different decision-making structures influences patterns of broadening and thickening. Moreover, no studies have analyzed how these arguments apply to small-scale arrangements created to manage shared natural resources.

Institutions created for governing shared natural resources are a useful setting for studying these and other arguments due to the variety and complexity of issues to which decision-makers must pay attention. In addition, these arrangements have a much limited scope than the institutions traditionally studied by the PET literature. In the governance of shared natural resources, actors are faced with an abundance of information pertaining to multiple ecological, social, and political aspects of the socio-ecological environment they are trying to manage (Ostrom, 2009b).

Within the environmental sciences, the literature has recognized this complexity and has advocated for forms of governance that are able to cope with the uncertainty of these changing environments (Chaffin et al, 2014). These approaches, much like the literature on Punctuated

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<sup>4</sup> <http://www.comparativeagendas.net/>

Equilibrium Theory, acknowledges the imperfect rationality of individuals, the role that institutions play in helping process the complexity of a changing socio-ecological environment, and the decision costs present in such institutional arrangements (Lee, 1993). In doing so, the literature advocates for a form of governance that is able to adapt to unexpected changes in the environment (Dietz et al, 2003; Folke et al, 2005).

This literature pays special attention to the role of institutional arrangements in supporting governance systems that are adaptive (Folke et al, 2005; Scholz and Stiftel, 2005; Koontz et al, 2015). Institutions direct interactions between relevant actors and their design can help or hinder an actor's ability to adapt to changes in their environments (Koontz et al, 2015). Moreover, to foster adaptation, institutional arrangements must be able to provide sufficient flexibility to facilitate innovation and experimentation. The adaptive governance literature has studied how aspects of institutional design, such as redundancy (Low et al, 2003), monitoring and enforcement (Dietz et al, 2003), and the ability to connect otherwise disconnected actors (Folke et al, 2005) contribute to such adaptation. Among these, the inclusion of relevant stakeholders in decision-making structures has received considerable attention (Brunner et al, 2005; Scholz and Stiftel, 2005; Foerster, 2011; Koontz et al, 2015). Granting multiple actors the possibility of influencing decisions can facilitate access to resources and increase the legitimacy of the decisions made (Scholz and Stiftel, 2005). It can also promote learning by exposing actors to other experiences, and allow for coordinating efforts across scales and levels (Koontz et al, 2015). Notwithstanding, increasing representation has its costs. Expanding the scope of representation can increase decision-making costs and reduce the possibilities of agreements between conflicting groups (Scholz and Stiftel, 2005).

Many studies in the adaptive governance tradition have focused on the importance of having decision-making structures that represent multiple interests. However, a common criticism to this literature is the existence of concepts that are often unclear (Koontz et al, 2015), and highly normative (Karpouzoglou et al, 2016). A next step in improving our understanding the design of adaptive institutions (Koontz et al, 2015) is to ask about the specific mechanisms through which a design feature may facilitate adaptation. We know that, for instance, representation is a goal of adaptive governance, and that too much or too little representation could undermine the ability of actors to adapt to their changing environments. Therefore, in what specific ways do variations in representation affect the outputs produced by actors in similar arrangements governing a shared natural resource?

This question opens the door for potential cross-fertilization between the literature on Punctuated Equilibrium and its broader theory of information processing with the literature on adaptive governance. Although originated in different fields and addressing different problems (PET originated in the study of public policymaking in American institutions, and adaptive governance stemming from the environmental sciences to understand mechanisms for the sustainable governance of natural resources), both approaches are suitable to inform each other. Both literatures share a fundamental understanding of the limited rationality of individuals. Moreover, both approaches recognize the role that institutions play in facilitating collective action, while acknowledging that institutions impose decision costs (Baumgartner et al, 2014; Lee, 1993). As a result, and with different goals in mind, both approaches pay special attention to institutional design.

The goal of Chapter 6 is to compare how variations in the design of decision-making mechanisms affect the patterns of adaptation in institutional arrangements designed to govern a shared natural resource. In doing so, the chapter combines the interest of the adaptive governance literature in the role of representation in adaptive institutions with arguments from the information processing theory about the effects of variations in decision-making systems. By showing the effects of different decision-making structures on the depth and breadth of activities conducted by actors in these arrangements, this chapter provides a novel approach to understand adaptation dynamics.

## **Understanding the design of institutions governing regional-scale natural resources**

Governing natural resources requires flexibility to deal with complex ecological and social environments. In the case of watershed management, one way of reducing complexity is by fencing off the watershed and securing ownership of the resource, thus reducing the influx of human-caused effects. However, this rarely occurs. Instead, it is more common to find situations where multiple actors own sections of a resource, and where collaboration is necessary to manage the resource. Moreover, the ecological aspects of watershed management are often intertwined and affected by what happens in other areas of the resource.

This dissertation studies the design of institutional arrangements to provide unfiltered drinking water in four U.S. cities: Boston (Massachusetts), New York (New York), Portland (Oregon), and San Francisco (California). All these cases rely on alternatives to maintain water quality that have the purpose of avoiding filtration, an effective yet expensive water treatment option. These alternatives are implemented on water resources owned by different governmental actors, which means that each of the four cities must develop agreements to access watershed lands and develop protection programs in lands not owned by them. In addition, the cases all differ in the number of actors and organizations involved in watershed-related issues. Federal legislation regulating filtration avoidance requires water providers to maintain specific water quality parameters. These parameters can be affected by myriad factors. Water turbidity, for instance, can be affected by unexpected climatic events like hurricanes and wildfires, or by changing patterns in land use. Therefore, arrangements designed to protect water quality at the source must develop and implement rules while allowing for adaptation to unexpected events.

The four cases have managed to maintain compliance with federal and state legislation, providing high-quality unfiltered water for human consumption. However, the arrangements they created to govern these resources differ across cases. In Portland and San Francisco, the agreements define mechanisms for dividing responsibilities between two actors, without relying on formal venues for decision-making. On the other hand, in Boston and New York, the arrangements rely more on formalized procedures for decision-making. Although these differences are influenced by the number and type of actors involved, as well as the water appropriation doctrine in each case (Portland / San Francisco in the West, and Boston / New York in the East), there are also significant differences within both pairs of cases. This project focuses on differences between and within pairs of cases, analyzing the causes and consequences of variation in the design of these agreements. Whether it is by dealing with a single federal agency, or with multiple local governments, or where a State government creates organizations to manage the resource, all four are different expressions of successful intergovernmental agreements for sharing the management of a natural resource.

The following chapters address different features of the design of these institutional arrangements. The common theme is a focus on the dynamics of design and adaptation of each agreement. Each chapter is structured around a specific research question:

Research Question 1: In the governance of regional-scale shared natural resources, does the previous history of interactions between the parties affects the design of their formal agreements? If so, in what ways do agreements vary when actors face different collective-action dilemmas?

Research Question 2: How do regional agreements for the governance of shared natural resources incorporate mechanisms to ensure monitoring, enforcement, and conflict resolution in each of these cases? Is the design of mechanisms affected by differences in transaction costs?

Research Question 3: Do variations in decision-making structures affect the breadth and depth of outputs produced by the parties to these agreements over time?

The first research question focuses on the nature of the social dilemma that the institutional arrangement attempts to deal with. Although CPR situations are a particular case of cooperation

problems, myriad dilemmas can also occur when actors collaborate in governing a shared natural resource. The four cases studied come from different historical trajectories that have marked the ways parties interact. Building on empirical and theoretical developments within the ICA approach, Chapter 4 analyzes the different historical paths prior to the establishment of the current institutional structure in each case, and tests hypotheses on how they affected institutional design.

Research question 2 focuses on how each agreement incorporates elements from the design principles in the CPR literature. Although Ostrom's design principles involve a total of eight elements, this question only focuses on three: monitoring, enforcement of the rules, and conflict resolution. The reason for this is twofold. First, these have been highlighted as important elements for ensuring adaptive management of natural resources at large scales (Dietz et al, 2003). Second, the features studied here all rely on the creation or definition of organizational mechanisms for their implementation, thus making it possible to analyze variations in their design across cases. Chapter 5 addresses how variations in transaction costs affect the design of mechanisms for monitoring, conflict resolution, and sanctioning of noncompliant behavior.

Finally, Chapter 6 focuses on how these agreements adapt to their environments. In particular, the goal is to assess whether differences in the decision-making structures created by these agreements affect their patterns of outputs. Arrangements designed to discuss information based on limited points of entry should present different patterns of collective-choice decisions than arrangements where information has multiple points of entry into the decision-making process.

The three chapters incorporate elements from different theories to understand institutional design in the governance of shared natural resources at regional scales. In doing so, the overall contribution of this project is twofold: First, different theories are combined and new methodological approaches are combined to explain and understand variations in institutional design. Second, the arguments developed here are applied to instances for which the literature in Common Pool Resources is still evolving: intergovernmental agreements to manage a shared resource. In that sense, the hypotheses developed and tested here serve as an initial take on identifying the sources and effects of institutional variations at regional scales. Rather than studying institutional variation at multiple scales, this project takes the more modest approach of digging deeper into understanding variations in design at a single scale.

The objective of this project is one of theory development, combining multiple approaches to understand a specific instance of natural resource governance. In doing so, the studies take the form of *plausibility probes* (George and Bennet, 2005; Eckstein, 2009). Plausibility probe studies are conducted to assess a new set of hypotheses in terms of their validity and potential for the advancement of a theory. These studies are useful when the goal is to consider the validity of a series of hypotheses, to the point of whether they are good enough to warrant further and more sophisticated testing (Eckstein, 2009). As warned by George and Bennet (2005), plausibility probes should not be associated with lax research standards. Instead, they provide with a good approach for assessing hypotheses in a way that is conscious of its limitations. In the studies presented here, such limitations refer to the nature and type of cases to be studied, in the sources of data used to ensure comparability (as in Chapter 6), and the level of operationalization of certain variables (as with the case of definitions of cooperation, coordination, and division problems discussed in Chapter 4).

Findings in the empirical chapters shed light on the plausibility of each theoretical argument in cases of water quality protection at regional scales. Chapter 4 shows that cooperation dilemmas will result in a higher level of redundancy in the interactions mandated by formal rules. Chapter 5 in turn shows that a history of high transaction costs between the parties results in variations in monitoring and consequence mechanisms, but does not seem to modify the design of conflict resolution. And finally, Chapter 6 shows that including more actors in decision-making processes tends to expand their involvement on new issues. This process, defined as "broadening" by the literature on Punctuated Equilibrium Theory, was never before studied in the context of special purpose arrangements. The findings also hint at potential variables that may mediate the extent to which broadening occurs in the arrangements studied here.

## **Conclusion**

This section laid out the main theoretical approaches that will guide the empirical analyses of this dissertation. Governing a natural resource demands multiple and flexible approaches to understand the numerous dynamics at play. In this context, understanding different dynamics of institutional design and implementation also requires of various analytical and methodological tools. The theories discussed in this section come from different backgrounds but they share an interest in the design characteristics of institutions.

One of the reasons why the Common-Pool Resource studies research agenda evolved immensely during the past decades is because of its ability to engage with other research traditions. I am convinced that doing this in a theoretically honest and systematic way will ensure that progress is still being made, in particular in a context of constant and unexpected environmental changes. My hope is that this project will shed light on our understanding of institutional design and adaptation dynamics for the management shared natural resources between government actors, and generate lessons that could illuminate future governing experiences of this kind.

The rest of this dissertation will be structured as follows: Chapter 2 will discuss the selection of cases and will provide a historical overview of each of the four cases of study. Chapter 3 describes the three sources of data and the coding protocols used in Chapters 4, 5, and 6. Chapters 4 and 5 will focus on the effects of contextual variables on institutional design. Chapter 4 applies a novel approach to capture institutional design using social network analysis tools, and assesses whether the type of collective action dilemma faced by a group of actors prior to devising an institutional arrangement affects the structure of interactions mandated by such agreement. Chapter 5, on the other hand, assesses how transaction costs influences the design of monitoring, conflict resolution, and enforcement mechanisms at regional scales. Chapter 6 analyzes how the design of decision-making processes affects the types and quantity of outputs produced by an institution. Finally, the dissertation concludes by providing an overview of the findings, addressing some limitations in the design of the project, and suggesting avenues for future research.

## **Chapter 2: Imperial cities and water: the quest of San Francisco, Portland, Boston, and New York to secure clean sources of drinking water**

### **Introduction**

This chapter discusses the selection of the four cases studied in this project. It does so by providing a methodological justification based on the types of analyses conducted in Chapters 4, 5, and 6. The methodological justification is joined by a substantive justification, showing how the arrangements studied were created to address the same legal mandate in different contexts. Finally, the chapter provides a brief historical overview of the evolution of water management decisions in each of the four cases, providing detailed contextual information to the discussions in the subsequent chapters.

### **Case selection**

The overall goal of this project is to assess some of the causes and consequences of variations in the design of institutional arrangements for the governance of a shared natural resource. In particular, this project analyzes variations in the design of arrangements created for providing unfiltered drinking water, where the producer and the resource users are different political jurisdictions. Studying these types of arrangements is useful in that their goal is the same: securing access and protection to high-quality drinking water via the development of activities aimed at reducing the effects of contaminants and human activity at the source. What differ are the contexts in which those arrangements are created.

The cases studied in this dissertation were chosen for a series of reasons. First, the goal of this project is to study variations in institutional design for the governance of shared natural resources. The focus is on situations where the actors managing the resource are governments and not individuals. In that sense, the dynamics occurring in the production of unfiltered drinking water provide a good setting for assessing how governmental actors address collective action dilemmas surrounding the access and production of high-quality drinking water.

Second, having cases dealing with similar issues helps reduce the effects of factors such as variations caused by the type of resource being governed. Studying arrangements dealing with the production of unfiltered drinking water and the protection of a shared natural resource allows for comparisons between cases dealing with the same issues but in different contexts. The four cities studied here took different approaches to design the institutions that govern their resources. In addition to geographic and historical differences, these cases also vary in the number and types of actors participating in their agreements. On one side, Boston and New York involve a large metropolitan area and small towns and municipalities where the resources are located. On the other hand, Portland and San Francisco involve bipartite agreements between the City and the Forest Service (Portland), and between the City and the National Park Service (San Francisco), given that the resources in question are located on federal lands. The goal in this project is then to analyze the differences in the design of their arrangements (Chapters 4 and 5), as well as to identify how variations in design can lead to different patterns of institutional change (Chapter 6).

Third, as of 2010 there were approximately 12 water systems in the U.S. operating under a filtration waiver. Although the four cases studied here are not the only examples of cities providing unfiltered drinking water in the U.S., they do constitute the universe of cities with a population of more than 500,000 that operate under a filtration waiver and where their water is sourced from lands not owned by them.<sup>5</sup>

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<sup>5</sup> Seattle (Washington) is another example of a city over 500,000 people operating under a filtration waiver. However, Seattle has sole ownership of the lands where their water sources are located (Egan, 2013). Therefore, the component of a “formal agreement with the landowner” required by filtration avoidance regulations is not present in that case.

Fourth, the empirical chapters develop new theoretical arguments regarding institutional design at regional scales. To assess these hypotheses, each chapter develops hypotheses as plausibility probes. These types of hypotheses allow assessing the validity of new hypotheses, evaluating whether more research should be developed on these topics. To do so, however, it is necessary to rely on cases that are comparable at least in their most fundamental features. In these studies, one of such features was scale and the types of actors involved. In recent years, the literature studying institutional design at larger scales has studied inter-state compacts (Heikkila et al, 2011) and agreements at international levels (Fleischman et al, 2014). However, with the exception of Hanlon (2015), few academic works have focused on cases within state boundaries, at least in the U.S. The three papers test hypotheses in arrangements developed to manage resources located within state boundaries.

In addition to counting on plausibility probes as a theory-building strategy, a corresponding theory-testing strategy must be implemented. The general approach for theory testing taken in the three papers is one of congruence analysis (George and Bennet, 2005; Van Evera, 1997). The congruence method starts with a theory that predicts outcomes under a series of conditions. After defining the conditions and hypotheses, the researcher assesses whether expectations on variations in the independent variables of interest are related to variations in the dependent variable. Results that fall in line with the theoretical expectations strengthen the possibility of a causal relationship (George and Bennett, 2005). Unlike other approaches, the congruence method does not necessarily rely on process-tracing methods to identify causal mechanisms (George and Bennet, 2005). However, applying a congruence approach warns the researcher about the need of additional methods to claim any causal relationship between the variables of interest.

Although the congruence method is commonly used to assess instances of within-case variation along with the ability of different theoretical constructs to explain a series of outcomes, it also lends itself for comparisons across cases. For instance, the congruence approach is useful for testing the performance of a given theory in explaining the outcomes observed in a single case or on a small number of cases (George and Bennett, 2005). In addition, when combined with the study of counterfactual cases the congruence analysis can be applied as a form of controlled comparison. Although this project does not include such counterfactual cases, the congruence analysis is applied to four cases that are similar in scale and in the goals they try to achieve, yet different in other relevant contextual aspects (for instance, in the history of relationships between the parties).

The congruence approach is preferred over a controlled comparison method in that it requires fewer and less strict assumptions about the cases observed. In particular, the controlled comparison method requires the assumption that the “*full range of socially and possible causal paths must be available for study*” (George and Bennett, 2005:155). For this to happen, cases with additional outcomes should be included in the study. An example of this could be cases where the arrangements failed at producing unfiltered drinking water. Instead, the four cases studied here are successful examples of intergovernmental arrangements for the production of unfiltered drinking water

Finally, this theory-testing strategy is complemented by the extreme nature of one of the cases studied here. Particularly in Chapters 4 and 5, the case of New York presents extreme values on the variables of interest. Having a case with extreme values in the variables of interest is useful for assessing the strength of the theoretical argument. If the expectations do not hold even in the presence of such extreme values, then the validity of the theories posited will be seriously discredited. In Chapter 4 the method of congruence is bolstered by relying on Exponential Random Graph Models, which compares the objects of analysis (networks) with multiple randomly-generated networks of equal size and characteristics. This approach allows controlling for potential confounders and produces results similar to those of multiple within-case comparisons.

### **Legal and historical context of the cases: why study filtration avoidance?**

In 1974, the U.S. approved the Safe Drinking Water Act, granting the Environmental Protection Agency (U.S. EPA) authority to define the maximum levels of contaminants that could be present in systems providing water for human consumption. In 1989, concerned with levels of *Giardia lamblia* parasites and *legionella* bacteria in public systems, the U.S. EPA issued the Surface Water Treatment Rule (SWTR). Because surface water can be polluted by storm water runoff, sewage water, agricultural runoff, wildlife, and other sources (Alcott et al, 2013), this new rule created tighter regulations for public water systems using surface water or ground water under the direct influence of surface water, by defining the criteria for filtration, disinfection, and the procedures for States to determine which systems must install filtration mechanisms. One of the conditions in the SWTR requires water providers to filter their water. However, a provider may apply for a waiver of this obligation as long as they can guarantee compliance with water quality and site-specific criteria. Within the site-specific criteria, the SWTR establishes that “*The public water system must demonstrate through ownership or written agreements with landowners in the watershed, or a combination of both, that it controls all human activities which may have an effect on the microbiological quality of the source water*” (Surface Water Treatment Rule, 1989). This requirement demands for agreements with the landowners demonstrating that there are plans in place for protecting water quality at the source.

Filtration avoidance provides an alternative to address water quality issues through a non-engineered approach. In modern times, the production and provision of drinking water became highly regulated and subject to myriad controls that are addressed mostly through highly effective engineered responses, such as filtration, fluoridation, and chlorination. All these approaches allow for the safe provision of drinking water, reducing public health risks. As a result, water that at the source may not be suitable for human consumption is now possible to be provided clean and safe to a community.

In recent years, however, the notion that the only response to water quality was through engineered approaches has been challenged. Water providers throughout the U.S. started to recognize the added value of watershed management and protection to improve or maintain the quality of their resources, in some cases reducing the levels of treatment prior to distribution (U.S. EPA, 1999; Alcott et al, 2013; Egan, 2013). Many of these approaches were then replicated in other parts of the world, under slightly different schemes, but with the same logic (Bennet et al, 2014; Huber-Stearns et al, 2015).

In the case of the SWTR, regulations require the creation of formal arrangements between landowners and resource users. This requirement creates situations of collective action problems in settings where water providers draw water from other jurisdictions. In these cases, at least two types of appropriators must collaborate: those located on the land where the resource sits, and those who from a distance want to appropriate the resource and exclude others from fully using it. The four cases studied provide water from unfiltered systems and have developed formal arrangements with landowners in other jurisdictions. Studying these four cases will help identify institutional features present in successful experiences, thus helping understand our understanding of watershed protection at regional scales as well as informing similar endeavors in the future. Those arrangements, and the rules and regulations that support them are the focus of study of this project.

The four cases studied here are not the only unfiltered systems in the U.S. In fact, as of 2010, over a dozen water systems in the U.S. operate under a filtration waiver (Alcott et al, 2013). However, of those, the cases of Boston, New York, Portland (Oregon), and San Francisco are the only ones that provide unfiltered water for a large population (over 500,000), and their water is obtained from watersheds located on lands not entirely owned by them. In addition, their location and historical evolution makes these four cases ideal for a comparative analysis. The next sections provide a historical overview of how actors in each case secured access to sources of high-quality drinking water located in other jurisdictions.

*San Francisco: how politics secured access to clean water*<sup>6</sup>

The City and County of San Francisco obtain approximately 80% of their drinking water (Lee 2002) for their 2.4 million populations from the Hetch Hetchy Reservoir. The reservoir is located 167 miles from the City in Yosemite National Park. Hetch Hetchy water originates from the snowpack of the Upper Sierra Nevada Mountains, descending through the Tuolumne River. The little development in the area and features of its soil add little sediment to the water, making it suitable for human consumption. To secure access and control of this extraordinary source of water, San Francisco embarked in an equally extraordinary political struggle to convince the Federal Government and the population of the City that installing a dam in the middle of one of the nation's most precious National Parks was necessary.

Hetch Hetchy has always been San Francisco's obsession. Since the end of the 19<sup>th</sup> Century, the City had the goal of having a publicly owned supply of drinking water. To achieve this, the City had to battle actors at different fronts, from the private corporation owning the City's water supply to environmental groups led by John Muir himself. At the end of the 19<sup>th</sup> Century, the City started investigating alternative sources of water. One of those options was the Tuolumne River, which meanders through Central California and joins the San Joaquin River in California's Central Valley. Although the City evaluated damming the river downstream, the Hetch Hetchy Valley showed to be an exceptional place for the dam. First, the Hetch Hetchy Valley was located on a fairly remote area that at the time was not included in the Yosemite Park Act of 1864. Second, being surrounded by Federally-owned land made it easier to negotiate land acquisitions in the area. And third, the physical characteristics of the valley made it an attractive location for building a reservoir (Righter, 2005).

In 1913, the City of San Francisco presented its case to a Congress that was already in favor of the City's proposal (Simpson, 2005). The City based its arguments on the economic feasibility of the project, arguing that it was the cheapest alternative to source their water. On December of 1913, President Wilson signed what was known as the Raker Act. The Act granted the City of San Francisco rights to appropriate water from the Hetch Hetchy watershed, and rights-of-way in adjacent areas.<sup>7</sup> The Raker Act authorized the construction of a dam on the Tuolumne River, flooding the Hetch Hetchy valley. The dam was finished in 1929 and was named after Michael O'Shaughnessy, City Engineer of San Francisco.

In the early 1920s, San Francisco saw in Boston an example of a system of regional water provision, and attempted a similar approach by offering other municipalities to join the Hetch Hetchy endeavor. Joining efforts would help fund the construction of O'Shaughnessy dam and create a single regional water provider. However, the City did not succeed and these municipalities decided to look for their own sources of clean water (Righter, 2005).

After passing of the Act, a series of struggles emerged between the City and Yosemite National Park regarding the definition of their watershed management responsibilities. Although the Act imposed a list of responsibilities to the City (for instance, the construction of roads allowing public access), the City saw the Act as a blank check for the appropriation of the entire watershed. Yosemite National Park's responsibility in the years following the sanctioning of the Raker Act was to remind the City that it was working on National Park Lands, and not on City property (Righter, 2005). Aside from these early differences, the relationship between the City and the Park throughout time was politically correct.

Given the superior quality of the watershed, in 1993 the City of San Francisco obtained authorization from the U.S. EPA and the California Department of Health Services to avoid filtration of this water. To maintain compliance with the requirements of filtration avoidance, the City and Yosemite National Park jointly drafted a watershed management plan in 1998. This plan required both parties to

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<sup>6</sup> This section is based on Simpson (2005) and Righter (2005)

<sup>7</sup> In exchange, the City must pay an annual fee of \$30,000 for the maintenance of roads and other improvements in the Park area (Lee, 2002). This rate, which translates to \$0,07 per acre of land has not changed since 1938 (Simpson, 2005).

create a Watershed Working Group to implement the plan and develop a formal Memorandum of Agreement between both parties (U.S. EPA, 1999). Due to bureaucratic delays (SFPUC Representative, Personal Communication, May 2, 2016) such agreement was not signed until 2005. This agreement was signed in 2005 as a 5-year agreement, which was revised in 2010. The last iteration of the agreement was signed in 2016 and will be renewed every two years.

In recent years, environmental NGOs like “Restore Hetch Hetchy” have advocated for the removal of O’Shaughnessy dam and the restoration of the Hetch Hetchy Valley. These organizations managed to get the State of California and the Federal Government draft reports on the feasibility of removing the dam. In 2012, a proposition (Proposition F) that would mandate the City to conduct a study to drain the reservoir was up for a vote in San Francisco. The proposition was defeated at the polls.

*Portland: where the federal government defined the pace<sup>8</sup>*

Water in Portland originates in the Bull Run watershed, 26 miles of downtown Portland, in Mt Hood National Forest. At the end of the 19<sup>th</sup> Century, the City was growing and access to drinking water was diminishing, posing health risks for Portlanders. To address this issue, the City found in the Bull Run River a source of excellent-quality water. As later occurred with San Francisco, Portland was attempting to use water sourced from federally-owned lands, thus, a case had to be made to the Federal Government about the importance of Bull Run for the City. In 1892, Oregon’s congressional delegation presented the case to President Harrison, who signed a proclamation declaring Bull Run a national forest reserve, protecting it from the development of human settlements in the area. Although the presidential declaration closed Bull Run for other landowners, it did not forbid its use for economic purposes. Portland was concerned with human access to Bull Run, and its desire was to keep everyone away from their pristine water. Shortly after President Harrison’s proclamation, the City started a campaign to convince the Federal Government to develop stricter regulations regarding access to Bull Run.

In 1904 President Roosevelt signed the Bull Run Trespass Act. The Act made it illegal for people other than government agents to enter the area. In 1905 the land was designated Forest Service jurisdiction. The peace of mind brought by the Bull Run Trespass Act allowed the City to spend the next decades developing its infrastructure, achieving things like full metering of all taps, something that New York City, for instance, did not complete until 1997 (Short, 2011).

In 1950, the Forest Service issued a memorandum titled “Plan of approach to better management of the Bull Run Watershed”. The memorandum argued about the need of allowing logging in Bull Run. Citing mainly safety concerns, the memorandum stated that parts of the old-growth forests ought to be logged in order to prevent catastrophic fires. Acknowledging the hazards that an uncontrolled fire could have on its water source, the City of Portland quietly agreed to the recommendations in the memorandum (Larson, 2009). Over time, logging authorizations became increasingly permissive, causing the City and environmental groups to request for a more strict interpretation of the Bull Run Trespass Act. These complaints caught the Forest Service facing two contradicting goals: to maintain the mandate of multiple uses as stated in the Multiple Use - Sustained Yield Act of 1960<sup>9</sup>, and to follow the watershed preservation mandates of the Trespass Act. This was particularly challenging for Forest Service agents, who often had to choose the former in order to advance their careers in the agency, as well as maintaining a steady source of income for Mt. Hood (Short, 2011).<sup>10</sup>

In the 1970s, issues of water quality became more notorious. Stringent water regulations were being developed at the Federal and State level, which led the City of Portland to study alternatives for

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<sup>8</sup> This section is based on Short (2011).

<sup>9</sup> The act mandated the Forest Service to manage their lands for “recreation, range, timber, watershed, and wildlife and fish purposes”. This act stated that none of these uses could predominate over another.

<sup>10</sup> During these times, the City and the Forest Service signed a series of agreements to address issues of common concern. These agreements, signed in 1956 and 1971 left most of the decision-making authorities to the Forest Service.

addressing deficiencies in its system. One alternative was filtering Bull Run's water. However, the City was concerned that doing so would give more incentives for loggers to increase their already extensive use of Bull Run. The solution came from a Portland resident. In 1973, a retired physician named Joseph Miller Jr. sued the Forest Service on the grounds that by allowing timber extraction from the watershed, the Forest Service was violating the Trespass Act. Although the Courts decided in favor of Mr. Miller and mandated an end to the timber extraction, the situation was not entirely solved. As stated in the Judge's resolution to the lawsuit, "the alleged law breaker is also the law enforcer" (Short, 2011:177). Following this, the City embarked in a quest to develop tighter regulations for Bull Run.

In 1977, President Carter signed Public Law 95-200 (PL 95-200), termed the "Bull Run Act". This law clarified the relationship between the Forest Service and the City regarding the management of Bull Run, and established guidelines for activities that did not have a negative impact on water quality. The Act also incorporated mechanisms for conflict resolution among the parties. Although logging stopped in Bull Run, timber companies continued extracting timber from the Little Sandy River area, one of the tributaries to the Bull Run River. By the late 1980's, concerns regarding the levels of logging on the Little Sandy River area were growing.

In 1993, President Clinton convened a timber summit in Portland, which would result in the drafting of the 1994 Northwest Forest Plan. The plan designated Bull Run's surroundings as a "late successional reserve", banning logging in the area (Short, 2011). Building off the triumph that the Plan meant, the City reached once again to Congress for help. In 1996, Congress sanctioned an omnibus act labeled "Oregon Resource Conservation Act" (ORCA). The Act amended PL 95-200 to include stricter logging prohibitions than the ones in the Northwest Forest Plan, making them now an act of Congress rather than a presidential administrative decision (Short, 2011). The logging prohibition, paired with closing the area for public access secured Bull Run for its strict use as a water source for the City of Portland (Larson, 1999). The last Congressional mandate came in 2001 with the passing of the "Little Sandy Protection Act". The Act amended PL 95-200 extending its coverage to the Little Sandy River Area, now protecting the entire Bull Run River and its buffer areas.

The Northwest Forest Plan and ORCA were central in removing the fundamental source of conflict between the City and Forest Service. With logging forbidden, actors had nothing much to disagree over, and in the year 2000 both parties hired a consulting agency to assess the Bull Run situation (USDA Forest Service and Portland Water Bureau, 2007). The assessment laid the foundations for a Memorandum of Agreement (MOA) between the City and the Forest Service signed in 2007. The agreement defines a co-management system and assigns responsibilities for both actors. This new MOA defined a program through which the City and the Forest Service would exchange land. Through this program the City would give the Forest Service scattered parcels of land it owned throughout the watershed, in exchange for lands along the Bull Run River.

The passing of ORCA signed the prohibition of Mt. Hood's most important source of revenue: timber sales. In this context, the MOA came to fill a fundamental gap in the relationship between Portland and the Forest Service, by providing mechanisms through which the City of Portland would fund Forest Service activities in the watershed. These agreements and regulations allowed the City to obtain a filtration waiver from the Oregon Health Authority.

*Boston: regionalization and a top-down approach led by the State<sup>11</sup>*

At the end of the 19<sup>th</sup> Century, the Boston metropolitan area was growing at high rates, increasing the pressure on Boston's water resources and also increasing public health risks. In 1895, the State Legislature asked the State Board of Public Health to write a report on alternatives to address the area's future water issues. The report recommended building a dam 35 miles east of Boston, on the South Branch of the Nashua River, creating what would later be called the Wachusett Reservoir. The Nashua River was chosen because of the purity of its water, the low level of development in the area, and

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<sup>11</sup> This section is based on Nesson (1983) and Metropolitan District Commission (1984).

the possibility of installing a gravity-driven system to bring water to Boston (Nesson, 1983). The report also recommended that the water system should provide for the entire Boston Metropolitan Area. This would alleviate construction costs and benefit a larger amount of people (Nesson, 1983; Metropolitan District Commission, 1984).

The report was resisted by every relevant actor: the City of Boston was not fond of the idea of sharing their water; communities in the metropolitan area did not want to invest in a system that would not provide them with immediate benefits; people in Western Massachusetts opposed to not receiving enough compensation for the losses in revenue caused by flooding their lands; and finally, the Town of Clinton (which would be inundated by the reservoir) vehemently opposed (Nesson, 1983). The State Legislature considered these arguments and modified the project in 1895, passing the Metropolitan Water Act. This act created a Water District in charge of managing the sources of drinking water for the City of Boston and 12 other municipalities in the metropolitan area.

By the time the Wachusett Reservoir was completed in 1908, the district served by its waters had already grown to a point where its sources would no longer be sufficient in the short term. In 1918, the Board asked the State Legislature permission to draft a new water supply plan. The new plan proposed bringing water from the Ware River and building a second reservoir 65 miles east of Boston, in the Swift River Valley (later named Quabbin reservoir). The State Legislature approved the new plan and created the Metropolitan District Commission (MDC), consolidating all water, sewer, and park responsibilities into a single agency (Metropolitan District Commission, 1984). The MDC would manage Boston's water provision.

In 1983, the MDC was sued over the dumping of wastewater to the Boston Harbor (MWRA representative. Personal communication, June 3, 2016). A series of mismanagement issues had led MDC to overlook the environmental situation in the harbor, putting the agency in direct violation of the Clean Water Act. As a result, in 1984 the State of Massachusetts decided to assign MDC's water and sewer responsibilities to a new agency: the Massachusetts Water Resources Authority (MWRA). MWRA was in charge of providing drinking water and sewer services to the Boston Metropolitan Area, and MDC was in charge of managing the watersheds. In addition, MWRA, as an agency funded by ratepayers, was in charge of funding 50% of MDC's budget. Over time, that percentage increased up to 100%.

The reason for this two-faceted approach rested largely on the concerns of legislators from Western Massachusetts, who did not like the idea of having a Boston-based agency managing land in their territory: *"folks in central mass, where the watersheds are, were concerned that if they transferred all of the watershed and all of the responsibilities for the reservoirs and the watersheds to this new Boston-based agency, that things like public access may not be maintained and the state would no longer have an influence on what happens on those lands"* (MWRA representative. Personal communication, June 3, 2016). After MWRA was created, Memorandums of Agreement were signed in 1989 and 1992, dividing responsibilities for the management of the watersheds.

In 1992, the state of Massachusetts passed the Watershed Protection Act (WsPA), to govern and protect lands located on the Ware, Quabbin, and Wachusett reservoirs. The WsPA gave authority to acquire parcels and govern land on these watersheds to the MDC, who would implement this mandate in collaboration with MWRA. That same year, after the Surface Water Treatment Rule was published, MWRA and MDC started the application for a filtration waiver. Given the differences in population density and uses MWRA and MDC filed different waiver applications for the Quabbin and Wachusett watersheds. In 1992, the Massachusetts Department of Environmental Protection (MassDEP - the Primacy Agency in charge of enforcing the SWTR) issued a filtration waiver for the Quabbin watershed (Stearns, 2000). However, the process for the Wachusett would prove to be much more complicated.

In 1993, MassDEP issued an Administrative Consent Order (ACO) to MWRA and MDC regarding filtration of the Wachusett. The ACO stated that MWRA and MDC would take a "dual approach" of improving water quality, while developing plans for a filtration plant by 2001. In 1997, the Department modified the ACO, providing extensions to the design of a filtration plant (Stearns, 2000). The U.S. EPA saw the amendments to the ACO as a sign that MassDEP was delaying the filtration

decision, and in 1997 filed an enforcement action arguing failure to comply with filtration criteria (Stearns, 2000). The Courts maintained the litigation pending until MassDEP decided on the issue. On December 22, 1998, a filtration waiver was issued for Wachusett water, defining that if at any time the parties failed to comply, filtration would be required (Stearns, 2000).

During this time, contaminants regulated by the SWTR were above safe yield levels in the Wachusett, which led U.S. EPA to request a cancellation of the waiver. MassDEP opposed, and U.S. EPA moved forward with its judicial request. On December 6, 1999, a trial began in the United States District Court in the District of Massachusetts. The Court decided not to require filtration. The argument was that the risks of avoiding filtration would not be different than having filtration. Water filtration could increase “public pressure to open restricted MDC lands to general recreational uses” (Stearns, 2000:67), thus worsening the environmental situation on the watersheds.

In 2003, Governor Romney replaced the MDC with the Massachusetts Department of Conservation and Recreation (DCR) by combining MDC with the Department of Environmental Management. Given these changes, MWRA had to redefine its relationship with the new State Agency in charge of managing their watersheds. This was achieved in 2004 through a Memorandum of Understanding (MOU) between MWRA and DCR’s division of Water Supply Protection. The MOU and Watershed Protection Act are also complemented by rules defining what activities are allowed on watershed lands (350 CMR 11.00).

To facilitate the funding of DCR with MWRA money, the State of Massachusetts created the Water Supply Protection Trust in 2004. The Trust is composed of representatives from the Secretary of Energy and Environmental Affairs (the agency that oversees the DCR), representatives from watershed users, a member from DCR, and two members from MWRA: their Executive Director and a member of the MWRA Advisory Board.

#### *New York: learning how to coexist with multiple actors<sup>12</sup>*

New York City obtains its water from three watersheds located 125 miles north of the City, on the Catskills, Croton, and Delaware watersheds. Like Boston and San Francisco, New York was surrounded by different sources of good quality water. However, for New York the problem was not resource distance or quality, but rather that landowners did not want to give up their resources. This anti-urban sentiment was present in every attempt by the City to access rural water sources.

The first attempt to tap water outside city limits took place in 1834 when the State of New York sanctioned an Act (Act Supplying the City of New York with Pure and Wholesome Water) authorizing the City to tap water from Putnam and Westchester Counties, north of the city. The Act authorized the City to condemn land for the construction of reservoirs, via the use of eminent domain (Hanlon, 2015). This authority granted to the City ignited feelings of distrust from the watershed communities that lasted for over a century.

By the end of the 19<sup>th</sup> Century, New York City was facing water availability issues. In 1902, the City hired engineer John Freeman (who will later be an advocate for Boston’s case in the Quabbin reservoir), to write a report on the City’s water system. The report recommended developing water infrastructure in Dutchess County and the Catskills. New York, just like Boston a few years later, saw the solution to their problems in territorial extension and control of extra-urban areas. By that time, neighboring communities passed legislation forbidding the City from tapping into their water resources. This narrowed the alternatives to Dutchess County and the Catskills region. The City decided to move forward with the Catskills plan, and lobbied for new legislation.

One of such legislations allowed municipalities in Westchester County to tap into the City’s reservoirs, transforming the City in a de-facto metropolitan water provider, similar to the Massachusetts case (Soll, 2013). The law also created a Board of Water Supply (BWS) in charge of extending the City’s water supply, and a Department of Water Supply (DWS), in charge of managing BWS’s

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<sup>12</sup> This section is based on Galusha (2016) and Soll (2013).

infrastructure. For the next 50 years, the BWS would define the City's water policy. Just like in the early years in Boston and San Francisco, the BWS in New York addressed issues of growing population via engineered solutions focused on system expansion rather than on curbing consumption.

During the following 50 years, conflicts would increase over the City's encroachment of watershed land, with landowners constantly suing the City regarding land compensations. Armed with teams of lawyers, the City always attempted to purchase lands at the lowest price possible. During this time, the City also lobbied for legislation that would define these lands as the least valuable taxing category, putting the viability of the small watershed communities at risk (Soll, 2013). The process of land taking and infrastructure building continued in the Catskills until the late 1960s. In 1978, after more than 5 decades of system expansion, worn out by extensive conflicts with landowners, embarked in a serious financial situation, and lacking goals that matched the system expansion purpose of the agency, the City of New York eliminated the Board of Water Supply and reassigned its responsibilities to the Department of Environmental Protection (NYCDEP). This marked an end in the period of system expansion and started an era of system maintenance (Soll, 2013).

In 1990, NYCDEP drafted a new series of rules and regulations for land use in the watershed. These rules had not been changed since 1953, and were about to be replaced by tougher regulations without even consulting the affected towns, villages, and counties. When communities in the watersheds heard about this, conflict unleashed. The regulations were seen as "draconian" (Coalition of Watershed Towns Representative. Personal communication, June 16, 2016), threatening the economic viability of most watershed communities. In response, watershed towns organized and created a "Coalition of Watershed Towns" (CWT). The CWT was composed of almost 35 watershed towns and village which all collectively hired a law firm to fight the City (Galusha, 2016).

In 1997, after more than 2 years of negotiations, the New York City Watersheds Memorandum of Agreement (MOA) was signed. Although none of the parties was fully satisfied with the agreement (Soll, 2013), the MOA granted small wins to everyone: the City would resign to the use of eminent domain as a land acquisition method and would instead develop "willing seller – willing buyer" programs for acquiring land. The CWT, on the other hand, agreed to a revised version of the watershed rules issued by the City, and to the creation of a new organization, the "Catskill Watershed Corporation" (CWC) that would be in charge of implementing many of the watershed protection, infrastructure development, economic development, and education programs defined in the MOA. The MOA also created a conflict resolution venue, the "Watershed Protection and Partnership Council", to address any controversy that may arise without resorting to State or Federal Courts (Galusha, 2016; Soll, 2013).

As a result of this agreement, the City obtained a 5-year Filtration Avoidance Determination, authorizing the supply of unfiltered Catskill and Delaware water. Water from the Croton watershed, which is about one-third of the City's demand, is the only one being filtered in a recently-finished filtration plant (Dunlap, 2015). Also, the State of New York issued the City a Water Supply Permit, authorizing and regulating the acquisition of land in the watersheds.

## **Conclusion**

This chapter presented the main justifications for the selection of these four cases. In addition, it laid out the historical processes that preceded the creation of the institutional arrangements studied in the following chapters. This historical account serves as a baseline to understand the decisions made in each case with regards to the management of resources shared by two or more users.

The following chapters will analyze how specific aspects of the relationships between the parties shaped the design of their institutions and the outputs produced in terms of watershed protection.

## Chapter 3: Data collection

### Introduction

This section describes the data analyzed and coded in Chapters 4, 5, and 6. Although each chapter includes an overview of the data used, this section provides a detailed description of all the sources analyzed. Three sources of data were used in each of the cases studied: formal arrangements and legal documents, reports and plans of watershed protection activities, and semi-structured interviews with key informants.

### Formal arrangements and legal documents

Chapters 4 and 5 focus on the role of collective-action dilemmas and transaction costs in affecting institutional design. To capture institutional design variables, the main formal documents guiding and constraining behavior regarding watershed protection activities were identified. Per federal regulations, every water provider receiving a filtration waiver must show proof that they have ownership or control over the land where the sources of drinking water are located. In the cases studied here, this was done through agreements between water providers and landowners. These agreements are also complemented by federal or state legislation, or by regulations issued by state or local actors. To ensure that the main formal documents were included, interviewees were asked to identify the main documents guiding and constraining behavior in their cases. Responses to this question ensured that no key document was left aside.

A total of 15 documents were coded. The documents identified in each of the four cases are the following:

- Boston (4 documents)
  - **1992 Watershed Protection Act (Chapter 92A ½ of Massachusetts General Laws):** *Regulates land use in the watersheds, along with responsibilities of the Division of Water Supply within the Department of Conservation and Recreation (DCR). This law was amended in 2003 after DCR was created.*
  - **1994 Watershed Protection Regulations (350 CMR 11.00)**<sup>13</sup>: *Issued by the Department of Conservation and Recreation. 350 CMR 11.00 defines and clarifies restrictions and prohibitions of the Watershed Protection Act.*
  - **2004 Memorandum of Agreement between Massachusetts Water Resources Authority and Massachusetts Department of Conservation and Recreation:** *Defines the relationship between Massachusetts Resource Authority (MWRA) and the Department of Conservation and Recreation (DCR) regarding watershed management activities.*
  - **2004 Watershed Protection Supply Trust Act (Chapter 10, Section 75 of Massachusetts General Laws):** *Created to oversee MWRA funding of DCR.*
- Portland (3 documents)
  - **1977 Public Law 95-200 “Bull Run Act” (with 1996 and 2001 amendments):** *Defines the relationship between the Forest Service and the City regarding Bull Run Watershed. The 1996 and 2001 amendments included stricter logging prohibitions and extended the area of coverage of PL 95-200.*

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<sup>13</sup> New regulations, 313 CMR 11.00, were issued in February 2017, after most of the coding and data analysis was done for Chapters 4 and 5. These new regulations were issued in response to an Executive Order from the Governor mandating a review of all state regulations. There are no significant differences in content between 350 CMR 11.00 and 313 CMR 11.00.

- **2007 Bull Run Watershed Management Unit Agreement:** *Agreement between the City and Forest Service defining joint management in the watershed, pursuant to PL 95-200.*
- **2010 Chapter 21.36 of Portland City Code Bull Run Watershed Protection (amended in 2014):** *City ordinances regulating access to and management of Bull Run watershed.*
- San Francisco (5 documents)
  - **1913 Raker Act:** *Allowed the City of San Francisco to build a dam on National Park Lands, establishes sanitary regulations for the reservoir area, and defines the basics of the relationship between the City and the Park.*
  - **1961, 1985, and 1987 Stipulations from the Department of the Interior:** *Complement the Raker Act, defining rates of flow releases from O'Shaughnessy dam (in Hetch Hetchy) to maintain fish, wildlife, recreational, and aesthetic values of the Tuolumne River downstream.*
  - **2010 Memorandum of Agreement:**<sup>14</sup> *Second memorandum of agreement signed between the San Francisco Public Utilities Commission and Yosemite National Park for the comprehensive management of the watersheds that provide water to San Francisco.*
- New York (3 documents)
  - **1997 New York City Watersheds Memorandum of Agreement:** *Defines the relationships between the City, Watershed Communities, regulators, and environmental NGOs regarding management and protection of the watersheds.*
  - **2010 New York City Rules and Regulations:** *Regulations for protecting water quality on watershed lands owned by the City.*
  - **2014 New York State Department of Environmental Conservation Water Supply Permit:** *Authorizes the City to acquire parcels of land from willing sellers within the watersheds, and their use as a drinking water source.*

*Coding strategy: Institutional grammar tool*

Institutions (whether formal or informal), create incentives affecting actors' behavior, influencing their decisions. To better understand how formal institutional arrangements affect an actor's incentives in an action situation, Sue Crawford and Elinor Ostrom developed the Institutional Grammar Tool (IGT) (Crawford and Ostrom, 1995; 2005, Basurto et al, 2010, Siddiki et al, 2011). The IGT allows dissecting the components of statements that create responsibilities and assign rights to an actor or group of actors within a formal document. The unit of analysis in the IGT is the *institutional statement*, defined as a "shared linguistic constraint or opportunity that prescribes, permits, or advises actions or outcomes for actors (both individual and corporate)" (Crawford and Ostrom, 1995: 583). The IGT allows identifying the components of each institutional statement. Statements contain an *attribute*, which refers to the actor or group of actors that should, should not, or may do something. Institutional statements also include a *deontic* that captures whether the rule obliges, permits, or forbids an action. A third component of the IGT is the *aim*, which refers to the action that the statement is prescribing. The IGT also captures the *conditions* necessary for the action to take place; and the consequences for not following the rule, captured by the *or else* component. As part of the further development of the IGT, Siddiki et al (2011)

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<sup>14</sup> A new iteration of this agreement was signed in late 2016 after most of the coding and data analysis was done for Chapters 4 and 5. The only changes in the new agreement are a reorganization of Core Tasks to align them with the organizational structure of the National Park Service (as defined in the Park's Annual Reports), and a change in the term of the agreement from 5 to 2 years, to align it with the biannual budget of San Francisco.

included a 6<sup>th</sup> component, the *object*. This component identifies the animate or inanimate receiver of the action described in the aim and executed by the attribute in an institutional statement (Siddiki et al, 2011).

Table 3.1 shows the IGT applied to an institutional statement from the New York City Watersheds Memorandum of Agreement. The statement, extracted from Article 5 reads: “*The CW Corporation shall give written notice to the City at least 10 days before the transfer of any funds pursuant to this subparagraph (e).*”

**Table 3.1. Example of an institutional statement analyzed through the IGT**

Attribute	Deontic	Aim	Object	Conditions	Or else
CW Corporation	shall	give	City of New York	Written notice [...] at least 10 days before the transfer of any funds pursuant to this subparagraph (e)	

This coding strategy also allows categorizing statements into seven rule types identified in the Institutional Analysis and Development framework (Ostrom, 2005). By paying attention to the aim component of each statement, it is possible to classify statements according to which type of action they prescribe: *aggregation rules* refer to joint actions undertaken by two or more actors; *boundary rules* prescribe the criteria for entering or exiting a position created by the institution; *choice rules* prescribe the types of actions an actor can, cannot, or may do; *information rules* define prescribed or forbidden channels of communication among the actors; *payoff rules* establish mechanisms for exchanges of economic resources, impacting on the costs and benefits of an action in a given circumstance; *position rules* create specific roles to be filled by an actor; and *scope rules* determine the range of a variable that must, must not, or may be affected as the outcome of an action.

The documents listed above were coded applying the IGT. Documents from Boston, Portland, and San Francisco were coded by the author. A second coder was then assigned a random sample of statements to code.<sup>15</sup> Intercoder reliability coefficients were assessed as the percentage agreement across IGT components between coders. The average percentage agreement in Boston was 80.4%, in San Francisco was 74.57%, and 81.36% in Portland. In New York, documents were coded by a team of three coders.<sup>16</sup> Each coder was assigned an entire document section to code. Reliability coefficients were obtained by assigning a random sample of statements to one of the coders who did not code the section. Average percentage of agreement in New York was 84%. All four coefficients are within ranges observed in the literature applying the IGT (see for example Siddiki et al, 2015; Carter et al, 2016).

*Coding strategy: Mechanisms*

The second coding strategy focuses on bundles of *institutional statements*. This approach, developed by Schlager et al (2015, 2017) builds on the IGT for capturing groups of institutional statements creating *mechanisms* for monitoring behavior, addressing conflict, and imposing penalties for noncompliant behavior. A *mechanism* is a group of 2 to *n* institutional statements that, as a whole, prescribe how actor behavior should take place around a specific Action Situation.<sup>17</sup>

To identify mechanisms, data obtained using the IGT was coded focusing on the institutional statements in each document. First, institutional statements were grouped according to the sections of the documents in which they appear. Sections in a document were used to determine the beginning and ending of a mechanism. Within a section, each statement was coded based on whether it referred to

<sup>15</sup> Thanks to Ute Brady for her help as second coder.

<sup>16</sup> Thanks to Edella Schlager and Jeff Hanlon for allowing me to use this data.

<sup>17</sup> Appendix C presents the protocol for identification and coding of mechanisms.

*monitoring, conflict resolution, or consequence* activities. If all statements within a section were coded as, for example, monitoring, that entire section would comprise a monitoring mechanism. However, sections can include more than one mechanism. In fact, a section can include several consecutive mechanisms. Sequences interrupted by two or more statements coded both as the same mechanism type (different from the one in the sequence), were considered as a new mechanism within that section.

Data from Boston, Portland, and San Francisco was coded by the author. To assess intercoder reliability, a second coder was given a random sample of approximately 20% of the statements in each document.<sup>18</sup> Average percentage agreement between both coders in Boston was 78%, in Portland 77.8%, and 74% in San Francisco.

Just as with the IGT coding, data from New York was coded by a team of three coders.<sup>19</sup> Each coder was assigned an entire document to code. The other two coders were assigned 20% of the statements from the documents they did not code, to assess intercoder reliability. The average rate of agreement in New York was 85%.

#### *Categorization of mechanisms*

In addition to identifying instances of monitoring, conflict resolution, or consequences, Chapter 5 focuses on different subtypes of these three categories. Subtypes were identified following an inductive approach. After revising all instances of the three mechanisms, patterns of similar subtypes of mechanisms were identified.

For monitoring, four subtype categories were identified. Each category captures the main feature of the mechanism, thus each mechanism can only adopt one category. The categories are the following: *Unilateral report or review*, refers to a report produced by a single author regarding their own actions OR when only one actor is authorized to monitor or review the actions of others (for instance, by reviewing applications submitted by other actors); *Joint Work*, occurs when a group of actors jointly produce a report OR when a group of actors is authorized to monitor or review another actor's actions; *Generate Information* refers to the creation of repositories of information OR that an actor or group of actors must conduct a study to assess a situation. Unlike *unilateral report* or *joint work*, these mechanisms refer to the generation of new information regarding an issue affected by the hypothetical actions (or lack thereof) of a party to the agreement. For instance, in San Francisco; the 1987 Stipulation mandates a study to assess the potential effects of adding a third water turbine for electricity generation near Hetch Hetchy reservoir. Finally, *Water Quality* assigns responsibilities on monitoring water quality or quantity indicators.

In the case of Compliance, five categories were identified. Each mechanism can adopt only one of the following categories: *Third Party* refers to mechanisms where a third party (not a signatory of the agreement), such as another State Agency or Courts have the ability to decide over a compliance issue; *Definition* are mechanisms that determine whether an action should be considered legal or not but do not provide any guidelines on who or how should potential noncompliance issues be addressed; *In-House* are situations where the compliance problem is addressed by a group of parties to the agreement (includes ad-hoc arbitration processes); *Individual Party* is whenever the decider is a single actor and member of the agreement; finally, *Venue* occurs when the decider is an actor created specifically by the agreement (includes the creation of arbitration boards).

For Consequence mechanisms the following six categories were identified: *Easement restrictions* take place whenever a City actor is forbidden from purchasing land or easements on the watersheds; *Administrative Decisions* include things such as blocking the issuance of a permit, or the issuance of regulations issued by a party; *Compensation* occurs whenever an actor has to provide an economic compensation as a consequence of their noncompliant behavior; *Modify obligations* are mechanisms that cancel, suspend, or extend mandates defined in the agreement whenever an actor violates the rules;

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<sup>18</sup> Thanks to Brittany Volz for her help as second coder.

<sup>19</sup> Thanks to Edella Schlager and Jeff Hanlon for allowing me to use this data.

*Define rules that apply* state the circumstances under which specific sections of the agreement will be implemented as sanctions for noncompliant behavior; *Consequences for individuals* are consequences aimed directly and solely for individuals (non-signatories). For instance, in Portland, since Bull Run Watershed is closed to the public, rules establish consequences for trespassers.

### **Reports and plans**

Chapter 6 focuses on annual reports and plans listing and describing watershed protection activities conducted or to be conducted in each case. Decisions in each agreement are made through different mechanisms, involving different actors, and are summarized in documents of varying periodicity. For Chapter 6, a total of 75 documents were analyzed:

- Boston
  - **Watershed Protection Plans** (9 documents):
    - Quabbin Watershed: Years 1991, 2000, 2008, 2013
    - Wachusett Watershed: Years 1991, 1998, 2003, 2008, 2013
  - **Annual Reports produced by Massachusetts Department of Conservation and Recreation** (12 documents):
    - Both watersheds: Years 2005 through 2016.
- Portland
  - **Annual Reports produced by Portland Water Bureau** (9 documents): Years 2007 through 2015.
- San Francisco
  - **Annual Reports produced by Yosemite National Park** (14 documents): Years 2002 through 2015.
- New York
  - **Long-Term Watershed Protection Plans** (5 documents): Years 1993, 2001, 2006, 2011, and 2016.<sup>20</sup>
  - **Annual Reports produced by New York City Department of Environmental Protection** (7 documents): Only for years 2002, 2007, 2009, 2012, 2013, 2014, and 2016.<sup>21</sup>
  - **Catskill Watershed Corporation Annual Financial Statements:** (19 documents): Years 1997 through 2015.

### **Semi-structured interviews**

The analysis of formal documents was complemented with interview data collected by the author. Interviews helped categorize the context in which decisions on institutional design were made, to understand the evolution of watershed protection activities, and also helped inform some of the findings obtained through the analysis of formal documents. Chapter 4 uses interview data to assess the collective-action dilemmas faced prior to defining the main rules governing watershed management in each case. In Chapter 5, interviews help identify the transaction costs around institutional design, in addition to providing a qualitative assessment of how monitoring, conflict resolution, and consequence mechanisms are applied. Finally, Chapter 6 uses interviews to complement findings in the analysis of

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<sup>20</sup> After several requests, the 1996 LT-WPP was not obtained. This is the only LT-WPP missing from the analysis.

<sup>21</sup> These were the only Annual Reports accessed.

reports and plans, and to provide contextual information to understand patterns of adaptation in each case.

Interviews were conducted over the phone with key actors in the four settings. Given the geographical extent of each case, along with the distances between cases, phone interviews were preferred instead of in-person interviews. This provided a more cost-effective alternative for qualitative data collection.

Although phone interviews may seem more impersonal than in-person interviews, the specialized literature has found no significant differences between both modes in terms of quality or extent of data obtained. Studies comparing modes of data collection were conducted in the fields of education studies, public health, and criminal studies. Miller (1995), for instance, showed that telephone interviews seemed to be “not better or worse than those conducted face-to-face” (37). Greenfield et al (2000) compared abstention rates and found no differences across modes. However, the authors did find that phone interviews were biased against low-income respondents. This finding is not of concern for the studies in this dissertation, since all interviewees are representatives of public organizations who are not providing personal information, and the sampling strategy is not aimed at capturing representatives from different socio-economic groups.

Another concern with phone interviews is that the interviewer is not physically present in the same room as the interviewee. Because of the absence of face-to-face interactions, the researcher may miss important facial cues that could add to the interview. However, the literature shows no evidence of this between in person and telephone interviews (Miller, 1995; Sturges and Hanrahan, 2004). In addition, phone interviews do allow capturing verbal cues that can help the researcher reformulate a question or wait for the respondent to think an answer (Sturges and Hanrahan, 2004). In sum, in the context of this project, phone interviews provide an equally valid and reliable tool for data collection.

A total of 23 semi-structured interviews were conducted. Interviews were conducted by the author between the months of March and August of 2016 with representatives from the main organizations involved in watershed management in the four cases. Respondents were identified based on mentions in formal documents, and complemented by snowball questions. Interview protocols and materials were approved by the University of Arizona Institutional Review Board on March 11, 2016.<sup>22</sup>

- Boston: 6 interviews, representing the following organizations:
  - Massachusetts Water Resource Authority (MWRA)
  - Department of Conservation and Recreation, Division of Water Supply (DCR)
  - MWRA Advisory Board
  - Massachusetts Executive Office of Energy and Environmental Affairs
  - Water Supply Protection Trust
  - Watershed Citizens Advisory Committee (WSCAC)
  
- Portland: 3 interviews, representing the following organizations
  - Portland Water Bureau
  - Mt. Hood National Forest, U.S. Forest Service
  
- San Francisco: 6 interviews, representing the following organizations or divisions:
  - Yosemite National Park, National Park Service (NPS)
  - Hetch Hetchy Water and Power Division, San Francisco Public Utilities Commission (SFPUC)
  - Water Quality Division, San Francisco Public Utilities Commission (SFPUC)

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<sup>22</sup> Protocol Number 1603429545.

- Natural Resources and Land Management Division, San Francisco Public Utilities Commission (SFPUC)
- New York: 8 interviews, representing the following organizations
  - New York City Department of Environmental Protection (NYCDEP)
  - Coalition of Watershed Towns (CWT)
  - Catskill Watershed Corporation (CWC)
  - Delaware County Soil and Water Conservation District
  - New York State Department of Environmental Conservation (NYSDEC)
  - New York State Department of Health (NYSDOH)
  - U.S. Environmental Protection Agency (U.S. EPA)

Interviewees were first contacted by the author via email. The first contact included a standard letter of introduction describing the project, the author, and inquiring about the possibility of a phone interview. This letter was sent to every potential interviewee. Subjects who agreed to the interview were then asked to choose a date and time for their interview. Then, they were sent a copy of the questionnaire to be used in the interview, along with a Consent Form for them to sign if agreeing to be interviewed. Similar questionnaires were developed for each of the four cases.

The day of the interview, the author called respondents at the agreed upon time. Before starting with the questionnaire, interviewees were asked if they would accept to be recorded. Of the 23 interviewees, 4 declined to be recorded. For those interviews, the author took notes that were shared with the interviewees for them to add, edit, or modify. Recorded interviews were transcribed by the author. All but 1 interview required one session, and 2 others required a follow up call a few days later. The average interview time was 71:40 minutes, with the shortest interview taking 26 minutes, and the longest 3:29 hours (divided in two sessions).

## **Chapter 4: Collective-action dilemmas and Networks of Prescribed Interactions: The effects of Cooperation, Division, and Coordination dilemmas on institutional design**

### **Introduction**

Collective action problems can be addressed in multiple ways, usually depending on the characteristics of the dilemma. The number of actors involved, as well as the number and types of problems they address will have an effect in the solutions to be implemented. In recent years, the Institutional Collective Action (ICA) approach (Feiock, 2013) has studied how the characteristics of the relationships between a group of actors and the types of dilemmas they face affect their interactions and the institutions they create. Using Social Network Analysis tools, empirical applications within this tradition have studied how issues like the degree of interpersonal trust affect the structure of stakeholder networks (Berardo and Scholz, 2010), or how the characteristics of different services influence the structure of networks of contracts between actors providing those services (Andrew, 2010).

This chapter combines insights from the ICA approach with analytical tools developed within the Institutional Analysis and Development Framework (Ostrom, 2005) to develop and test hypotheses on how collective action dilemmas affect the patterns of interactions created by formal rules. Hypotheses are tested on four different institutional arrangements created to secure the production of unfiltered water to a metropolitan area. First, the relationships between the parties to each agreement are analyzed and categorized using secondary sources and qualitative data collected by the author. Second, the rules governing interactions in each case are analyzed combining the Institutional Grammar Tool (Crawford and Ostrom, 1995; 2005) and Social Network analysis methods.

Results show that the nature of a collective-action dilemma has similar effects on the design of institutions than those observed by the literature on behavioral networks. However, these effects are only distinguishable when actors are in the presence of cooperation dilemmas. Findings highlight the need of continuing studying the nuances regarding how coordination and division problems may affect the design of institutional arrangements and the role they assign to certain actors.

The rest of this chapter is structured as follows: first, a discussion of the different types of collective action dilemmas, what they mean, what are their effects, and how they should be addressed is presented. Second, the cases of Boston, New York, Portland, and San Francisco are presented, describing the main collective action problem faced in each case regarding the production of unfiltered drinking water. Third, the Network of Prescribed Interactions (NPI) approach is presented, along with a description of each case's NPI. And finally, the structural features of these NPIs are analyzed, discussing how the collective action dilemma that preceded the arrangements affected their design.

### **Collective-action: what is the difference between coordination, division, and cooperation?**

Problems addressed via formal institutional arrangements can assume infinite forms, from individual-level and single-item problems like sharing an irrigation system (Ostrom, 1990), to the multi-faceted problems experienced by sovereign entities when creating a new constitutional regime (Bednar, 2007). A characteristic common to all these problems is that they involve two or more actors engaging in collective action to address a common concern.

Game theory provides ideal types of collective action dilemmas. This typology is based on identifying the sources of disagreement between actors and the consequences of opportunistic behavior. Although authors often assign different names to them, in general it is possible to identify three ideal types: coordination, cooperation, and division problems. Coordination problems take place whenever actors would benefit from exchanging or producing goods or services because neither party could do it on their own. In these situations, the interpersonal risk lays on the difficulty of reducing transaction costs for the assignment of tasks and communication between the parties. Division problems occur when either the achievement of specific gains involves that some of the parties will suffer more losses than the rest, or that the parties have disagreements on how to distribute the costs or benefits of their joint work.

Finally, Cooperation problems emerge when actors have different goals and thus face incentives to behave opportunistically. In this case, the benefits earned by the self-interested individual will be fewer than the costs paid by the collective group, leaving the remaining actors in a worse off situation (Scharpf, 1997).

Game theory has represented these situations as archetypal games: the Prisoner's Dilemma is a classic example of a non-cooperative game. In this game, actors have little incentives to cooperate, and in the attempt of satisfying self-interest, outcomes are both individually and socially suboptimal. Another example is the Assurance game, which is similar to a "pure coordination" dilemma (Scharpf, 1997). Unlike with the Prisoner's Dilemma, in the Assurance game both actors have incentives to work together and the best payoff is obtained when both actors cooperate (Steinacker, 2004). However, if one of the actors does not cooperate, both parties will end up with the worst possible outcome. Finally, the Bargaining game is a good example of division dilemmas. The game captures situations where actors agree on their goals but disagree on how to divide the benefits of their joint work. In this game, cooperative solutions are likely to occur whenever both parties have similar advantages (Steinacker, 2004). The Battle of the Sexes is also an example of a division problem. In this case, both actors have incentives to cooperate, but have different preferences on how that cooperation should occur. However, both parties prefer cooperating and being defected on than not participating at all (Scharpf, 1997).

In the last two decades, different literatures have paid attention at how collective-action dilemmas affect institutional design and which policy tools are available to address those dilemmas. For instance, the literature studying contracts for service delivery in urban and metropolitan areas has used concepts from transaction cost economics and game theory to study how contracts address the risks involved in cooperative actions. Maser (1998), for instance, studied how collective-action dilemmas shape the design of constitutional documents. Combining insights from transaction cost economics and contracting theories, Maser (1998) analyzed the design of 145 municipal charters in the U.S. and identified how constitutional arrangements include different types of institutional safeguards to address coordination, division, and defection dilemmas.

From a more strict transaction cost approach, authors have also paid attention to what factors make governments more prone to contract out the provision or production of certain goods or services (i.e. Brown and Potoski, 2003), or how the characteristics of a public good affect the design of government contracts (Brown et al, 2016). In addition, the Institutional Collective Action approach (ICA) (Feiock and Scholz, 2010; Feiock, 2013) has also included ideas from transaction cost economics to understand joint production decisions in the context of local governments in urban areas (Carr and Hawkings, 2013).

The ICA approach pays attention to the mechanisms governments implement to address the risks involved in collective-action. The characteristics of the problems play an important role in the way governments react. The central argument of the ICA is that "Mechanisms with the lowest decision costs will be most efficient for resolving ICAs with the lowest transaction costs" (Feiock and Scholz, 2010:15). The ICA states that coordination, cooperation, and division are common problems that arise whenever governmental actors attempt to create joint arrangements with others (Carr and Hacketorn, 2013). These problems create different types of risk between the actors involved. This *risk* is always interpersonal, but can adopt multiple forms: it can refer to risks of defection (when an actor may not comply with the rules), risks of division (when actors may disagree in assigning costs or distributing benefits of their joint work), or risks of coordination (regarding the aggregation of responsibilities for achieving complex tasks).

Each of these problems highlights one feature of a collective-action dilemma requiring specific responses. For instance, cooperative problems like the Prisoner's Dilemma demand for credible commitments that eliminate or reduce the possibilities of mutual defection (Scharpf, 1997). Alternatively, in coordination problems the risk lies in not being able to effectively synchronize each party's role, thus hampering the collective's ability to produce or provide the good in question. Instead of worrying about noncompliance with the rules, actors facing coordination problems are focused on being organized so that interjurisdictional goods or services are provided efficiently. Coordination

problems, in general, require mechanisms that facilitate communication and decision-making (Feiock, 2013). Finally, division problems may hinder collaboration efforts if actors are not able to effectively assign costs and benefits. One of the reasons why this occurs is because the preferences of actors are often unclear for the other parties, and making them explicit can turn costly in negotiating an agreement. As a result, actors face the risk of stalling the negotiations, making them inefficient, and potentially not addressing the problem at stake (Miller, 1992). Division dilemmas require mechanisms that favor decisiveness over the distribution of resources. A potential solution to these dilemmas lies in the creation of hierarchical structures that can unilaterally allocate costs and benefits on the parties (Miller, 1992; Feiock, 2013).

In the past decade, myriad empirical analyses have tested hypotheses from the ICA approach applying network-analytical tools. Most of these studies have focused on behavioral interactions: either informal relationships among stakeholders to understand how they complement formal arrangements (Berardo 2010); or contracting dynamics, analyzing the structures linking governmental actors and service providers in metropolitan areas (Andrew 2010; Shrestha, 2010). This chapter focuses on the structures of interactions created by formal rules<sup>23</sup> and how the interactions they prescribe vary when actors face different collective-action problems. By observing how rules create patterns of information flow, resource exchange, relationships of authority between actors, and how they allow or block actors from participating in decision-making arenas, we can better understand the structural features of these relationships and compare them with theoretical arguments developed through the observation of behavioral networks.

Berardo and Scholz (2010) argue that the structure of policy networks varies depending on the nature of the social dilemmas they face. The “risk hypothesis” (Berardo and Scholz, 2010), posits that actors select ties in order to mitigate interpersonal risk. As a result, the structure of their networks will be affected by the nature of the social dilemma they perceive. “Low risk” coordination dilemmas occur whenever actors share the same goals, have little incentives to defect, but have trouble agreeing on a shared course of action (Berardo, 2014). In this situation it is important to have access to high-quality information as efficiently as possible. Networks in these settings tend to adopt bridging-like structures, encouraging the access and distribution of unique information. On the opposite, in high-risk cooperation situations where actors do not share the same goals and have little incentives to collaborate with others, networks adopt bonding-like structures. Cooperation dilemmas demand for credible information and commitments that the other parties will honor their obligations. As a result, their networks will adopt redundant and overlapping structures for the exchange of information.

In spite of the more recent developments within the ICA, conceptual and operationalization issues often prevent assessing how each type of collective-action dilemma (cooperation, division, and coordination) affect behavior or institutional design. The “risk hypothesis” pointed out the behavioral consequences of two of such dilemmas (cooperation and coordination), recognizing that situations are more complex than high-risk/cooperation or low-risk/coordination problems, especially when analyzing dynamics over time (Berardo, 2014). Hypothesis 1 combines insights from the risk hypothesis with the ICA approach and game theory to understand how networks of interactions mandated by formal rules should in the presence of different collective-action problems.

Cooperation problems require mechanisms to address and reduce defection. In these circumstances, the literature studying behavioral patterns of interactions has found that actors opt for developing bonding relationships (Berardo and Scholz, 2010; Berardo, 2014). Access to high-quality information about other actors’ behavior is useful in the governance of a shared natural resource, where the social and natural aspects of resource management are interdependent. When facing cooperation

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<sup>23</sup> The IAD framework highlights the difference between rules-in-form (formal rules in paper), and rules-in-use (which guide and constrain behavior, and are comprised both of formal and informal rules). Although some rules-in-form may not be enforced as much as others, this paper focuses on the formal rules in each of the cases.

problems in these contexts, formal institutional arrangements should favor the generation and distribution of redundant information so as to quickly monitor and sanction opportunistic behavior.

In coordination problems, the source of the dilemma lays not on the possibility of defection, but on the risk that uncoordinated actions may have for the collective. In these situations, the individual and collective payoffs are higher when actors coordinate with one another. Thus, contributing with collective action is the dominant strategy. However, in order to effectively coordinate with each other, actors must be aware of everyone else's actions, so as to align their actions to the group. Doing so demands of structures of interaction where information can reach everyone in the network as quickly and efficiently as possible (Berardo and Scholz, 2010). In network terms, this can be achieved through structures that facilitate bridging over bonding. Therefore, formal institutional arrangements addressing coordination problems should favor the efficient distribution of information through bridging structures.

Finally, division problems are similar to coordination problems in that in both cases the dominant strategy is to engage in collective action (as opposed to self-interested behavior). The difference is that in division problems (and in problems with conflict over distribution), if both players collaborate, the outcome will not be the optimal one. For instance, in the Battle of the Sexes game, both actors have different preferences over where they would like to go out. Even in the presence of communication between them, each actor will still prefer one combination of choices over the other (i.e. going out to the place they prefer over going to the place their partner prefers). However, both actors prefer going out with each other than staying at home. As a result, even though one actor must sacrifice their most preferred option, the outcome of still going out is preferred to staying at home.

The Battle of the Sexes game is a good example showing that even in the presence of division problems, communication and negotiations will not always lead to socially optimal results (Scharpf, 1997). An alternative is to facilitate decisiveness in decision-making. To avoid the costs involved in negotiating an action, a directed choice may enable decision-making and yield similar results. Therefore, in order to reduce transaction costs and facilitate collective action, institutional arrangements addressing division problems should rely on a small group of actors in charge of decision-making. In network terms, this would be represented in highly-centralized structures where a small group of actors are able to decide and communicate their decisions to the rest of the network.

*H1.A NPIs created to address Cooperation problems will present bonding-like structures, with redundant and overlapping ties between actors.*

*H1.B NPIs created to address Division problems will present high centralization*

*H1.C NPIs created to address Coordination problems will present bridging-like structures and less centralization than in situations of Division problems.*

Different collective action dilemmas may make some actors more popular and active than others. Popular actors are those that receive a large amount of ties from all the actors in a network. Active actors, on the other hand, are those that send a large amount of ties to all the actors in a network. The risk hypothesis in particular and the general literature on behavioral policy networks highlight the importance of resource differentials in making some actors more active or popular than others (for instance, Henry, 2011 or Leifeld and Schneider, 2012). This effect is often observed for governmental actors in policy networks, because of their access to larger organizational resources. Governmental actors in policy settings often have the authority to make and impose decisions over other actors in a network (often times making them very active in the network), thus making them the target of other actors in the network who want to influence those decisions or be aware of their actions (often times making government actors highly popular in a network). Those effects, however, have been captured for behavioral networks where actors have more flexibility in deciding who they interact with. In the case of NPIs, relationships are mandated by formal rules, and as such, actors cannot change them in the short

run. Moreover, the cases studied here focus on intergovernmental agreements, thus all (or a majority of) the actors in these NPIs represent a level of government. Notwithstanding, NPIs should reproduce some of these situations, product of the power imbalances between actors of different kind. In the particular cases studied here, most of the actors are governmental. However, the degree of relative influence and the interests of some actors (particularly City actors) in these networks could result in similar patterns of activity and popularity.

NPIs reflect the interactions prescribed by formal institutional arrangements. These arrangements are designed to deal specifically with the nature of the social dilemma at hand. Therefore, NPIs should define roles for specific types of actors. The cases studied here have one common denominator: a City actor or metropolitan water provider interacts with Federal, State, or Local actors to protect water quality sourced from other jurisdictions. Depending on the nature of the dilemma, institutions should divide responsibilities differently.

In the cases studied here, City or water providers have a special interest in making the agreements work. The expectation, therefore, is that in these circumstances City actors will be more active and popular than the average actor in the NPI. However, in cooperation NPIs, responsibilities should be assigned differently. A characteristic of cooperation dilemmas is the risk of defection, which actors respond to by creating redundancy in their ties. Therefore, the level of popularity and activity of City actors should be indistinguishable from other actors in the NPI.

*H2.A When facing Coordination or Division dilemmas, City actors will be more active and popular than non-City actors in the NPI.*

*H2.B When facing Cooperation dilemmas, City actors will be equally as active and popular than non-City actors in the NPI.*

**Table 4.1. Measures used to assess concepts of interest**

<b>Network concept</b>	<b>Measures used</b>
Bridging	Betweenness, Eigenvector
Bonding	Density, Transitivity, reciprocity
Centralization	Network centralization (in-degree and out-degree)
Actor activity	Out-degree
Actor popularity	In-degree

**The cases: collective-action dilemmas in the production of unfiltered drinking water**

This chapter analyzes the dilemmas faced in Boston, New York, Portland, and San Francisco prior to the creation of institutions for the governance and production of unfiltered drinking water. In order to deliver unfiltered water, water providers must satisfy criteria defined by the U.S. Environmental Protection Agency. These criteria, established in the Surface Water Treatment Rule (SWTR) of 1989, require providers to demonstrate control human activities in the watersheds via ownership and or agreements with the landowners. These four cities have some form of agreement regulating their interactions with the owners of land around their water sources. In each case, the City or regional water provider has had relationships with the landowners for almost a century. However, the SWTR required new agreements creating specific watershed protection programs for maintaining the quality of these resources, as well as clarifying ownership and management responsibilities. In cases like New York, the arrangement was created from scratch, defining the interaction and decision-making dynamics between the parties, whereas in other cases (Portland, for instance), the agreement was anchored in pre-existing

federal legislation. In those cases the agreement did not define the entirety of relationships between the parties, but rather specified how they would manage the resource and address recent issues.

This section describes the collective-action dilemmas faced prior to the signing of these agreements. Data from this section was gathered through secondary sources (publications on the history of each of these cases) and semi-structured interviews conducted by the author. Interviews were conducted with key representatives from the most important organizations in each case. Respondents were asked to define the relationship between the parties prior to signing the agreements regarding filtration avoidance. Responses were analyzed for indications of disagreements over overarching goals, over implementation of shared goals, or over distribution of costs and benefits.

For the City water providers, the goal is to ensure that landowners from a different jurisdiction collaborate in a way that is accepted by all parties. For landowners, the goal is to collaborate with the City while still maintaining ownership and the ability to make their own independent decisions.

Building on the above discussion, coordination, division, and cooperation problems are defined in the following way. Cooperation problems occur whenever two or more parties have different goals, and whenever the unilateral actions by one party will have negative consequences for the others. This definition captures, first, the existence of conflicting interests between the parties (Feiock, 2013), which makes it difficult to find incentives to collaborate and increases distrust towards others. And second, a result of conflicting interests is a tension between group rationality (collaborate to obtain the common good) and individual rationality (behave opportunistically or without considering the effects on the other parties) (Miller, 1992). Cooperation problems will occur in the presence of different and conflicting goals between actors leading to disagreements between them.

Coordination and division problems share a common characteristic that distinguishes them from cooperation problems. In coordination and in division problems, actors have a shared understanding on the goals of collaborating. However, in the coordination case, actors may disagree in the way those goals may be achieved. These problems should occur whenever actors agree in the need of collaborating but have different ideas on how to fulfill those goals. In division problems, the common goal of collaboration may have multiple equilibria. Although actors agree on the overall goal, they disagree on how to divide the costs or benefits of such collaboration. Division problems should occur when actors have similar collaboration goals but disagree on the distribution of benefits or funding responsibilities.

### *San Francisco*

Drinking water in San Francisco is provided by the San Francisco Public Utilities Commission (SFPUC), a municipal utility. SFPUC provides water to a total of 2.6 million people in the Bay Area and neighboring communities. One third of that water is directly provided to the consumers in the City of San Francisco, and the other two-thirds are sold to water providers in the counties of Alameda, Santa Clara, and San Mateo.<sup>24</sup> 85% of SFPUC's water comes from the Hetch Hetchy reservoir, located within Yosemite National Park. The geography of the area, along with the relative low human activity makes Hetch Hetchy's water of exceptional quality. Because of this, and the watershed control activities conducted in the area, SFPUC is allowed to provide Hetch Hetchy water for human consumption without filtering it.

The City of San Francisco (represented by SFPUC) and Yosemite National Park signed their first Memorandum of Agreement (MOA) in order to comply with SWTR mandates in 2005. The agreement defines the implementation of watershed control programs for maintaining the quality of the water resources. The agreement is rooted in the Raker Act of 1913, which granted the City access to National Park lands for constructing a reservoir and established sanitary provisions for water quality.

The MOA rests on having the City fund Park activities and projects to maintain the quality of the water in the watershed. The activities implemented by the Park include installing and maintaining proper

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<sup>24</sup>SFPUC. *About us*, available online at: <http://www.sfwater.org/index.aspx?page=355>. Last retrieved, September, 2016.

infrastructure, briefing Park visitors that they are entering a water supply, and policing the watershed, among others. In addition, the Park Service continues to manage the watershed following Park mandates.

Although the creation of the National Park Service (NPS) did not occur until three years after the passing of the Raker Act, the NPS never fully opposed or challenged the installation of a reservoir in Hetch Hetchy. However, this does not mean that the Park blindly followed San Francisco's will. The Raker Act allowed the City of San Francisco to exploit federally-owned resources. The NPS, on the other hand, wanted to avoid the City from encroaching territory other than the one granted by the Act, and closely enforced the Raker Act (Righter, 2005). Besides these differences during the early years of the Raker Act, the literature and interviews do not mention signs of overt conflict between the parties.

The construction of a dam within National Park lands was (and still) is a politically-charged issue. Yet, both NPS and SFPUC distance themselves from the debate, focusing exclusively on accomplishing their goals of providing high quality water and protecting it at the source (Simpson, 2005). *"It's one of those things that the people here, in the park and in the city, we've inherited that legacy, and we do the best we can to both manage the water system, and they manage the park under the terms of the agreement that we have. And, there's always going to be an interest in the reservoir and the dam, that's how always have been; it's never going away."* (SFPUC Representative. Personal Communication, April 11, 2016). In similar words, a NPS representative mentioned that *"Maybe it wouldn't have been our choice [having the dam in the park], but 'it is what it is'. We, as a bureaucratic entity, have no opinion about it"* (Yosemite National Park Division Ranger, Personal Communication, April 12, 2016). According to the Raker Act, the City must pay NPS \$30,000 every year in concept of trail maintenance and "other improvements". In addition, the City has been funding Park-proposed projects from even before the 2005 agreement (Simpson, 2005).

In the past decades, a series of changes and modifications to the Park's and City's mandates have provided even more incentives for collective action to these parties. The Park has a Federal mandate to protect their lands, especially in the Tuolumne River, which is within the area designated as wilderness status in Yosemite National Park. In the case of San Francisco, the Raker Act of 1913 and the interest for a Filtration Waiver forced the City to pay even more attention to water quality and watershed protection issues. These changes brought the parties even closer, defining a shared goal: the protection of the resources in the area.

The existence of common goals is recognized in the interviews. An interviewee mentioned that, before the 2005 agreement *"the Park and the City of San Francisco worked to the same goals. We had the same overarching objectives in the watershed, providing clean, pristine water. So, all of our goals and visions were matched exactly the same [...] in fact, everything in the MOA was already being done, but now there was a paper on it. [...] We are dealing with the Park Service, their goal isn't making mining or drilling or anything like that. So we have the same goals, so it wasn't difficult"* (SFPUC Representative. Personal Communication, May 2, 2016).

Notwithstanding the compatibility in their goals, another theme emerged throughout the interviews: the importance of defining who is going to bear the costs of watershed protection. Per Raker Act mandates, and prior to signing the first agreement, SFPUC had provided the funding and the Park implemented watershed protection programs. However, issues often emerged regarding the proper use of those funds. When discussing the role of the MOA, a SFPUC representative mentioned *"There is a lot of money that goes into this, and we wonder where it's going and we want to make sure that it's directed towards activities that are supported in the Raker Act"* (SFPUC Representative. Personal Communication, May 2, 2016). The 2005 agreement addressed this by formalizing a budgeting and funding process. In it, the Park drafts a budget including the programs and activities they would like to conduct over a 2-year period. The draft is then analyzed by SFPUC and modified based on the agency's resources. Since the overarching goals of the National Park Service go beyond just watershed protection, the City often has to carefully analyze the scope of the proposed projects, and *"Some of those details go back and forth about how much we think they need to do versus how much they would like to do and can do"* (SFPUC Representative. Personal Communication, April 11, 2016). Both SFPUC and Park

representatives are aware of this, and try to act accordingly: *“One of the things that happen in organizations is that when people spot funding sources, people come rushing in. The City wanted to make sure that other divisions weren’t coming in and cherry-picking the PUC”* (Former Yosemite National Park Division Ranger, Personal Communication, July 29, 2016).

Evidence shows that the Park and SFPUC had an overall shared understanding based on similar goals prior to signing their 2005 agreement. These goals are fueled by different motivations: for San Francisco is about providing safe and reliable drinking water, whereas for NPS is about resource and wilderness protection. These goals had been memorialized mostly throughout the Raker Act and then developed over time, addressing potential issues that could emerge. This does not mean that there were no issues prior to the 2005 agreement. The only disagreements were minor coordination issues and a few division issues regarding the scope of funding responsibilities in the years prior to the first MOA.

The two main legal documents guiding the relationship between the City and Yosemite National Park are the Raker Act from 1913 and the Memorandum of Agreement. Of these two, the 2005 Memorandum (later modified in 2010 and in 2016) was the one addressing the coordination and division issues discussed above.

### *Portland*

The Portland Water Bureau (PWB) is the City agency in charge of providing drinking water services in Portland. PWB water is mostly obtained from the Bull Run watershed, located within Mt. Hood National Forest. This water is provided unfiltered to a population of approximately 958,000 people within Portland’s metropolitan area.<sup>25</sup>

In 2007, PWB and the United States Forest Service (USFS) signed an agreement dividing responsibilities for the management of Bull Run. The goal of the agreement is *“to try as much as possible to put activities into one court or the other in terms of primary responsibility [...] The intent was really to have not a whole lot of things that would be a joint action”* (PWB Representative, Personal Communication, June 13, 2016).

The Portland case shares characteristics with San Francisco: in both cases, the local public utilities obtain high-quality water from federally-owned lands. As a consequence, Portland and San Francisco had to deal with only one major actor: a federal agency. However, there are important differences. First, Portland had to interact with the Forest Service, which had a different approach to land management than the NPS. Second, the land from where Portland obtains its water (the Bull Run Watershed Management Unit – BRWMU) is closed to the public. Thus, managers do not need to consider camping, hiking, or hunting interests when making decisions about BRWMU. In addition, the history of the relationship between the City of Portland and the Forest Service is more complex than in San Francisco. Throughout most part of the 20<sup>th</sup> Century, Portland and the Forest Service had conflicting goals with regards to managing BRWMU.

These differences help understand the interactions between the City and USFS. During part of the 20<sup>th</sup> Century, PWB and USFS had a conflictive relationship regarding timber harvesting. Although federal legislation from 1904 had declared the BRWMU closed for public access and assigned it as a drinking water source, the second half of the Century saw an increase in logging in BRWMU. During this time, the USFS had to comply with contradicting mandates, on one hand protecting Bull Run as a drinking water source. On the other hand, the Multiple Use - Sustained Yield Act of 1960 mandated USFS to make use of the timber resources in the area, in addition to providing drinking water for Portland. These differences would be the root of cooperation problems that extended throughout most of the century.

During this time, both parties had conflicting goals, and neither of them was showing signals of changing their views. The City was increasingly worried about how timber extraction was affecting

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<sup>25</sup> Portland Water Bureau, “What we do?” Available at: <https://www.portlandoregon.gov/water/48904>. Last retrieved, September, 2016.

water quality. USFS had the mandate to encourage multiple uses of their land, and was facing pressures to maintain timber harvest as their most important source of income. During this time, the relationship between the parties was difficult. *“I think then we had some conflict at a higher, bigger picture scale, because they had a management direction from Congress to manage for multiple use which included timber cutting. [...] So they had direction to go that way, we had concerns about what effects would that have on water quality, and we were also representing a constituency and the City of Portland that was becoming increasingly uncomfortable with how much logging was occurring in federal forest land”* (PWB Representative, Personal Communication, June 8, 2016).

In 1977, in response to a lawsuit from a Portland physician, Congress passed legislation establishing stricter regulations for the extraction of timber, and created conflict resolution mechanisms between the parties (Public Law 95-200). However, it would not be until 1994, with the Northwest Forest Plan that the relationship between both parties would change. The trend continued with modifications to PL 95-200 in 1996 and 2001 forever ending commercial logging practices in BRWMU. The pivotal role of these changes is highlighted by PWB representatives, who mention that it *“was a major change in direction for the Forest Service across the Pacific Northwest region, but also specifically in Bull Run. It caused a change from a multiple-use approach to land management, to a custodial approach to land management in Bull Run”* (PWB Representative, Personal Communication, June 8, 2016).

The changes imposed by the Northwest Forest Plan and subsequent federal legislation signified a turning point in the history of Bull Run, eliminating the primary policy difference between the parties, and promoting joint objectives and responsibilities (Larsen, 2006). These changes in mandates ended the period of cooperation issues, opening the door to a new era of collaboration.

During the post Northwest Forest Plan era, the parties increasingly shared the same goals of maintaining the quality of the resources. However, as a consequence of the logging prohibitions, the activities conducted by the Forest Service in the area and their revenue diminished considerably, affecting its staff and capabilities. Finally, after more than 6 years of negotiation and incorporation of public input, a Bull Run Watershed Management Unit Agreement was signed between the USFS and PWB in 2007. This agreement addressed a series of coordination issues that remained as a consequence of the updates to PL 95-200. The agreement provided an updated framework for the management of BRWMU, in which *“the purpose of the agreement was to deal with this budget constraint and this staffing constraint by just giving each other a little bit more freedom to do the things that we were sort of more responsible for, and that the other agency didn’t really need to be involved in the details of”* (PWB Representative, Personal Communication, June 8, 2016).

Throughout most the 20<sup>th</sup> Century, both actors faced cooperation problems in the management of Bull Run. During that time *“the mission[s] of the City and the Forest Service were at odds”* (USFS Mt. Hood Representative, Personal Communication, June 22, 2016). However, external interventions via the Northwest Forest Plan and reforms to PL 95-200 in 1996 and 2001, altered the nature of the relationship. Since USFS no longer had incentives to log in the area, its main objective became to act as a custodian of the natural resources in BRWMU. This aligned the goals of both agencies: *“There was a time when I think the Forest Service and the City disagreed on whether or not logging activities negatively affected water quality. I think there was just a fundamental disagreement. Then there was a lawsuit in 1976 that basically challenged the Forest Service’s practices [...] Post 1976 [...] there was this agreement that logging practices should not and could not impact water quantity and quality, but then there were still disagreements about whether or not a particular category fell on to that category or not”* (PWB Representative, Personal Communication, June 13, 2016).

The changes and updates to federal legislation switched the relationship from mostly a cooperation and enforcement problem to one of coordination, almost ten years prior to the signing of their agreement. In 2007, the Agreement was signed to define in more detail how coordination would occur. Soon after the agreement, in 2010, the City of Portland enacted a City Ordinance applicable to BRWMU. This ordinance created operational-level rules for city-owned land in the BRWMU that were

compatible with the federal mandates guiding USFS actions on federal land in Bull Run, namely a prohibition on timber harvest. The 2007 agreement and the 2010 City Ordinance are considered for this analysis.

### *Boston*

Boston's water is managed by two State-level agencies: the Department of Conservation and Recreation (DCR) and the Massachusetts Water Resource Authority (MWRA). MWRA is a public independent authority created in 1984, in charge of providing wholesale water and sewer services to 2.5 million people in 61 communities throughout the Boston metropolitan area.<sup>26</sup> Unlike the other three cases, Massachusetts is the only one where the City is not in charge of demonstrating compliance with the SWTR. In this case the responsibility belongs to MWRA and DCR.

Water is sourced from three watersheds: the Quabbin, Wachusett, and Ware. The Department of Conservation and Recreation (DCR) is a State Agency within the State's Office of Energy and Environmental Affairs. DCR was created in 2003, assuming the responsibilities previously held by the Metropolitan District Commission (MDC). DCR is in charge of managing the lands and ecosystems surrounding the reservoirs from where MWRA obtains its water. Per State Legislation, MWRA entirely funds DCR's budget. In 2004, MWRA and DCR signed a Memorandum of Understanding (MOU) defining responsibilities for the management of the water sources.

Unlike San Francisco and Portland, the watersheds in Boston are located on lands owned by local governments. However, the involvement of the City of Boston and watershed towns is indirect at best.<sup>27</sup> All watershed management decisions are made by DCR and MWRA, representing ratepayer communities in the metropolitan area and Central Massachusetts.

The Boston case presents a more nuanced relationship between communities and City representatives regarding resource extraction. Ever since City interests (indirectly through a State agency) settled on eastern Massachusetts, an anti-urban feeling emerged in these communities. However, differences between Boston (the agencies managing the watersheds) and the communities in Eastern Massachusetts never reached the levels of antagonism than in New York (Nesson, 1983). A study conducted in 1995 surveyed 765 residents of the Wachusett reservoir, the most urbanized of the watersheds. The survey asked about attitudes towards the managers of the watersheds. Surprisingly, a majority of respondents showed positive perceptions of the water managers, and although they exhibited some distrust towards urban interests, a majority of these respondents expressed interest in maintaining a partnership with watershed managers to increase water protection (Steinberg and Clark, 1999). This sentiment is also present on the other side of the table, when comparing the relationships between towns and city in New York with the ones in Massachusetts, an MWRA representative said: "*We never had that meltdown. I wouldn't say that we had a perfect relationship with the towns in the watershed, [but] we never got to that level of political disaster [...] It was a much more friendly, a much more responsive relationship*" (MWRA representative, Personal Communication, June 3, 2016). This does not mean the total absence of differences, but these shared favorable opinions are a good indicator of the lack of "overt antagonism" (Steinberg and Clark, 1999) between these actors.

Since its creation, DCR has maintained a close working relationship with MWRA. This good relationship is based largely on a shared organizational history. DCR was created to replace the Metropolitan District Commission (MDC) in 2003. MDC was in charge of managing the watersheds as well as providing wholesale water and sewer services to the metropolitan area, and did this single-handedly for almost 80 years. In 1984, the MWRA was created to assume the wholesale of water and sewer, leaving MDC in charge of managing the watersheds. DCR replaced MDC, and began working with MWRA in maintaining the quality of the drinking water supply. As result of the shared

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<sup>26</sup> About the MWRA: <http://www.mwra.com/02org/html/whatis.htm>. Last retrieved August, 2016.

<sup>27</sup> Although this is referred to as the "Boston" case, the official water provider and who received the filtration waiver is the MWRA, and not the City of Boston.

administrative past, members of both agencies maintain personal relationships, which facilitates collaboration. Even today, there are agents in DCR who started their careers in MDC, then worked for MWRA, and were later hired by DCR.

In the early 90s, when MDC was still in place, both agencies faced coordination and division issues: *“there were places where we [MWRA] had a crew and a land mower, but didn’t have any land, and other places where they [MDC] had a crew and a land mower and we had land”* (MWRA representative, Personal Communication, June 3, 2016). These inconsistencies in State legislation led both agencies to create a series of Memorandums of Understanding to better divide responsibilities. With the creation of DCR, those agreements had to be replaced by updated prescriptions that not only assigned responsibilities, but also incorporated filtration avoidance mandates, leading to the signing of the 2004 MOU.

State legislation regulating watershed management in MWRA watersheds (Chapter 92 A ½ of Massachusetts General Laws) mandated MWRA to fund MDC/DCR, but curtailed MWRA’s ability to say how those funds would be used. Throughout this time, *“the MDC was part of a State Agency and they had their own bureaucratic rules about hiring and spending money, and even though the MWRA was reimbursing them for expenditures, it didn’t always work that successfully”* (DCR Representative, Personal Communication, June 11, 2016). This caused frustration within MWRA, a member of the MWRA Advisory Board defined the situation in the following way: *“you probably haven’t heard of the old Bill Parcells line. When he was coach of the Patriots, there was this whole thing, and when he left, he said: ‘you know, if you’re not going to allow me to pick the groceries, how can I make the dinner?’ So, similar, the frustration arose dramatically that if we’re not allowed, even though we’re spending the money, we’re not allowed to participate in the decisions, how are we going to progress?”* (MWRA Advisory Board representative, Personal Communication, July 14, 2016). These differences point towards division issues between the parties, where one of them was not satisfied with the distribution of costs of activities that were beneficial for all.

In response, the State Legislature created a Water Supply Protection Trust in 2004. The Trust is composed of representatives from the State Office of Environmental Affairs, MWRA, the MWRA Advisory Board, and two watershed users’ representatives. The new legislation removed DCR from the Massachusetts budget and placed it under the scope of the newly created Trust. This allowed MWRA to have more control over DCR’s budget requests, as well as insulating DCR from State-wide managerial decisions regarding budget cuts or management of personnel.

In sum, the relationship between the main actors managing Boston’s water resources has always been of standing collaboration. The way they jointly manage these watersheds is defined in four formal documents: the Watershed Protection Act (revised in 2003), a 2004 MOU between DCR and MWRA, the Water Supply Protection Trust Act of 2004, and rules and regulations issued by DCR for watershed management (350 CMR 11.00).

### *New York*

New York City obtains its drinking water from the Catskills, Croton, and Delaware watersheds, located 125 miles north of the City. Of all four cases, New York has the longest history of conflict. In addition, New York presents the most complex decision-making and regulatory structure.

The long history of conflicts reached a breaking point in 1997, when Local, City, State, and Federal representatives signed a Memorandum of Agreement (MOA). The agreement puts in place a complex set of mechanisms for collective decision-making and payment for ecosystem services, where the City provides the funding for economic and infrastructure development in the area. Although the City provides the funding, most operational-level decisions regarding program implementation are made through a regional venue called “Catskill Watershed Corporation” (CWC). The CWC is composed of representatives from the City, State, and elected officials from watershed towns. The agreement also created a regional conflict resolution venue, the “Watershed Protection and Partnership Council” tasked with monitoring program implementation and working as a local instance for conflict resolution.

The MOA is complemented by a Filtration Avoidance Determination (FAD) issued by the New York State Department of Health, a Water Supply Permit (WSP) issued by the New York State Department of Environmental Conservation, and Rules and Regulations issued by the City (R&Rs). The FAD authorizes the City to use unfiltered water for drinking purposes and mandates watershed management and conservation programs. The Water Supply Permit authorizes the City to use the watersheds as a water supply and to acquire land in the area. Finally, the R&Rs regulate watershed activities. The Memorandum of Agreement operates as the constitutional document that provides the overall framework for the interactions among actors for the management of the resources. The FAD, WSP, and R&R constitute safeguards that define the operational aspects of the MOA (Hanlon, 2015), and provide for the creation of credible commitments between the parties. Unlike Boston, both the City (water provider) and watershed communities play an active role in the governance of these resources.

Conflict in the watersheds started in the late 19<sup>th</sup> Century, when the State of New York granted the City the power of eminent domain to claim rights to lands on these watersheds. This allowed the City to build reservoirs in the area, flooding existing towns and forcing people to relocate. Throughout the 20<sup>th</sup> Century, the City managed their watersheds paying little to no attention to local interests. During this time, the City and landowners were constantly suing each other over payments for land owned by the City, and over City actions that prohibited local communities from using resources from their own watersheds. This encroaching from the City left marks that are present even today in some of the older inhabitants of the watersheds. As one interviewee mentioned, *“There was a lot of animosity between the locals. They hated the City. I grew up hating the City [...] they moved us out and scattered us to the four winds.”* (CWC representative. Personal Communication, June 17, 2016).

The conflict assumed new dimensions in the early 90s, when in a first attempt to comply with SWTR, the City distributed a draft of their new Rules and Regulations. *“The City was proposing to do certain things in order for it to be able to demonstrate that it could receive a filtration avoidance determination. There were certain, if you want, requirements or certain conditions that sort of put the city that they had to come up with revised watershed rules and regulations and how they were going to protect their drinking water supply”* (New York State Department of Environmental Conservation representative. Personal Communication, July 12, 2016). These regulations were more detailed and stringent than previous versions, which caused local communities to react against them. *“And suddenly, because of the SWTR, the City drops new regulations out of the blue on the towns. No groundwork, no discussion, suddenly ‘this is what we’re planning to do’. And they were incredibly draconian. They would have essentially forced out all agricultural uses, they had ridiculous restrictions on septic systems far greater than anything else on the state. Far higher requirements for treatment levels on wastewater treatment plants and anywhere else in the State, and no means to pay for anything.”* (Coalition of Watershed Towns representative. Personal Communication, June 16, 2016). Communities joined forces and created the “Coalition of Watershed Towns” (CWT), an advocacy group representing local interests in challenging the City. The CWT would later be a key party in the negotiations for the MOA, and it is still an active representative of watershed interests against the City.

The animosity of the watershed communities towards the City, paired with the City’s little interest in incorporating the communities in watershed decisions made this a situation of antagonistic interests. The City prioritized its individual rationality (maintaining unfiltered status at any cost) over the collective rationality (maintaining unfiltered status in a way that it is also favorable for the watershed communities). The communities, on the other hand, had no intention of collaborating in the terms imposed by the City. The preference of individual rationality over group rationality on behalf of the City, joined with the antagonistic goals of the watershed communities, led to a highly conflictive cooperation dilemma.

No collaboration seemed possible, and the local communities had no State Agency to run towards in search of help. Since the City was another local government with especial authority over another local government’s territory, the State had little room for political maneuvers that would deter the City.

The conflict would be settled in 1997 with the signing of the New York City Watersheds Memorandum of Agreement. The Agreement created a series of watershed protection, economic development, and education programs funded by the City. In exchange, it promised the issuance of revised Rules and Regulations that were attentive to the needs of the communities. But most importantly, the MOA was grounded in other State and Federal regulations that would provide the check and balances needed to prevent opportunistic behavior from any actors.

Table 4.2 summarizes the main social dilemma faced in each case and lists the rule sets created to govern and address collaboration problems in the watersheds.

**Table 4.2. Characterization of each case and main rules in place<sup>28</sup>**

City	Actors involved	Dominant dilemma	Formal rules
<b>Boston</b>	Several	Coordination with elements of division	1992 (2003) Watershed Protection Act, 2004 MOU, 2004 Watershed Protection Supply Trust Act, and DCR Regulations (350 CMR 11.00)
<b>New York</b>	Many	Cooperation	1997 MOA, 2010 NYC Rules and Regulations, 2014 Water Supply permit
<b>Portland</b>	Few	Coordination	2007 Agreement between PUC and USFS, Portland City Ordinance 21.36
<b>San Francisco</b>	Few	Coordination with elements of division	2010 MOA

### **Quantitative data, coding and creation of Networks of Prescribed Interactions**

Each rule set was coded applying the Institutional Grammar Tool (IGT) (Crawford and Ostrom, 1995; 2005; Basurto et al, 2010; Siddiki et al, 2011).<sup>29</sup> Grounded in the Institutional Analysis and Development Framework (Ostrom, 2005), the IGT provides a systematic and theoretically-driven approach for the analysis of institutional design. The unit of analysis in the IGT is an *institutional statement*, which is a “shared linguistic constraint or opportunity that prescribes, permits, or advises actions or outcomes for actors (both individual and corporate)” (Crawford and Ostrom, 1995: 583). Within each statement, the IGT identifies the actor who has to do (or not do) a certain action, and who (or what) is the recipient of that action. The “doer” of the action is termed “Attribute” by the IGT, and the recipient (another actor or an inanimate element) is defined “Object”.

By defining who is supposed to do an action and the recipients of those actions, rules carry an intrinsic relational purpose. In that sense, it is possible to create dyads between the Attribute in an institutional statement and their Object. The content of those dyads is expressed by the type of rule

<sup>28</sup> The 1917 Raker Act and PL 95-200 were not included in the analysis because they do not address the collective action dilemmas prior to the granting of a filtration waiver in each of these cases. Although both laws are fundamental to the management of these resources, they addressed prior issues. In the case of San Francisco, the Raker Act provided the basis for collaboration between the City and the National Park Service, and in the case of Portland, PL 95-200 addressed cooperation issues between the City and USFS that emerged during the first half of the 20<sup>th</sup> Century.

<sup>29</sup> For a detailed explanation of the IGT and coding procedures, see Chapter 3.

mandating that relationship<sup>30</sup>. Dyads can then be aggregated in the form of a directed network. A network created by coding the formal rules in an institutional arrangement is defined “Network of Prescribed Interactions” (NPI).

The goal of this paper is to assess how the structure of mandated relationships between groups of actors varies in the presence of different collective-action problems. Although the data obtained through the coding of institutional statements capture a wider array of interactions (e.g. interactions that are forbidden by the rules, or interactions between a policy actor and an inanimate object – for instance, a building that must be built by an actor), only a subset of that information is analyzed in this paper. The focus of this paper is on statements that define positive relationships (rules that either mandate or permit a relationship, but not forbid it), and that affect only animate objects (the receiver of the action mandated by the rule is an individual actor or organization). As a result, Networks of Prescribed Interactions capture a particular type of relationships, those that according to a set of formal rules must occur. These networks are substantially different than those commonly studied by the literature on behavioral networks, in that NPIs capture how an institution says that those interactions *should* occur, versus the actual patterns of interactions commonly studied in the policy networks literature. Therefore, NPIs provide an alternative approach for measuring institutional design.

The four directed networks analyzed here (one per each case) have been dichotomized for analytical purposes. Table 4.3 lists the number of statements identified in each case and the amounts used to create the NPIs.

**Table 4.3. Rules used for the creation of each NPI**

<b>NPI</b>	<b>Institutional Statements</b>	<b>Statements used for NPIs (% of total)</b>
Boston	570	129 (22.6%)
New York	2083	675 (32.4%)
Portland	143	31 (21.7%)
San Francisco	102	36 (35.3%)

## **Results**

Boston and New York are settings of one metropolitan water provider (MWRA in Boston, and the City in New York) and multiple landowners. In Massachusetts, local communities have no veto power in decisions over watershed-related issues, whereas in New York they have several avenues to provide direct and indirect input. On the other hand, in Portland and San Francisco, a single City actor and a single landowner are the main parties (USFS in Portland and NPS in San Francisco). As a result, the number of nodes differs considerably across networks.

The first set of hypotheses focus on structural differences between NPIs, arguing that network structure will be affected by the nature of the social dilemma dominating each case. One way of assessing structural differences between networks is by analyzing descriptive coefficients. To assess Hypothesis 1, five measures were obtained for each NPI, presented in Table 4.1. These coefficients are normalized to ensure comparability across NPIs.

The first measure used is density. Density is defined as the number of observed ties divided by the total number of ties possible in a network. Of all four networks, Portland presents the highest relative

<sup>30</sup> In the IAD Framework, rules can adopt 7 forms, ranging from having authority over something or someone (choice rules), to defining channels of communication (information rules) or resource exchange (payoff rules). Chapter 3 expands on the IAD’s rule typology.

density, with 16.7% of the possible ties present in the network. On the other side, Boston has the lowest density, at 2.4%. The expectation of H1 would be for New York (the cooperation case) to present the highest density levels. However, of all four NPIs, Portland has the highest density.

The second measure used is reciprocity. This measure focuses on all the existing dyads in the network and obtains the proportion of which are reciprocated (a tie is reciprocated whenever a tie  $i \rightarrow j$  is joined by a tie  $i \leftarrow j$ ). Reciprocity is a node-level variable that can be aggregated at the general network level to assess the percentage of dyads that are reciprocated. Rules in New York mandate that each actor should send and receive ties to others more than in any of the other cases, with 32% of the dyads in the NPI being reciprocated. On the other hand, rules in Portland prescribe less reciprocity than in any other case, with only 4.8% of all ties being reciprocated. These scores align with the expectations from H1a, where the cooperation case (New York) shows more redundancy than any of the other cases.

The third measure is transitivity. This network-level variable captures the percentage of paths of length two (ties connecting actors  $i \rightarrow j \rightarrow k$ ) for which a tie between  $i$  and  $k$  is present, “closing” the triangle. Transitivity scores go in line with hypothesis H1a. With a 13.8% coefficient, New York shows the highest level of transitivity when compared to the other cases. This is a direct indicator of the existence of redundant, overlapping ties in the network. Portland has the second highest transitivity coefficient (10%), followed by San Francisco (4.1%) and Boston (2.7%), the other mixed cases.

**Table 4.4. Network Structural Measures**

<b>Measure</b>	<b>Boston</b>	<b>New York</b>	<b>Portland</b>	<b>San Francisco</b>
Number of Nodes	82	139	12	27
Density	0.024	0.027	0.167	0.053
Reciprocity	0.101	0.324	0.048	0.156
Transitivity	0.027	0.138	0.1	0.041
Betweenness	0.01	0.006	0.005	0.004
Eigenvector Centrality	0.074	0.051	0.261	0.128
Network Centralization (Outdegree)	0.39	0.37	0.18	0.38
Network Centralization (Indegree)	0.25	0.24	0.06	0.34

To assess the level of bridging in these networks, two measures associated with the ability of connecting otherwise disconnected nodes were used. The first bridging measure is *betweenness* centrality. An actor has high betweenness centrality when it is able to connect a group of actors through the shortest possible path. NPIs in coordination and division problems should favor the creation of linkages between actors through the shortest number of paths, to facilitate the efficient distribution of information (Berardo and Scholz, 2010). Therefore, division and coordination NPIs should present the highest average levels of betweenness. Results in Table 4.4 are inconclusive: the Boston NPI has the highest relative betweenness average, followed by New York.<sup>31</sup>

Bridging structures are those where a subgroup of actors plays a key role in keeping the network together, or in ensuring that information is distributed across the network. Betweenness captures actors that are central based on the number of times they connect actors through the shortest possible path. However, an actor can also be central by having ties that connect them to other popular alters, allowing them to access important information and then distributing it to other sectors of the network. In the

<sup>31</sup> High betweenness centrality takes place in networks with few actors occupying central positions, thus connecting otherwise disconnected actors. Because of this, theoretically, NPIs dealing with Coordination or Division problems should rank high on this variable.

context of NPIs, actors in this position could be decision-makers who are not necessarily connected to everyone in the network, but who rely on the information provided by others who have more connections to everyone else.

Eigenvector centrality is another node-level measure that assigns each actor a score based on how close that actor is to others that are central in the network. An actor with a high eigenvector score will not necessarily be connected to many alters, but rather will be connected to those that are very central in a network, thus having a positional advantage. Average eigenvector scores provide support to the expectations of H1. First, the only cooperation case (New York) has the lowest score as measured by eigenvector centrality. Second, Portland presents the highest relative average eigenvector values, followed by the two cases with a mixed coordination-division dilemma (Boston and San Francisco). Overall, this shows that the three non-cooperation cases have higher levels of eigenvector centrality, indicating the presence of more centralized network structures. However, the two coordination-division cases show lower average levels of eigenvector centrality than Portland, thus not fully supporting H1c.

To assess H1b it is important to analyze whether there are differences in the degree of centralization of these networks. The Network Centralization variables capture the variance in the degrees (number of incoming or outgoing ties) of the actors in a network. The higher the coefficient, the closer a network is to having a perfect star network (with all but one actor having similar degrees). Results show Boston, New York, and San Francisco having similar high levels of both in- and out-degree centralization. This finding does not support H1b or H1c, in that New York (the cooperation case) has similar levels of inequality in degrees than the two coordination-division cases. Moreover, Portland has the lowest levels of degree inequality, in direct opposition of H1b.

Hypothesis 2 focuses on the role of City<sup>32</sup> actors in each NPI. In division and in coordination situations, an NPI should centralize decision-making into a small group of actors. In the cases studied here, City actors are the most interested in securing access to and managing the resources. Per federal regulations, if the City cannot prove that they own or manage watershed lands, they risk losing their filtration waiver. In coordination and in division dilemmas, since actors share the same goals it is more feasible to assign responsibilities to a single actor. However, when actors do not share the same goals, they should be more interested in controlling the City’s activities to avoid defection, resulting in NPIs with more redundancy.

Table 4.5 presents a comparison of the average in-degrees (incoming ties) and out-degrees (outgoing ties) for City-level actors versus non-City actors. In all four cases, City actors have, on average, higher out-degree than their non-City counterparts. In the case of in-degree, only MWRA actors and New York City actors are more popular than their counterparts. In the cooperation case (New York), the difference between City and non-City actors out-degree is smaller than in the rest of the cases, pointing out that City and other actors may play similar roles in the structure of interactions created by the formal institutional arrangement. These coefficients are at odds with H2a and H2b. Furthermore, t-tests for the difference in means in each of the cases showed no statistically significant differences. This could be in part because of the broad distribution of values in these variables. In all four networks there are a few outliers with high in- and out- degree scores, altering the variance and distribution of observations.

**Table 4.5. City and Non-City degree coefficients in each NPI**

	<b>Boston</b>		<b>New York</b>		<b>Portland</b>		<b>San Francisco</b>	
	<b>MWRA</b>	<b>Non-MWRA</b>	<b>City</b>	<b>Non-City</b>	<b>City</b>	<b>Non-City</b>	<b>City</b>	<b>Non-City</b>
Number of Actors	5	77	13	126	4	8	9	18
In-Degree	2.4	1.961	4.385	3.635	1.75	1.875	1.22	1.44
Out-Degree	4	1.857	4.629	3.603	2.75	1.375	1.67	1.22

<sup>32</sup> MWRA in the case of Boston.

So far the descriptive statistics have provided partial support for H1 and no support for H2. A challenge with the analysis of single structure coefficients is that values are often affected by factors such as size (number of actors) and density of a network. As a result, it may be difficult to distinguish between effects caused by network dynamics from effects from those that are a byproduct of size or density (Anderson et al, 1999). To control for this, Exponential Random Graph Models (ERGM) (Robins et al, 2007; Lusher et al, 2013) were fitted to each NPI. ERGMs allow analyzing whether a particular configuration is present in a network, contingent on the network’s characteristics. Rather than comparing structural coefficients between networks of different size, ERGMs offer a way of comparing a network’s configuration with that of multiple randomly generated networks of equal size and characteristics, providing a more nuanced approach to study these configurations.

Although usually applied to identifying the underlying dynamics of tie formation in a network, ERGMs in this chapter are used to assess whether particular structures are present in a given NPI. In doing so, two caveats apply: first, coefficients should not be interpreted as the probability of an actor single-handedly creating a tie with another, but rather as the presence or absence of ties mandated by formal rules. This conceptual difference is because NPIs do not capture behavioral patterns of interactions but rather mandated interactions. Second, model parameters in these ERGMs models are chosen mainly based on theoretical expectations, and tangentially on which parameters allow a model to converge (reproduce characteristics of the network of choice in the randomly generated networks that will work as the baseline for comparison).<sup>33</sup> The NPIs studied here differ in size and density, therefore finding parameters that consistently converge across models is a challenge. Models in Table 4.6 directly test H1a and H2, and indirectly allow to partially assess H1c, while providing the best goodness-of-fit among other potential model configurations.<sup>34</sup>

Models in table 4.6 include five parameters. The *mutual* and *transitive ties* parameters measure bonding. The expectation is that cooperation NPIs should present positive and significant coefficients, and that these coefficients should be higher than coordination or division NPIs. The *Nodeofactor* and *Nodeifactor* parameters capture the number of times a City node sends (*Nodeofactor*) or receives (*Nodeifactor*) a tie. The expectation of H2 is that City actors should have positive and significant coefficients in the cooperation NPI, and no significant effects in the coordination and division NPIs.

**Table 4.6. ERGM Coefficients**

	<b>Boston</b>	<b>New York</b>	<b>Portland</b>	<b>San Francisco</b>
Edges	-4.4252***	-5.308***	-1.867***	-3.5937***
Mutual	1.1431**	2.704***	-0.8416	1.5353*
Transitive ties	1.5541***	1.899***	No Convergence	1.1205***
Nodeofactor City	0.4882*	0.1318	0.8624*	0.3359
Nodeifactor City	-0.2017	7.825e-05	0.0798	-0.2606

\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05

Models were obtained using the *ergm* package for R (Handcock et al, 2016; Hunter et al, 2008). The *edges* parameter is a baseline coefficient capturing the observed number of ties in the network and works as an intercept in the model. The parameters *mutual* and *transitivity* capture two basic bonding

<sup>33</sup> Appendix A lists Goodness of Fit plots for the models in Table 4.6.

<sup>34</sup> Appendix B lists results for ERGM models using all legal documents pertaining to watershed protection in each case (Table B1), and models using only Memorandums of Agreements (Table B2).

structures. *Mutual* focuses on the number of ties from actor  $i \rightarrow j$  for which a tie from  $i \leftarrow j$  is also present. This parameter has a positive and statistically significant effect on three of the four networks. The New York NPI has the highest relative coefficient, showing more reciprocal ties than in Boston, San Francisco and Portland. Results of the *mutuality* effect support H1a.

*Transitivity* focuses on the number of dyads  $i \rightarrow j$  that are also connected by a two-path  $i \rightarrow k \rightarrow j$ . This parameter helps identify the presence of overlapping ties created by the rules in each NPI, providing redundancy to the network. The inclusion of this parameter in the Portland ERGM yielded models that would not converge, thus it was dropped from this specific model. In the other two cases, the parameter behaves according to the expectations in H1a, with the New York NPI having the highest propensity to form transitive ties.

Finally, the model includes two parameters to capture the activity of City actors in each of the four NPIs. The *Nodefactor City* parameter gives the number of times a City Actor (MWRA in the case of Boston) sends any ties to others. On the other hand, the *Nodefactor City* parameter focuses on the times a City Actor receives any ties. These effects are relative to Non-City actors. The ERGM models show statistically significant effects only for situations when the City sends out ties, and only for the cases of Boston and Portland. In addition, the lack of statistically significant results in New York is taken as an indication that there are no significant differences in out- or in-degree between City and non-City actors. However, the lack of statistically significant effects in San Francisco only provides partial support to H2.

## Discussion

Overall, results from the analysis of descriptive and ERGM coefficients provide support to H1a. When actors face cooperation dilemmas, their formal institutional arrangements tend to create more redundant and reciprocal interactions. On the contrary, when actors faced coordination and a mix of coordination and division dilemmas, their arrangements relied less on bonding structures between their members. This finding goes in line with the risk hypothesis (Berardo and Scholz, 2010). Up until now, no existing analysis had tested whether the nature of the social dilemma affected the ways in which rules mandated how actors should interact. The cases studied here are all examples where the good or service to be provided is held constant, and the preferences of the different actors in each case vary. Just like with networks of behavior, NPIs are also affected in the same way by cooperation dilemmas. This opens the door to studies that track the coevolution of behavioral networks and NPIs, to observe how interpersonal risk affects the features of each other, and how behavior affects rule design and vice versa.

However, an interesting feature of these NPIs emerged. The ERGM coefficients showed that even in cases with little indication of cooperation problems like Boston or San Francisco, NPIs had positive and statistically significant coefficients for reciprocity and transitivity. This finding may indicate the presence of a common baseline of redundancy in institutions facing more than just coordination problems.

In the case of Hypothesis 2, the evidence provided partial support. ERGM results show that rules in the cooperation dilemma assigned indistinguishable amounts of responsibilities for City actors versus non-City actors, perhaps due to the lack of trust between City and non-city actors. Of the cases with coordination issues, the evidence is mixed. Only Boston and Portland showed a significant difference in the role NPIs assigned to City and MWRA actors. However, this result did not hold in San Francisco, the other case with a coordination and division component. These inconsistencies raise two important issues: one, more theoretical work is needed to understand how actors address division issues in practice. A possibility is that the result observed here was driven by the intensity of the division problem in San Francisco compared to Boston, and better ways of capturing variation within division problems are needed. A second issue refers to the conceptual differentiation between division and coordination problems. Although the game theory literature clearly distinguishes between the two (for instance, Scharpf, 1994), other authors define bargaining and division games as a subtype of coordination

dilemmas (see Miller, 1992, for instance). Therefore, more precise definitions are required to distinguish these two in real-life scenarios.

### **Conclusion**

This chapter discussed the effects of different type of collective action dilemmas on the design of institutional arrangements for the governance of shared natural resources between governmental actors. Results have shown that, like in the case of individual behavior when facing cooperation or coordination dilemmas, the design of institutions is also responsive to the nature of the dilemma faced by its participants, but only for cooperation problems. This sheds light to the shared features of formal rules and behavior in how they address social dilemmas. Results also highlight the need of more empirical and theoretical work on the different effects caused by division and coordination dilemmas on institutional design. In consequence, two aspects of this analysis should be addressed in future research. On one hand, the consistency of the results for the cooperation case needs to be assessed in other cases facing cooperation problems. And second, more conceptual work is needed to refine the indicators used for identifying coordination and division problems

Results also show the applicability of the NPI approach as an alternative to measure institutional design, and ultimately, with the hopes of comparing it to patterns of observed behavior. The ultimate goal is to develop and test hypotheses regarding the coevolution of formal institutions and observed behavior in a given policy setting. Understanding how these two elements interact will greatly contribute to our understanding of why actors make certain decisions under specific circumstances, controlling for the existing rules in place, as well as for the collective-action dilemma faced by the actor in a specific point in time.

## **Chapter 5: Context and institutional design at regional scales: Do transaction costs affect the design of monitoring, conflict resolution, and consequences?**

### **Introduction**

Institutional arrangements provide solutions to collective problems. Such problems are common in the governance of natural resources where multiple actors are involved. In past decades, studies within the Common-Pool Resource (CPR) literature have identified a series of design principles present in successful cases of long-standing CPR governance (Ostrom 1990; 2005). However, at medium and large scales, the literature still debates the characteristics of those design features for addressing the challenges of collective action.

This paper switches the discussion from assessing whether successful instances of joint natural resource governance include relevant aspects of design, to focusing on the specific ways these design features are included in such arrangements. Findings from this study provide a different look at how features of institutional design can be modified to address a variety of transaction-cost situations emerging in the governance of a shared natural resource. By showing the distinct ways in which institutional mechanisms are adjusted to deal with varying levels of transaction costs, this paper is a step forward to understanding whether the design (and not just the presence) of institutional features included in a formal arrangement can increase the likelihood of successful CPR governance.

This chapter studies the relationship between institutional design and context. In particular, the paper combines insights from Common-Pool Resource theory and transaction-cost approaches to analyze how relative levels of transaction costs may affect the design of institutional arrangements created to govern natural resources shared by two or more governments. Rather than looking at the effect of a single variable (i.e. asset specificity) on design, this paper focuses on a broader set of variables and their joint effect on three specific aspects of institutional design: monitoring, conflict resolution, and consequences for noncompliant behavior.

The cases studied are in New York City (New York), Boston (Massachusetts), Portland (Oregon), and San Francisco (California). Drinking water in these cases is provided unfiltered and it is obtained from sources outside city limits. To secure access to those sources and maintain compliance with federal regulations, providers must develop formal arrangements with the landowners to tap into that water and protect quality at the source. Failure to do so would result in a mandate to filter their drinking water.

Findings in this paper show that, at regional scales, larger transaction costs affect the design of formal mechanisms for monitoring and for sanctioning noncompliant behavior. These results help understand the effects of contextual factors in the design of formal arrangements, while identifying variations in the design of common-pool resource institutions at regional scales.

The following sections will discuss the importance of institutional design in governing shared natural resources, followed by a discussion of the role that contextual factors play in affecting transaction costs. Three hypotheses will be presented, positing how context may affect the design of monitoring, conflict resolution, and consequences in institutions created for the governance of shared natural resources. Following this, the four cases will be presented, along with a discussion of the data analyzed. Finally, this paper will conclude with a discussion of the findings.

### **Context and institutional design in regional-scale shared natural resources**

The literature on Common-Pool Resources (CPRs) focuses on how, under given circumstances, self-governing arrangements constitute an effective alternative for governing shared natural resources. To understand those cases of good governance, context plays an important role. However, reducing the explanation of successful CPR governance to a mere “context matters” is not a satisfactory answer (Ostrom, 2005). After studying relatively small scale systems, Elinor Ostrom (1990, 2005) developed

eight design principles (DPs) present in robust institutional arrangements for governing CPRs.<sup>35</sup> The principles highlight the conditions under which collective action can be maintained (Cox et al, 2010). Most of the research on CPRs developed around small and medium scale resources, where users (and parties in these self-governing arrangements) are individuals. At larger scales, however, other actors and dynamics become relevant (Cash and Moser, 2000; Young, 2002, 2006; Berkes 2002) .

Most analyses of institutional arrangements at medium or large scales focus either on how these institutions incorporate Ostrom's Design Principles or how they create linkages between decision-makers and relevant actors at different levels and scales.<sup>36</sup> Recent scholarship shows that specific configurations of DPs matter (Baggio et al, 2016), and that at larger scales, specific types of DPs are more salient than others (Heikkila et al, 2011; Epstein et al, 2014; Fleischman et al, 2014). However, it is also important to know whether the design of the rules addressing certain types of DPs matter and the sources of that variation. This paper focuses on the latter.

Given the challenges of extrapolating DPs to larger scales, a different approach is required to analyze what contributes to the successful governance of a social-ecological system. Dietz et al (2003) point to four issues that can help develop adaptable institutions at larger scales: the *provision of information, dealing with conflict, inducing rule compliance, providing infrastructure, and be prepared for change*.

This manuscript will focus on three of those requirements: the provision of information, conflict resolution, and rule compliance. Institutions must *provide information* about natural processes as well as their interaction with human behavior. This requires generating and distributing information about the status of the natural environment and the behavior of the actors affecting it. Governing arrangements must also *deal with conflict* regarding decisions, interpretation, or implementation of a rule. Finally, by *enforcing rule compliance*, institutions must provide ways of sanctioning noncomplying behavior.<sup>37,38</sup>

#### *Context and transaction costs*

Transaction costs “consist of the costs of measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements” (North, 1990:27). In the economics literature, these costs determine a firm's decision to produce in-house or purchasing a product in the market (Coase, 1937; Williamson, 1981).

The transaction cost scholarship, largely stemming from economics, is characterized by a nuanced understanding of individual rationality and by acknowledging that institutions and context matter (Williamson, 1981; Ostrom, 2009a). Within this tradition, scholars in transaction cost economics (Williamson, 1981, 1994), property rights (Libecap, 1989), institutional economics (North, 1990);

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<sup>35</sup> The principles are: clearly defined boundaries; congruence between appropriation and provision rules with local conditions; the individuals affected by operational-level rules can participate in modifying those rules; monitors are accountable to the appropriators or are the appropriators; appropriators who violate the rules are likely to be assessed graduated sanctions; appropriators have rapid access to low-cost local arenas to resolve conflicts; the rights of appropriators to devise their own institutions are not challenged by external governmental authorities; appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

<sup>36</sup> Cash et al (2006) distinguish between “cross-scale” interactions as those taking place between actors in different scales such as spatial domains and jurisdictions, and “cross-level” interactions occurring among levels within a scale.

<sup>37</sup> Dietz et al (2003) also argues that institutions must be prepared for change, and must be able to provide common technologies for the use of the resource. Since all four cases rely on similar approaches to maintain water quality, this chapter will not focus on the provision of common technologies. The adaptation component, on the other hand, will be the main focus of Chapter 6.

<sup>38</sup> These three aspects of institutional design are also recognized as “protective safeguards” in the transaction cost economics literature (Williamson, 1996:62).

common-pool resource governance (Ostrom, 1990), among others, all share a similar concern: how to govern collective action in the face of social dilemmas.

Authors in these traditions acknowledge that individuals operate in an environment of uncertainty. Aspects from the environment affect the nature of interactions among a group of actors, often requiring of additional rules (i.e. safeguards or institutions) to help reduce the levels of uncertainty. However, negotiating and enforcing such rules imposes bargaining costs. In these circumstances, actors “must weigh those gains [of the rules] against their expected private losses from the at least temporary continuation of common pool conditions” (Libecap, 1989: 20).

Among the sources of bargaining costs, authors have identified the type and quality of the resource to be produced or acquired (Williamson, 1981), the number of actors involved in collective action (Libecap, 1989), and the existence of information asymmetries between the parties of the agreement (Williamson, 1981; Libecap, 1989; Ostrom, 1990). A fundamental aspect of transaction cost economics is recognizing that features of the resource exchanged will impose different costs. In its fundamental form, asset specificity plays an important role in an organization’s decision to buy a good or produce it internally (Williamson, 1981). Recently, this argument has been applied to the decisions governments make when designing contracts for the provision or production of certain goods (Brown and Potoski, 2003; Rodrigues et al, 2012; Brown et al, 2016).

Whenever a good has low levels of asset specificity, or when their quality is easy to assess (through the price mechanism), actors can anticipate potential problems and design arrangements that address them. Given the characteristics of these resources, formal arrangements for their production or provision will not require resorting to specific or costly mechanisms for assessing the quality of the resource or resolving disputes. Conflict can be addressed by finding different providers or by resorting to pre-established conflict resolution mechanism (such as Courts). When issue specificity is high, actors are better off devising mechanisms that prevent others from behaving opportunistically. Therefore, instances of monitoring, conflict resolution, and specific consequences that limit opportunistic behavior are needed (Brown et al, 2016). Recent studies have found that actors can anticipate issues related to asset specificity in the design of governing arrangements by relying on different types of rules and monitoring mechanisms (Schlager et al, 2017).

Another important factor is the number and heterogeneity of parties involved (Libecap, 1989, Maser, 1998). Devising a bilateral contract is not the same as devising and agreeing on an arrangement involving multiple actors and interests. The amount of actors involved in contracting for property rights, as well as the heterogeneity of their interests will impact on the number of claims to be addressed by the new institutional arrangement (Libecap, 1989:22). As a result, the possibilities of arriving at a consensus with the new arrangement will decrease.

This issue is also addressed in recent approaches studying government interactions. The Institutional Collective Action (ICA) approach (Feiock, 2013) argues that the number of actors involved, and the scope of the issues to be discussed will have a direct effect on what the new institutional arrangement is expected to provide. Bilateral and unidimensional issues can be addressed through informal interactions or contracts, whereas more centralized arrangement may be needed to consolidate multiple actors dealing with a broader array of issues (Maser, 1998; Feiock, 2013).

Finally, the third contextual factor refers to the uncertainty and information asymmetries produced by different social dilemmas (Williamson, 1996). Libecap (1989) discussed information problems as one major cause of conflict in contracting for property rights. These problems pertain to the lack of quality information regarding the actions of the different parties involved. This refers not only to the availability of information, but also to the fact that actors can behave opportunistically, distributing information strategically, and even sharing deceiving information (Libecap, 1989:24).

Building on game theoretical approaches, the ICA identifies three types of risks associated with information asymmetries: cooperation risk (associated with different goals, and where unilateral actions may result in suboptimal outcomes for the rest of the participants); coordination risk (where actors share goals but disagree on how to implement them, therefore the key is in securing information to avoid

uncoordinated actions); and defection risk (where actors agree on the goals of collaboration but have different preferences on how to distribute the benefits or costs of their joint work; these risks require reliable information) (Steinacker, 2004; Feiock, 2013). The classic Common-Pool Resource dilemma (Hardin, 1968) is an example of a cooperation problem. In this setting, multiple actors have incentives to behave opportunistically, favoring their immediate self-interest rather than the long-term collective interest. At larger scales, however, when the actors are governments and not individual resource users, the social dilemmas behind the management of a shared natural resource may adopt different forms, beyond cooperation problems.

Unlike with the production or provision of material goods, governments cannot always rely on a “make it or buy it” approach when governing shared natural resources. Instead, they rely on some form of institutional arrangement that guides and constrains their behavior. However, in the cases studied here, governments are presented with a choice: to protect water quality at the source by negotiating and enforcing a governing arrangement with the owners of the resource in order to protect water, or to filter their water. Filtration is one of the most effective water treatment options, but also an expensive one. Therefore, water providers in these cases must weigh the bargaining costs of negotiating and implementing a governing arrangement versus the production cost of filtering their drinking water. This paper analyzes the design of monitoring, conflict resolution, and enforcement mechanisms when governments face different bargaining and enforcement costs, in a context of high production costs.

Although there is an extensive literature studying the decisions governments make when creating formal arrangements (for instance Ostrom et al, 1961, Oakerson, 1999, Feiock, 2013), this literature focuses on the broad choices governments make in these contexts. For example, do governments decide to create a single overarching authority to provide a service in multiple jurisdictions? Or do they prefer to rely on bilateral agreements in order to maintain their independence? This chapter shifts the attention to how contextual variables shape the design of specific features of a governing arrangement. In particular, the paper asks, do governments rely on similar types of monitoring, conflict resolution, and consequence mechanisms when facing different levels of transaction costs?

#### *Monitoring, conflict resolution, and consequences*

Monitoring individual behavior is central to ensure rule-abiding behavior. Governing a natural resource that is shared by multiple jurisdictions requires ensuring that the parties are engaged in rule-abiding behavior. When actors share similar goals and incentives, investing in redundant and resource-intensive mechanisms may result counterproductive, utilizing resources that could be spent differently. For instance, in the “Battle of the Sexes” game, communication between the parties (or in some cases via an external intermediary) is enough to produce efficient outcomes (Banks and Calvert, 1992). In cases like these, actors should be more likely to not challenge the veracity of the information produced by their counterparts, and therefore more willing to rely on them.

To analyze transaction costs, these must be analyzed in comparison to the alternatives actors face. Low transaction-cost situations will occur whenever the alternatives faced by actors do not differ or impose many more additional costs than the one currently taken. On the other hand, high transaction cost situations will occur when opting out of the current path is more costly. In these cases, the stakes of maintaining the agreement are much higher.

*H1: As bargaining and enforcement costs increase (relative to the costs of producing a public good internally), formal arrangements will rely on more and different types of monitoring mechanisms.*

If the purpose of an institutional arrangement is to sustain collaboration over time, it is important to be prepared to address differences on rule interpretation (Ostrom, 1990, 2005). In this chapter, conflict resolution mechanisms define ways for deciding whether someone’s behavior was rule compliant or not, and define how to address differences over interpretation of the rules.

Access to local mechanisms to address conflict can help solve differences in ways that will not jeopardize the maintenance of rule-abiding behavior. Access to conflict resolution mechanisms becomes important when actors have multiple and diverse preferences, which tend to increase the probability of conflict (Libecap, 1989). These types of problems should also be more likely to occur in the presence of cooperation dilemmas, where the maintenance of the agreement requires them to engage in behaviors that are costly at the individual level, but that provide collective benefits (Calvert, 1995:73). In addition, conflict resolution mechanisms should be more salient when actors have different goals, have heterogeneous values or when the potential of conflict is high (Ostrom, 1990; Stern et al, 2000).

*H2: As bargaining and enforcement costs (relative to the costs of producing a public good internally), formal arrangements will rely on specifically created conflict resolution venues and mechanisms (in addition to pre-existing venues, such as Courts).*

In federal regimes, governments have little authority to impose sanctions on other governments at the same level. Whenever a party to an intergovernmental agreement breaks the rules, actors face a series of alternatives: devising new mechanisms allowing them to impose sanctions, resorting to sanctions from higher-order venues (i.e. Courts), or exiting the agreement. The first alternative requires investing in agreement-specific mechanisms or actors in charge of enforcing the rules. This alternative, although effective and a clear signal of credible commitment, may not be worth it when expected levels of opportunistic behavior are low, when sanctions can be imposed through informal mechanisms, or when interactions are based on a limited number of issues. When the scope of an agreement increases, sanctioning noncompliant behavior becomes important to avoid conflict escalation. Also, in these agreements, sanctioning mechanisms need to vary in accordance with the different types of activities to be conducted. The second alternative requires fewer investments, but the costs come in the form of the time it may take a Court to make a decision. Finally, actors may leave the agreement. In some circumstances, the threat of abandoning the agreement may be enough to put other actors back in line (Bednar, 2009).

The ICA approach posits that the higher the costs of cooperation, the more willing an actor would be to invest in mechanisms to mitigate collective action problems (Feiock, 2013). On the other hand, when actors do not face many risks for collaboration, they will resort to less formal mechanisms for mitigating ICA problems. In sum:

*H3: As bargaining and enforcement costs of designing and maintaining an agreement increase (relative to the costs of producing a public good internally), formal arrangements will rely on multiple types of sanctions to punish noncompliant behavior without crowding out collaboration.*

In the four cases studied in this paper, water providers face two alternatives: negotiate with landowners and develop strategies to maintain water quality at the source, or relinquish that relationship and filter their water prior to distributing it to consumers. The second option, although effective at addressing contamination issues, is highly expensive.

### **The cases: Institutional arrangements for the maintenance of Water Quality in Boston, New York, Portland, and San Francisco**

Unlike most cities in the country, water providers in Boston (Massachusetts), New York (New York), Portland (Oregon), and San Francisco (California) provide unfiltered drinking water from sources outside city limits. To comply with federal legislation, water providers must develop formal agreements with the landowners where the water is sourced. These agreements are meant to show that the water provider has access and control over the land in order to ensure water quality protection at the source.

These four settings are good examples of a collective action dilemma between different resource appropriators: those located on the land where the resource sits, and actors who from a distance want to use the resource and exclude others from affecting its quality.

*Portland and San Francisco: bilateral agreements based on shared goals*

Portland and San Francisco share a number of similarities. First, both cities source their water from federally-owned lands. Portland obtains it from the Bull Run watershed, located within Mt. Hood National Forest. San Francisco, on the other hand, does it from the Hetch Hetchy watershed in Yosemite National Park. Having only one actor with whom to negotiate facilitates the generation of trust and reduces the need of resorting to highly formalized mechanisms for maintaining collaboration.

Notwithstanding, in the presence of conflicting goals, attempting to arrive at an agreement may prove unsuccessful without intermediaries willing to play such roles. This leads to another source of transaction costs: the existence of information asymmetries and different preferences. In San Francisco, the history of Hetch Hetchy is marked by a divided public opinion on whether tapping into those resources was an act of encroachment or a necessary evil to ensure the growth of the City (Righter, 2005; Simpson, 2005). This degree of polarization, however, was never present in interactions between the two interested parties. Aside from minor differences, there is no evidence of major disagreements over the use and appropriation of the resource during the early 20<sup>th</sup> Century, when the City started appropriating water from Hetch Hetchy (Righter, 2005), or prior to the signing of their more recent Memorandums of Agreements. A City representative mentioned that before signing the first agreement (in 2005), “we [the City and the Park Service] *had the same overarching objectives in the watershed [...] there weren’t many conflicting challenges or goals that one part had over another. We are dealing with the Park Service, their goal isn’t mining or drilling or anything like that*” (SFPUC Representative, Personal Communication, May 2, 2016). A Park Service representative also shared this sentiment, indicating that both parties strive for the protection of the resource, although perhaps for different reasons (Yosemite National Park Representative, Personal Communication, April 12, 2016). The only differences between the parties occurred over the distribution of funding early on in their relationship. (SFPUC representative, Personal Communication, May 2, 2016)

In Portland, although the City and Forest Service share goals of resource protection, there were times when they had deep disagreements. In the early 20<sup>th</sup> Century, Congress recognized Bull Run as a source of drinking water for Portland. However, the Forest Service had also a mandate to allow for timber extraction in the area, affecting water quality (Larson, 2009; Short, 2011). These disagreements halted in 1996 when Congress sanctioned stricter prohibitions regarding logging in the watershed. Since then, both parties have enjoyed a good working relationship based on shared goals. Several interviewees defined this as a “*pre and post logging relationship*” (PWB Representative, Personal Communication, June 13, 2016) characterized by a “*mismatch in agendas*” (USFS Mt. Hood Representative, Personal Communication, June 22, 2016). The prohibition of timber extraction in the watershed limited the sources of income for the Forest Service in the area. As a result, Mt. Hood became even more dependent on the City (PWB Representative, Personal Communication, June 8, 2016).

Finally, transaction costs can also be affected by the characteristics of the issue being contracted. Both Portland and San Francisco have signed agreements with their counterparts defining specific watershed protection activities. In addition, since ownership of Bull Run and Hetch Hetchy is held by a single actor, and since public access to these lands is limited, watershed protection activities are focused mostly on controlling biophysical indicators. In San Francisco, the arrangements provide a framework for the City to fund activities implemented by the Park Service; “*the agreements [...] are also a funding authority that allows us to provide the funding and the resources to the Park Service, to provide that service. [...] We’re really lucky in this case that we have primarily one entity that is responsible for how the land is managed, which is the Park Service*” (SFPUC Representative, Personal Communication, April 11, 2016), “*the City is helping provide funding to the Park Service to do that watershed protection we have agreed*” (Yosemite National Park Representative, Personal Communication, March 24, 2016). In

Portland, the situation is similar, with the agreement providing a funding and administrative framework. As stated by a City representative, “*the purpose of the agreement was to deal with this [Forest Service’s] budget constraint and this staffing constraint by just giving each other a little bit more freedom to do the things we were responsible for*” (PWB Representative, Personal Communication, June 8, 2016).

In sum, Portland and San Francisco present relatively low transaction costs. In both cases, the filtration alternative is more costly than collaborating with landowners and protecting water quality at the source. However, the existence of only one major landowner with similar goals reduces the transaction costs of developing a partnership. These features also lower the costs of maintaining the relationship. For instance, in San Francisco, since the goal of the National Park Service is to protect the quality of the natural resources in the area, the Park does not have to go out of its way to conduct watershed protection activities. The same occurs in Portland, where after the Northwest Forest Plan and subsequent federal legislation, the U.S. Forest Service’s role became limited to protecting resources for maintaining water quality.

*Boston and New York: similar issues, different institutions*

Unlike San Francisco and Portland, both Boston and New York source their water from watersheds that are largely open to the public. In there, both local governments and private actors own land. As a result, the number of potentially affected actors and interests is larger.

In Boston rather than creating an agreement directly between the City and watershed communities, the State of Massachusetts created two state agencies to manage the three watersheds (Quabbin, Wachusett, and Ware) that supply the Boston metropolitan area. One of these agencies, the Massachusetts Water Resource Authority (MWRA) is a public authority in charge of providing wholesale water and sewer services to communities in the metropolitan area. The other agency is the Department of Conservation and Recreation (DCR), in charge of implementing watershed protection measures in the watersheds. In the early 20<sup>th</sup> Century, the State created the Metropolitan District Commission (MDC) in charge of sourcing and distributing water. (Nesson, 1983; MDC, 1984). MDC was in charge of providing wholesale water and sewer services to the Boston metropolitan area, while also protecting the watersheds in western Massachusetts. In the 1980s, the provision side of water provision was tasked to a new agency: the Massachusetts Water Resources Authority (MWRA). In 2003, the Department of Conservation and Recreation (DCR) replaced MDC. Within the new department, the division charged with managing and protecting the watersheds is 100% funded by the MWRA. In 2004, DCR and MWRA signed a memorandum of understanding to define their watershed protection responsibilities.

Unlike Portland and San Francisco, the watersheds in Boston are populated. This means that DCR and MWRA must develop ways of controlling the effects of having multiple actors living in the watersheds. In this arrangement, DCR designs and implements watershed protection plans, purchases land, and enforces regulations controlling human activities in the watershed.

In this setting, watershed communities are not directly involved in decisions regarding watershed protection. “*Towns get money called Payments in Lieu of Taxes, or PILOT payments that come through the MWRA for facilities or land that was acquired for the water system. But they [watershed communities] don’t have a formal relationship. [...] DCR has to patrol, and work, and get to know the towns in order to make their protection points. The towns are not required to listen, but they [watershed communities] can’t ignore them [DCR] either, because they benefit from this management*” (MWRA Advisory Committee representative. Personal communication, August 15, 2016).

This does not mean that communities are completely overlooked. However, their involvement is mostly in a consultative role on a project-by-project basis. In addition, although the communities have had their differences with representatives from Boston, conflicts between them never reached high levels like in the case of New York (Steinberg and Clark, 1999).

The bilateral structure in Boston also affected the nature of collaboration between the parties. DCR develops plans and programs for acquiring land, maintaining watershed infrastructure (including

wastewater and stormwater management), managing and monitoring wildlife, maintaining the security of critical infrastructure, researching and monitoring biophysical standards, and education in the watersheds. These activities are conducted primarily by DCR, with funding from MWRA, and overseen by a Board of Trustees composed of representatives from the State, MWRA, MWRA's Advisory Committee, and representatives from individual users' interests.

The closeness between DCR and MWRA, as well as a shared history (both replaced the MDC) naturally aligned their goals. However, some differences remained between the agencies. After the division into two agencies "*there were a bunch of things which were not perfectly clear in the legislation [...] like, 'who is in charge of this, or who is in charge of that'*" (MWRA representative. Personal communication, June 3, 2016). Those differences were the ones that required the creation of agreements between both agencies. But in general, "*when it comes to issues of water quality and protection and so on, we [DCR and MWRA] work very much as a team*" (MWRA representative. Personal communication, June 3, 2016).

In New York, the main agreement is between New York City, Local Governments (Municipalities and County Governments) located on the watersheds, State Agencies (New York State Department of Health, and New York State Department of Environmental Conservation), the U.S. Environmental Protection Agency, and environmental NGOs.

New York's case is famous for the long and conflictive history between the City and watershed communities (Soll, 2013; Galusha, 2016). A sentiment of animosity towards the City added to the already conflicting goals between both actors. These sentiments originated in the unilateral actions the City had been conducting for over a century in the watersheds. During these times, the City "*kind of just did what we thought we needed to do around the water supply system without giving a great deal of thought to how the communities would feel about that*" (NYCDEP representative. Personal communication. July 7, 2016).

The Boston and New York agreements encompass a broader array of activities than San Francisco or Portland. In Boston and New York, the City (MWRA in Boston) provides the funding for watershed protection activities, including land acquisition. Since both cases deal with watersheds owned by multiple actors, securing access to and ownership of land is fundamental for maintaining unfiltered status. This is an issue that neither Portland nor San Francisco deal with, since their resources have a single owner and public access is limited.

To gain support from watershed communities, the parties in New York created economic development programs funded by the City. Through these programs, the City compensates for the lost costs (in terms of tax revenue and productive use of the land) faced by the communities for selling parcels of land to the City. In addition, the New York City arrangement creates a conflict resolution venue (the Watershed Protection and Partnership Council – WPPC), and a regional venue composed of elected local officials in charge of implementing many of the watershed protection programs funded by the City (the Catskill Watershed Corporation – CWC).

Boston and New York share similar features. Both rely on larger watersheds occupied by local governments and private actors. However, transaction costs in each case are different. In Boston, the agreement between DCR and MWRA resembles the bilateral agreements of Portland and San Francisco. In addition, the entire governing arrangement in Boston is based on State legislation that defines responsibilities for both agencies, and establishes development restrictions in different sections throughout the watersheds (M.G.L. 92 A1/2). State laws impose responsibilities to MWRA and DCR but do not require a vote from watershed communities regarding watershed protection activities.<sup>39</sup> In consequence, the actors formally involved are fewer than in New York.

Also, land ownership differs between both cases. This affects the degree of control, and therefore the need of collaboration required from other actors to protect water quality. The more land

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<sup>39</sup> Nevertheless, communities and local interests get to provide input on new plans and projects developed by DCR and MWRA. Chapter 6 provides a more detailed description of this.

owned by the water provider, the less they depend on collaborating with the different communities in the area. In Boston, DCR owns 60% of the land in the Quabbin Watershed, around 30% in the Ware watershed, and 30% in the Wachusett (MWRA Advisory Board representative. Personal Communication, July 14<sup>th</sup>, 2016). Of these three, the Quabbin is the largest. In New York, land ownership is approximately 38% (NYC Department of Environmental Protection, 2016).

Transaction costs of maintaining these agreements relative to the filtration option also vary between the two. In New York, by the time the City signed the agreement, the economic cost of building a filtration system would near 8 billion dollars (Galusha, 2016) and 300 million in operation costs annually (Hanlon, 2015). These costs make opting out not a viable option in New York. Ever since the City relinquished its ability to claim watershed lands through eminent domain (a condition for the 1997 MOA), the absence of this arrangement would make it impossible to maintain the same levels of watershed protection.

For Boston, transaction costs are lower than New York for three reasons: the existence of two major parties in the agreement, their overall consensus regarding goals, and the high level of protection and land ownership in the watersheds. In 1999, the cost of adding filtration to MWRA's treatment facilities was estimated to be \$180 - \$200 million (Kavanaugh, 1999, Stearns, 2000).<sup>40</sup> Although maintaining the agreement is still preferred to filtration, the costs of losing the filtration waiver are smaller than in New York. As an MWRA representative mentioned, *"if we have to do it, we'll do it. I prefer not to in the short term because it has allowed us to build better water quality preservation, and I think that that's a long term benefit. If we had moved to filtration back in the 90s, our long term water quality would be lower. The watersheds would have developed differently. So there's some real benefit there. But we're not wedded to it in the long term"* (MWRA Representative. Personal Communication, June 3, 2016).

In sum, transaction costs are higher in Boston and New York than in Portland and San Francisco. However, in New York, the costs of maintaining the agreement are even higher than in Boston, not only because of the nature of the agreement, but also because the alternatives if the agreement falls back are considerably more expensive.

#### *Identifying monitoring, conflict resolution, and consequence mechanisms*

The purpose of this chapter is to assess how transaction costs affect the design of rules guiding the governance of shared natural resources. Table 5.1 presents the main rule sets guiding and constraining actor behavior in the four cases.<sup>41</sup> To capture monitoring, conflict resolution, and consequence in these arrangements, each rule set was coded.<sup>42</sup>

**Table 5.1. Formal Rules in each case**

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<sup>40</sup> In 1999, U.S. EPA sued MWRA and MDC regarding noncompliance with Surface Water Treatment Rule Regulations. MWRA's argument to maintain filtration avoidance status was that the costs of adding filtration (at the time estimated to be between 180 and 200 million dollars), would outweigh the benefits of watershed protection and infrastructure renewal programs (Kavanaugh, 1999; Stearns, 2000).

<sup>41</sup> Although the Northwest Forest Plan affected the way in which the Forest Service would manage its land in the region, indirectly affecting the Bull Run area, its guidelines are not directly related to the governance of the watershed. Therefore, the Northwest Forest Plan was not include it in the analysis. Instead, PL 95-200 and its subsequent modifications were used. In New York, the Catskill Watershed Corporation has developed multiple programs to address specific issues related to the maintenance of water quality in the watersheds. Those program rules were not analyzed in this paper because they address specific collective-action dilemmas related to the implementation of the agreement.

<sup>42</sup> I would like to thank Edella Schlager and Jeff Hanlon for allowing me to use the coded data from New York.

<b>Formal rules</b>	
<b>Boston</b>	1992 (2003) Watershed Protection Act, 2004 MOU, 2004 Watershed Protection Supply Trust Act, and 2011 DCR Regulations (350 CMR 11.00)
<b>New York</b>	1997 MOA, 2010 NYC Rules and Regulations, 2014 Water Supply permit
<b>Portland</b>	1977 PL 95-200 Bull Run Act (modified in 1996 and in 2001), 2007 Agreement between Portland Water Bureau and U.S. Forest Service, Portland City Ordinance 21.36
<b>San Francisco</b>	1913 Raker Act, Department Of the Interior Stipulations from years 1961/1985/1987, 2010 Memorandum of Agreement between San Francisco Public Utilities Commission and National Park Service

The coding process involved two steps. First, each document was coded applying the Institutional Grammar Tool (Crawford and Ostrom, 1995; 2005; Basurto et al, 2010). The Institutional Grammar Tool (IGT) provides guidelines for identifying and coding statements prescribing how actors should, may, or should not behave to achieve common goals in a formal document.<sup>43</sup> Recent approaches (Schlager et al 2015, Schlager et al, 2017) build on the IGT for capturing groups of institutional statements creating *mechanisms* for monitoring, addressing conflict, or imposing penalties for noncompliant behavior. A *mechanism* is a group of 2 to  $n$  institutional statements that, as a whole, prescribe how actor behavior should take place around a specific Action Situation.<sup>44</sup> Table 5.2 lists the number of mechanisms identified.

**Table 5.2. Number of statements and mechanisms by case**

	Monitoring Mechanisms	Conflict resolution Mechanisms	Consequence Mechanisms
Boston	19	9	3
New York	93	127	59
Portland	5	10	2
San Francisco	13	3	3
<b>TOTAL</b>	<b>130</b>	<b>149</b>	<b>67</b>

The documents from Boston, Portland, and San Francisco were coded by the author, and a second coder was assigned a random sample of 20% of all the institutional statements present in each document.<sup>45</sup> The New York City documents were coded by a team of three coders. Each coder was assigned an entire document to code. Then, inter-coder reliability coefficients were obtained by assigning a random sample of statements to the two coders who did not code the entire document. Coefficients were calculated by obtaining the percentage of agreement between coders. This was measured by taking the number of institutional statements where the coders disagreed divided by the total number of statements assigned. The average percentage agreement for each of the four cases was never below 70%.

Data obtained from coding each document was aggregated into a database with the mechanism as the unit of analysis. This database yielded 346 observations.<sup>46</sup> After creating the dataset, the content of

<sup>43</sup> Chapter 3 describes the Institutional Grammar Tool.

<sup>44</sup> Appendix B includes the protocol for the identification and coding of mechanisms.

<sup>45</sup> Thanks to Brittany Volz for her help as second coder.

<sup>46</sup> Some observations included mechanisms with only 2 institutional statements, where each statement was coded as a different mechanism: for instance, a two-statement mechanism may have a statement coded as monitoring

each observation was analyzed for emerging patterns between mechanisms. This inductive approach allowed identifying four subtypes of monitoring, six types of compliance, and six types of consequence mechanisms. Table 5.3 presents the distribution of these values by case.<sup>47</sup>

**Table 5.3. Types of mechanisms by case<sup>48</sup>**

	Boston	New York	Portland	San Francisco
<b>Monitoring</b>				
Unilateral Report	8 (42.1%)	69 (74.2%)	3 (60%)	3 (23.1%)
Joint Work	5 (26.3%)	10 (10.8%)	1 (20%)	3 (23.1%)
Generate information	0	7 (7.53%)	0	3 (23.1%)
Water quality	6 (31.6%)	7 (7.53%)	1 (20%)	4 (30.8%)
<b>Conflict Resolution</b>				
Third Party	2 (2.22%)	26 (20.5%)	2 (20%)	2 (66.7%)
Definitions	0	31 (24.4%)	2 (20%)	1(33.3%)
In-House	1 (11.1%)	11 (8.66%)	2 (20%)	0
Individual Party	6 (66.7%)	40 (31.5%)	3 (30%)	0
Venue	0	19 (15%)	1 (10%)	0
<b>Consequence</b>				
Easement restrictions	0	9 (15.3%)	0	0
Administrative decision	0	8 (13.6%)	0	2 (66.7%)
Compensation	0	4 (6.78%)	0	1 (33.3%)
Modify obligations	0	23 (39%)	0	0
Define rules that apply	2 (66.7%)	15 (25.4%)	0	0
Consequences for individuals	1 (33.3%)	0	2 (100%)	0
<b>TOTAL</b>	<b>31</b>	<b>279</b>	<b>17</b>	<b>19</b>

Hypotheses 1 through 3 posit that the design of monitoring, conflict resolution, and consequence mechanisms should vary in the face of different levels of transaction costs. To assess whether there are differences between the four cases, pairwise comparisons of the types of monitoring, conflict resolution, and consequence mechanisms between cases were conducted. The comparisons were carried out using the package *compareGroups* (Subirana et al, 2014). Given the nature of the variables and amount of observations in them, Fisher's exact tests were used. Table 5.4 presents p-values for the bivariate comparisons on the types of monitoring, compliance, and consequence mechanisms between pairs of Cities.

and the second one coded as consequence. In these cases it is not possible to distinguish which of the two categories is the predominant. Therefore, those observations were deleted from the dataset.

<sup>47</sup> Chapter 3 includes definitions of each subtype of mechanism.

<sup>48</sup> Percentage values are obtained by Case within each Mechanism Type. For instance, Boston's value of 42.1% in the Unilateral Report cell indicates that 42.1% of Boston's Monitoring mechanisms were coded as Unilateral Report.

**Table 5.4. Pairwise comparisons of mechanisms types between cases<sup>49</sup>**

	p-values						
	Overall	Portland Vs San Francisco	Portland Vs Boston	San Francisco Vs Boston	New York Vs Portland	New York Vs San Francisco	New York Vs Boston
Monitoring	0.001	.687	1	.373	.600	.006	.009
Conflict resolution	0.351	.828	.788	.381	.828	.684	.381
Consequence	<0.001	.240	.400	.240	.003	.058	.058

Results show statistically significant differences in the design of monitoring and consequence mechanisms across cases. Interestingly, the differences are all with regards to New York City. These results do not show statistically significant differences between Boston, Portland, and San Francisco. In the case of monitoring, mechanisms differ between New York and San Francisco, and between New York and Boston, but not with Portland. However, on their own, these findings do not provide sufficient evidence to support the hypotheses described above. To address that, the analysis turns to qualitative evidence.

#### **Do levels of transaction costs lead to variations in monitoring and consequences?**

The comparison above identifies differences in the design of monitoring and consequence mechanisms. The four cases do not seem to be significantly different in their mechanisms for conflict resolution, thus not supporting Hypothesis 2.

Results show that the mechanisms used to monitor actor and resource behavior are significantly different between New York and Boston, and between New York and San Francisco. In addition to having similar numbers of actors as parties to the agreements, Boston and San Francisco also showed differences between the parties over the distribution of resources, where they disagreed over how much and who would pay for certain watershed protection activities. This may indicate that when facing division problems<sup>50</sup>, actors rely on a different distribution of monitoring mechanisms than when facing deeper disagreements as in the case of New York.

In terms of monitoring, Table 5.3 shows that New York relies mostly on unilateral reports. On the other hand, there seems to be a less-skewed distribution of monitoring mechanisms in Boston and San Francisco. However, in Portland, the distribution of monitoring mechanisms does not seem to follow the trends of the other two low-transaction cost cases, and instead resembles that of New York. This is further supported by the lack of statistically significant differences between the two cities.

The existence of similar monitoring structures in New York and Portland could be the product of a non-monotonic distribution in preferences for more varied monitoring mechanisms. Although this effect goes against the hypothesized relationship between transaction costs and monitoring, it suggests the presence of a more nuanced relationship between the two. A feature of that nuanced relationship was highlighted by Agrawal and Goyal (2001). In their paper, the authors assessed the relationship between group size and third party monitoring costs in the governance of common forest resources. The authors found a similar non-monotonic function in the preferences for third party monitoring, arguing that the costs of providing such monitoring outweigh its benefits at small scales (due to technological costs) and at large scales (where free-riding problems will limit the effectiveness of this mechanism).

<sup>49</sup> Values in each cell are p-values adjusted using the procedure defined in Benjamini and Hochberg (1995).

<sup>50</sup> For definitions of division problems, see Scharpf (1997), Steinacker (2004).

Findings in this paper show that a similar logic may apply to agreements between government actors. When facing situations of low transaction costs, actors may rely mostly on self-reporting. As costs increase, other monitoring mechanisms may come in handy, up to a certain point when cost considerations of providing this collective good will make unilateral reporting the most efficient way of communicating large amounts of information. Another reason for this may be due to path dependence. Earlier in the history of Bull Run, the Portland Water Bureau and the Forest Service had different goals regarding the use of the resource, which prompted some early conflict between them (Short, 2011). Although this issue was indirectly addressed after the implementation of the Northwest Forest Plan, remnants of this conflict may have forced their way into subsequent agreements, in spite of the lack of conflict between the parties at the time.

Table 5.4 also shows statistically significant differences for consequence mechanisms. Of all cases, New York shows the most variation in types of consequences. The remaining cases rely mostly on two types of consequences, with Portland including only one type. The institutional arrangement in New York City does not seem to pay attention to establishing sanctions for acts of noncompliance committed by individuals. Instead, consequences focus on establishing sanctions for the different signatories of the agreement.

In Portland there are no agreed-upon formal sanctions for whenever the City of Portland or the Forest Service violates their agreement. This is attributed to the nature of their relationship, “*they [the Forest Service] do a lot less than what they used to do. So there’s not a whole lot. We [the City] don’t have expectations of them doing a whole bunch of things that we’d need to be checking out*” (Portland Water Bureau Representative. Personal Communication, June 13, 2016). Another Water Bureau representative also mentioned that “*We [PWB] can take things to the City Council, people can call people and make sure that’s clear that we are not happy, but I wouldn’t say there’s formal mechanisms other than what’s available in Federal Rules*” (Portland Water Bureau Representative. Personal Communication, June 8, 2016). A representative from the Forest Service had a similar reaction, arguing that “*I think it would come down to lawsuits, that’s where sanctions would come into play [...] I think there can be sanctions that can be applied, there’s none that’s straight out of the document that says ‘this is what happens if you don’t do [something] [...] I think that the dedication to working in partnership really kind of preclude the need for sanctions*” (USFS Mt. Hood Representative. Personal Communication, June 22, 2016).

Interviewees in San Francisco identified similar reasons for the relative lack of consequence mechanisms. A SFPUC respondent mentioned that “*There is no enforcement. There is no ‘if you don’t do this, we’re going to withhold the payment’. They get their payment anyway [...] it goes back to the fact that we’re dealing with one of the nation’s parks, and they have the same goals as we do.*” (San Francisco Public Utilities Commission Representative. Personal Communication, May 2, 2016). This sentiment was also present on the National Park Service side, where a ranger mentioned that a reason why sanctions are not needed is the “*lack of animosity*” (Yosemite National Park Division Ranger, Personal Communication, April 12, 2016). Another Ranger also mentioned that “*if the city did not comply with what was in the Raker Act, we can take them to Court and say ‘you’re responsible for giving us \$30,000 every year per the Raker Act and you haven’t done that [...] For things like the agreement, [...] the City can come back at us and say ‘you didn’t uphold what you said you would in the agreement’. Basically is like a contract where those funds would need to be returned to the City.*” (Yosemite National Park Division Ranger, Personal Communication, March 24, 2016). The absence of consequence mechanisms seems to be grounded on shared goals.

Portland and San Francisco also share another feature: they are bilateral agreements between a federal agency and a local government. First, the bilateral nature of an agreement will likely preclude a party from imposing sanctions on another, aside from just exiting the agreement. In these types of agreements, if a party violated the agreement, enforcement of such mandates may be fruitless. This issue was raised in 1976 by Judge James M. Burns in *Miller v. Mallery*, when a private citizen sued the U.S. Forest Service for violations of a federal mandate in Bull Run. Judge Burns highlighted that in this case,

*“the alleged law breaker is also the law enforcer”* (cited in Short, 2011:177). This logic would also apply when “the alleged affected party is also the judge”, potentially leading to an escalation in conflict that could harm the stability of the agreement. Second, these agreements involve a local government and an agency located at a higher level. In a federal regime, a federal agency would not be subject to sanctions imposed by a local government. This, plus the relatively low level of transaction costs, would not make necessary the inclusion of consequence mechanisms in these agreements.

However, how do these arguments apply to Boston, where there are also few consequence mechanisms? First, Boston is also a bilateral agreement, thus the issues of one actor imposing consequences also apply. The difference is that, in Boston, the agreement is between two State-level agencies. If the lack of consequence mechanisms in San Francisco and Portland were exclusively due to the presence of federal-level actors, then more or different consequence mechanisms should be in place in Boston. Instead, Boston showcases similar number and types of mechanisms. This finding is supported by the comparisons in Table 5.3, which show no statistically significant differences between these cases. Notwithstanding, the lack of consequence mechanisms in Boston could also be due to the nature of the parties. Two state agencies may lack the authority to enforce sanctions on one another, and therefore need to resort to administrative decisions at higher levels or to the State legislature. The latter happened in Boston. After the creation of DCR in 2003, DCR and MWRA had differences over the funding of DCR. The State Legislature addressed this by creating the Water Supply Protection Trust.

The qualitative evidence also points to similarities in addressing and sanctioning conflict in Boston. When discussing the existence of such mechanisms, an MWRA representative mentioned *“our approach has been that because we share so many of our viewpoints and our objectives, almost everything has been resolved at that level of staff-to-staff relationship. And if you read the 2004 MOU there’s a lot of dispute resolution stuff in there. We’ve never had to use any of that”* (MWRA representative. Personal Communication, June 3, 2016). This perspective was shared by a member of the MWRA Advisory Board, who stated that *“Clearly, Court action on any issue could always occur. And it has not been the direction that things have gone”* (MWRA Advisory Board representative. Personal Communication, July 14, 2016). In fact, the MWRA Advisory Board representative provided some evidence as to why the agreements in Boston focus particularly on addressing the behavior of individual users (not signatories of the agreement): *“a major debate that’s been going on is trail bike riders, mountain bikers I should call them. They like using the watershed lands as their personal track. They cut trees down to do whatever they want, and don’t feel that there should be any hindrance placed on them”* (MWRA Advisory Board representative. Personal Communication, July 14, 2016). This may explain why the arrangement pays more attention to addressing issues of noncompliance at the individual level, rather than focusing on the compliance of its signatories.

Portland, San Francisco, and Boston highlight three reasons for the lack of consequence mechanisms. First, in line with Hypothesis 3, the relatively low levels of transaction costs make it unnecessary to add redundancy to the sanctioning of noncompliant behavior. Second, the three are bilateral agreements. Allowing unilateral imposition of consequences in these types of agreements may jeopardize their stability. And third, they involve government agencies as landowners. In San Francisco and Portland, a federal agency may not be willing to accept sanctions imposed by a local actor. Perhaps a more general logic lies in the three cases: agencies cannot be sanctioned by actors at the same or lower level (i.e. another federal agency, or a local government). In New York, the fundamental consequence mechanisms rely on the intertwined nature of the rule documents holding the agreement together. Most importantly, a defining feature of New York is the incorporation of multiple actors. Unlike the other cases, New York includes a mix of local, state, and federal actors. In this arrangement, the State and Federal actors have the ability to impose sanctions for noncompliance. For instance, if the City fails to comply with the agreement, the State could deny the issuance of a Water Supply Permit, thus blocking the City from acquiring land on the watersheds. If this occurs, the City would not be able to comply with the filtration waiver. Also, the State Department of Health could deny issuance of the Filtration Avoidance Determination in cases of overt noncompliance. *“if something happened and the City was no*

*longer able to acquire land, that could jeopardize the FAD, which would also then jeopardize the funding for the water quality programs. On the other hand, if the City didn't pay for the water quality programs, that would jeopardize their FAD and also they would lose their Land Acquisition Program”* (CWC representative. Personal Communication, June 17, 2016). These redundancies in the design of the agreements are some of the defining features of the New York City Watershed agreements (Hanlon, 2015).

The involvement of State and Federal agencies in New York is mostly as regulators and not as parties involved in the production of water quality. This explains why the agreement tasks them with the ability to enforce rules, but never puts them in the position of receiving sanctions by another agency or local government.

The New York agreement also incorporates specific mechanisms designed to avoid the escalation of conflict, *“one of the most important tools we have in the MOA is if the CWT [Coalition of Watershed Towns] has to go to Court to enforce the rights under the MOA, we get attorney's fees. And as you know, you rarely get attorney's fees under US law. And, because the City has its legal department of hundreds of lawyers, it was always hard to litigate against them at the cost. So we got that provision that if we win we get attorney's fees. So we won that case and got our attorney's fees. Which that becomes effective to tell the City 'stop doing these things or we'll sue you again'.”* (Coalition of Watershed Towns representative. Personal Communication, June 16, 2016). Since the parties have a long experience of disagreements with each other, they deliberately included mechanisms to make this conflict more costly if they decide to take that route.

In sum, results from Table 5.3, along with the qualitative evidence provide support to hypothesis 3 by showing that cases with a history of higher transaction costs rely on more varied mechanisms for sanctioning noncompliant behavior. In line with the transaction cost argument, actors anticipate less noncompliant behavior that could jeopardize the stability of the agreement, thus they decide not to invest in devising mechanisms for addressing such situations. The analysis also emphasized two contextual variables affecting the design of consequence mechanisms: the number of actors in the agreement (with bilateral agreements relying less on specific consequences), and the types of actors involved, with State or Federal agencies not being subject to sanctions by lower or same-level actors.

## **Discussion**

Findings have shown that at regional scales, arrangements created for governing shared natural resources include some of the design features identified in the literature. Most importantly, findings indicate that such design features are affected by transaction costs. High transaction cost settings demand different types of monitoring and consequence mechanisms than cases with lower transaction costs.

This study contributes to the understanding of institutional design at regional scales by showing that not only the presence of mechanisms is important, but also that their design varies in order to address different levels of transaction costs. These findings have opened the door for future discussion on issues of design in regional-scale arrangements

Although similar in many aspects, specific features of these cases have proven useful in addressing the hypotheses in this paper. First, all four have succeeded in maintaining unfiltered status. This demonstrates that the arrangements are effective in maintaining collective action in different contexts. Second, having two cases in the American west (Portland and San Francisco) and two cases in the east (Boston and New York) helps control for regional variations of issues such as water appropriation rights. Third, findings have shown that the effect of transaction costs on mechanism design is not constant. Instead, and only for the case of monitoring, transaction costs generate non-monotonic preferences in design. Although not hypothesized, this finding goes in line with previous findings analyzing specific monitoring mechanisms at smaller scales (Agrawal and Goyal, 2001). Fourth, although the two western cases refer to relationships between a local government and a federal agency,

the Boston experience helps assess the hypotheses on a bilateral agreement in a different context. This, for instance, uncovered a contextual feature that was not hypothesized but proved to be relevant: the type of actors involved matters, at least at the time of designing consequence mechanisms. And fifth, the extreme nature of the transaction costs faced in New York, serves the purpose of contrasting a high-transaction-cost setting with the relatively low-transaction-cost nature of Boston, in similar geographic, political, and legal settings.

Having a case with extreme values in the independent variables such as New York provides useful when the goal is to assess the strength of initial theoretical assumptions, as well as to identify potential intervening variables that were not hypothesized (Seawright, 2016). Although the goal of this paper is to assess the *joint* effect of number of actors, information asymmetries, and scope on institutional design, the existence of an extreme case helps identify potential avenues for future research. In particular, New York shows differences with the other three cases, in line with the extreme nature of its transaction costs. Adding to this, the fact that a similar case like Boston does not differ from San Francisco and Portland raises interesting questions for future research. Perhaps the number of actors and their history of relationships (feature shared by Boston, San Francisco, and Portland), and not so much the scope of the signed agreements (where Boston resembles New York), are driving variations in design. Or perhaps the inclusion of economic development activities changes the nature of these agreements.

Finally, in terms of causal inference, the evidence gathered so far constitutes “hoop tests” (Collier, 2011) of the theoretical expectations. Future work should focus on disentangling the potentially different effects of variations in number of actors, information asymmetries, and scope of the agreements on the design of monitoring, conflict resolution, and consequence mechanisms. The evidence provided here suggests that these variables may play a role in the design of such mechanisms, although it does not entirely discard the existence of unobserved alternative hypotheses.

## **Conclusion**

This paper analyzed variations in the design of mechanisms for monitoring, conflict resolution, and rule enforcement in formal agreements for the governance of shared natural resources at regional levels. A characteristic of resources at this scale is that governments, rather than individual users devise the formal arrangements. This entails the use of different institutional features to ensure rule compliance.

In line with the arguments from the literature on Common-Pool Resources, findings in this paper have shown that formal institutions include mechanisms for monitoring, enforcement, and conflict resolution. However, this paper does not end at assessing the presence/absence of important institutional mechanisms. Rather, the main contribution is in showing the specific ways authors modify those mechanisms to assess varying levels of bargaining costs. In particular, how mechanisms for monitoring behavior and enforcing the rules are modified in the presence of high or low transaction costs. Findings in this paper show that when analyzing arrangements for the production of shared goods at regional scales, there are benefits for taking a broader approach and considering the overall context in which those decisions are made.

A large amount of ground remains uncovered in the analysis of the design of agreements at these scales. A logical next step would be to isolate the effects of specific sources of transaction costs on institutional design, and identify the weight these factors carry in the design of mechanisms. Additionally, future research must address whether such variation is observed in institutional arrangements that failed at jointly governing a shared natural resource.

## **Chapter 6: Representation and institutional outputs: how variations in decision-making processes affect patterns of adaptation**

### **Introduction**

In recent years, a large literature stemming from the environmental sciences has focused on the importance of adaptive institutions in the governance of shared natural resources. Adaptive institutions are those that can be modified by a group of actors in the face of changes in their environments. Much of this scholarship, however, focuses on ambiguous notions of adaptation and is mostly characterized by a normative approach (Chaffin et al, 2014). This paper focuses on a different notion of adaptation, by paying attention to the breadth and depth of patterns of institutional change in adaptive institutions. In particular, the focus is on assessing the effect that variations in decision-making structures have on institutional change dynamics. Understanding these variations can help address how specific decision-making mechanisms lead actors to produce different patterns of adaptation.

To assess this, arguments from the literature on Punctuated Equilibrium Theory (PET) (Baumgartner and Jones, 1993) are incorporated to the discussion. These arguments are brought in to identify whether patterns of outputs present in multi-purpose institutions, like Congress or the Executive are also present in “special purpose” arrangements dealing with environmental management issues (Oakerson and Parks, 2011). The goal is to assess whether differences in decision-making structures result in institutional arrangements that lead actors to increase the scope and/or depth of their involvement.

These arguments are applied to four instances of natural resource governance in the U.S. The cases refer to the production of high-quality drinking water in the cities of Boston (Massachusetts), New York (New York), Portland (Oregon), and San Francisco (California). These cities provide unfiltered drinking water that is obtained from sources outside city limits. To do so, they are required to develop formal arrangements with the landowners where the water sources are located. The purpose of these arrangements is to demonstrate that water providers have control and access to the watersheds, and that they develop watershed protection measures to maintain water quality at the source. These agreements provide excellent settings to analyze the design of adaptive institutions. Reports, plans, and interview data will be studied to identify the breadth and depth of activities conducted in these watersheds over time.

The remainder of the paper will be structured as follows: first, the paper will discuss the main features of adaptive governance, highlighting the need for more work on the effects of variations in institutional design. Second, the literature on Punctuated Equilibrium Theory will be presented, focusing on the effects of features of institutional design on outputs produced over time. Third, the four cases will be presented, explaining their decision-making processes. Fourth, the data and methods section will discuss and assess the evidence. Finally, the paper will conclude with a discussion on the findings and avenues for future research.

### **Adaptation in the governance of natural resources**

Recently, scholars have been calling upon a form of governance that allows coordinating efforts at different scales and levels, to cope with the uncertainty of managing natural resources (Chaffin et al, 2014). This approach, termed “adaptive governance” (Dietz et al, 2003), focuses on how institutions incorporate mechanisms to make decisions in changing environments. Adaptive institutions are needed not only because of the often unpredictable features of their environments, but also (and more importantly) because of human limitations at the time of processing information. Learning in contexts of uncertainty is a costly process affected by individual cognitive limitations and by the friction imposed by the institutions that facilitate collaboration (Lee, 1993).

The main theoretical corpus of this literature comes from the environmental sciences, highlighting the interdependences of the social and ecological components of natural resource

governance. These interdependencies require forms of governance that are able to “absorb both natural and human disturbances while still maintaining structure and function” (Chaffin et al, 2014). Institutions can successfully adapt to their environments whenever they “are able to adjust to encourage individuals to act in ways that maintain and improve to a desirable state” (Koontz et al, 2015: 141). In order to do so, however, adaptive institutions must be able to facilitate processes of social and institutional learning (Folke et al, 2005; Armitage et al, 2008). Social learning involves developing expertise in dealing flexibly with new situations (Folke et al, 2005), as well as incorporating both scientific and local sources of knowledge (Brunner et al, 2005). Institutional learning, on the other hand, refers to resource users creating and modifying rules that adapt to their social-ecological systems.

For the literature on adaptive governance, institutions are a key social variable in enabling collective action and governing interdependent ecosystems (Folke et al, 2005; Koontz et al, 2015). However, the interest in institutions has fostered a multiplicity of concepts that are often unclear (Koontz et al, 2015) and with a high normative content (Karpouzoglou et al, 2016). Much of the literature on adaptive governance has paid attention to which aspects of institutional design facilitate adaptation. Dietz et al (2003) was among the first to highlight the importance of institutions that facilitate a dialogue among stakeholders, that are redundant in relation to other institutional arrangements, and that are flexible enough to facilitate policy experimentation. Brunner et al (2005), for instance, argue that adaptive governance represents a departure from traditional approaches to managing natural resources. The traditional approach, termed scientific management, is characterized for centralized decision-making structures and a desire to apply sound science to inform decisions. Alternatively, adaptive governance assumes a broader notion of science, incorporating local knowledges and experiences, as well as sound science. For this to happen, decision-making structures must also pay attention to community-based strategies, thus increasing the number of interests involved.

In the governance of such resources, actors face myriad uncertainties, and in doing so, they create policy solutions that have unintended consequences. In the case of adaptive institutions, some studies have focused on how aspects of institutional design may foster adaptive governance in empirical settings. Scholz and Stiftel (2005) point out five challenges that the analyst (or decision-maker) must consider: the challenge of representation (who should be represented in the institution); the challenge of process design (providing decision-making processes that satisfy the parties involved); the challenge of scientific learning (how to incorporate scientific information effectively); the challenge of public learning (how can users learn about the consequences of their individual behavior); and the challenge of problem responsiveness (how well is the institution addressing the underlying sources of conflict between its members).

These arguments have been used to study reforms implemented on institutions for the management of shared natural resources, particularly in water governance (for instance, Foerster, 2011; Berardo et al, 2013). Studies like these have focused on how certain design features may help or hinder adaptation. What is still needed is to understand the effects of particular design features, not in terms of whether they facilitate adaptation or not, but rather in terms of how they may do so.

One way of addressing this is by combining insights from the Adaptive Governance with concepts stemming from literature on policy change, in particular to understand what the effects are of variations in design on institutional learning. Moreover, since the Adaptive Governance approach acknowledges that learning in the context of adaptive governance is “neither free nor politically neutral” (Armitage et al, 2005), insights from the literature on policy dynamics and adaptation may provide useful to assess the effects of institutional design on patterns of institutional change.

This paper will address such question by focusing on a specific aspect of adaptive institutions: their decision-making structures. One of the challenges identified by Scholz and Stiftel (2005) has to do with representation, or in other words, “who gets to sit at the table?” Scholz and Stiftel argue that representation can be a double-edged sword, in that too much representation may lead to increased transaction costs, and may increase conflict and lack of legitimacy. The literature in Adaptive Governance and Adaptive Institutions highlights the importance of representation in the design of such

institutions (Scholz and Stiftel, 2005; Lebel et al, 2006). However, in the context of institutional learning, the effects of who participates and what rights are they assigned to these processes remains understudied in the literature (Armitage et al, 2008).

This paper focuses on the following question, should we expect differences in the outputs produced by institutions having different degrees of representation in their decision-making structures? Understanding these dynamics can add another layer of complexity to the study of adaptive institutions.

### **Information processing and institutional outputs**

The Adaptive Governance literature has emphasized issues of institutional design and how they may help or hinder adaptation. In the context of institutions, adaptation is understood as the ability to monitor, evaluate, and modify governance rules over time (Folke et al, 2005; Ostrom, 2005). This notion of institutional change is applied to a context of boundedly rational individuals that attempt to pursue this adaptation through collective action.

Such notion of institutional change where adaptation is a constant process of trial-and-error by boundedly rational actors, and where learning is not free of political struggles is also present in the literature studying dynamics of policy change. The theory of Punctuated Equilibriums was first developed by Frank Baumgartner and Bryan Jones (1993) to understand policy change within policy subsystems. The approach was developed as an alternative to incremental explanations of policy change, by positing that policies often present patterns of change that resemble the incremental, but are interrupted by periods of abrupt change.

For this theory, boundedly rational individuals are unable to allocate attention equally to all policy problems. Instead, they rely on alternatives to reduce the costs of information search. Such efforts to reduce the cost of information acquisition and processing are also present in the design of institutions. In particular, institutions must be able to help decision-makers identify and prioritize the demands from their environments.

In recent years, the literature on PET evolved from a theory of political decision-making to a broader theory of organizational information processing (Jones and Baumgartner, 2005; Workman et al, 2009). In doing so, it expanded its focus to the effects of institutional design on outputs, all within a context of boundedly rational individuals. To this approach, the purpose of institutions is to translate inputs into outputs, and in the process of doing so, they impose frictions or costs (Jones and Baumgartner, 2005). As a consequence, regardless of the flows of inputs an institution receives (for example, the opinions and viewpoints provided by decision-makers, or the demands of constituents), their outputs will tend to be stable and punctuated. In other words, institutions will ignore some signals and react strongly to others (Jones et al, 2003).

In this context, learning plays a central role. However, learning takes place as a fallible process where individuals update their beliefs with difficulty and sporadically (Jones and Baumgartner, 2005). One of the attractive aspects of the PET approach is its understanding of institutional change as a process where boundedly rational individuals attempt to develop and modify policies in a context where existing formal rules impose varying levels of decision costs (or “friction”). This results in patterns of policy decisions addressing changes in their environments (Jones and Baumgartner, 2005).

Following the “friction” hypothesis, the literature on PET has studied whether institutions that impose higher levels of friction produce more punctuated outcomes (Jones et al, 2003; Robinson, 2004; Robinson et al, 2007; May et al, 2008). Robinson (2004), for instance, found that highly bureaucratized school districts were less prone to show punctuated patterns of expenditures than non-bureaucratized districts, which may indicate that the former are better at adapting to changes to their environments than the latter. This finding hints that bureaucratization may help in the processes of information acquisition and processing (True et al, 2014). Robinson et al (2007) continued this analysis and found that centralization and organizational size (two dimensions of bureaucratization) were not likely to produce outcomes as predicted by PET. In a more nuanced take, May et al (2008) argued that the way in which

bureaucracies organize attention (either through formal or informal routines) affects their abilities to respond to policy demands. The authors found that structures that delegate authorities tend to dampen policy signals, resulting in agenda stability and constrained responses. On the other hand, structures of centralized authority and informal routines provide more flexibility in responding to new problems, resulting in more agenda instability.

Recent approaches within this tradition have looked at whether the processes through which institutions search for problems affect their outputs. Institutions designed to deal with complex issues and that incorporate multiple points of view (for instance, by granting multiple actors the right to participate in decision-making) will identify new areas that require attention, expanding their scope of action. This effect is defined as “broadening” (Baumgartner and Jones, 2015). Conversely, institutions designed to deal with narrow and technical issues will attempt to foster “agenda denial”, limiting their scope of action and increasing their involvement on issues they were traditionally involved in. This is defined by Baumgartner and Jones (2015) as “thickening”.

By analyzing the number of policy issues addressed by the U.S. Government over time (for instance, in budget allocations, in the creation of new agencies, in the number of topics discussed in Congressional Hearings, or the topics and length of legislation produced), the authors found that changes in the processes of search and prioritization of information led to variations in the breadth and depth of policy-making activity. During the 1950s and 1970s, the U.S Government experienced a period of broadening. The authors associate this with changes in the patterns of problemistic search in the Executive and Legislative. Changes in the analytical capacity of Executive agencies during the 1950s and 1980s, as well as an increase in Congress’ ability to search for problems through agencies like the General Accountability Office (created in the 1920s) and the Congressional Research Service helped identify new problems requiring government attention.

In the 1980s, the dynamics of information search and processing changed again. An example of this occurred in the decreasing role played by analytic agencies. These changes hindered the government’s ability to search for new information. As a result, the dynamics of government outputs switched from broadening to thickening, in which the government started to focus more intensely on issues they were already involved.

Granted that institutions governing shared natural resources have a smaller scope (Oakerson and Parks, 2011) than Congress or the Executive, the dynamics and consequences of problemistic search can nonetheless be extended to their study. In particular, variations in the number of actors involved in decision-making may increase the number of viewpoints, and thus, the sources of information in adaptive institutions. These arguments present a different approach to understand institutional change. Such approach has never been applied to the study of adaptive governance, and doing so provides a new way of assessing the effects of variations in design on adaptive institutions. Therefore:

*H1 (Thickening hypothesis): Institutional arrangements where few actors participate in decision-making will increase their involvement on issues they were previously involved more than institutions including multiple actors.*

*H2 (Broadening hypothesis): Institutional arrangements where multiple actors participate in decision-making will respond to new information by broadening their scope of involvement more than institutions including fewer actors.*

These hypotheses focus on a specific aspect of institutional design: decision-making structures. In particular, on the challenge of representation (Scholz and Stiffler, 2005) and how variations in decision-making structures may affect the breadth and depth of outputs produced over time. For instance, in bilateral arrangements focusing on a limited array of issues, outputs produced by joint decisions should, in general, ignore any new information that could enter the system demanding attention. Combining this with insights from Baumgartner and Jones (2015), these decision-making structures should “thicken”

their involvement on issues in which they were already involved. On the other hand, arrangements allowing multiple actors to have a say should present a different pattern of outputs. Allowing multiple sources of information should increase the awareness of problems demanding action. Actors in these institutions should expand their scope of involvement, addressing issues they were previously not involved in.

These hypotheses contribute not by arguing if including more actors is better, but rather whether different decision-making structures affect the depth and scope of outputs produced by actors in such institutions.

### **Decision-making in the production of high-quality drinking water: Boston, Portland, San Francisco, and New York**

The cases studied are four cities providing unfiltered drinking water obtained from sources outside city limits. In 1989, the U.S. EPA issued the Surface Water Treatment Rule (SWTR), a series of rules affecting public water systems relying on surface water. The regulations limit the presence of certain contaminants and mandate most water systems to filter their water to maintain quality and health standards. Under specific circumstances, however, water providers are waived from the filtration mandate. To qualify for a waiver, a provider must show that water quality at the source is high, and that they have control over human activities in the watersheds.

The cases studied here are in Boston, Portland, San Francisco, and New York. Water providers in these cities obtain their water from other jurisdictions and have developed arrangements with landowners to protect water quality at the source. In addition, all four cases undergo periodic assessments by regulators in order to show compliance with unfiltered criteria. This section describes the processes through which providers and landowners make decisions regarding watershed protection in each case. Attention is centered on the organizational structures and routines used to aggregate decisions regarding the management of the resource, as well as the number of actors with decision-making authority.

#### *San Francisco*

In San Francisco, water is drawn from lands on Yosemite National Park. Decisions in this case are made following a Federal Act from 1913 (Raker Act), and a series of memorandums of agreement between the City (through the San Francisco Public Utilities Commission - SFPUC) and the Park (NPS).

The topics addressed by both parties are defined in the memorandums of agreements. In there, both parties commit to address “Core Tasks” that further define the mandates from the 1913 Raker Act. The Core Tasks are “*basically a mutual relationship where they [SFPUC] help pay for our [NPS] costs*” (Yosemite National Park Division Ranger, Personal Communication, March 24, 2016). The 2010 agreement included three of such tasks: Source Water Protection, Environmental Stewardship, and Security. In addition to the Core Tasks, which are broadly defined in the agreements, both parties recognize the possibility of Special Projects addressing unexpected events.

Every year, NPS submits a draft budget to SFPUC with the activities planned for the next calendar year. The budget is negotiated with SFPUC, who then makes a recommendation to their Board of Supervisors and the Mayor’s Office to secure funds. According to a SFPUC representative, “*in my time here, our recommendations have been forwarded and nobody has ever tried to question or change the recommendation [...] Sometimes they tell us ‘gee, you don’t get this amount of money, you get that amount of money. That’s something we don’t get to decide, if they constrain the funding, then we go to the park and tell them ‘hey, this is all we get, let’s talk about how we’re going to spend it’*” (San Francisco Public Utilities Commission Representative, Personal Communication, April 11, 2016). Aside from SFPUC and NPS negotiating the budgets, and the SFPUC’s Board of Supervisors deciding, no other actors have a formal or informal say on the content of watershed protection activities.

Every year, the Park Service produces a Report describing all watershed protection activities conducted with SFPUC funding. As part of the requirements for the filtration waiver, the Division of

Drinking Water in the California State Water Resources Control Board (SWCRB, the agency with primacy over STWR implementation) conducts on-site inspections in the watersheds to assess compliance with filtration waiver criteria. In addition, SFPUC conducts Sanitary Surveys evaluating infrastructure issues and potential contamination problems.<sup>51</sup> Annual Reports are appended to the sanitary surveys to show watershed protection program implementation (San Francisco Public Utilities Commission Representative. Personal Communication, August 29, 2016). Some of the activities conducted in the watershed include: facilities management, interpretation services, resources management (including water quality monitoring), visitor and resource protection, and research projects on water quality and wildlife indicators.

### *Portland*

Portland's system shares similarities with San Francisco. First, it only involves two actors: the City of Portland through the Portland Water Bureau (PWB) and the U.S. Forest Service, who owns the watershed lands. Second, like in San Francisco, most programmatic decisions are made on an annual basis. An agreement signed in 2007 by both parties assigns individual responsibilities and minimizes the need of joint action between the City of Portland and the Forest Service. Doing this "*lower[s] administrative and transaction costs for both agencies, resulting in savings for taxpayers and water rate-payers*" (2007 Bull Run Watershed Management Unit Agreement).

For issues that are of joint interest, the 2007 agreement mandates the creation of "functional plans" to further clarify the division of responsibilities between the parties. The drafting of such plans is largely driven by the City of Portland, "*because, the Forest Service [...] has less staff and is less present every day, I would say that, generally speaking, the City takes the lead on the plans, we share drafts with them to make sure it's going to work on the Forest Service side. I don't know if any of them, per se, are things the Forest Service has to approve in a formal way*" (Portland Water Bureau Representative. Personal Communication, June 8, 2016).

Although both parties meet regularly and discuss watershed protection activities, most activities are conducted by the City with Forest Service input. As a Portland Water Bureau representative mentioned, "*I'd say the City is probably responsible for more within the [Bull Run Watershed] Unit than the Forest Service. A lot of it has to do with that they no longer have the funding to do what they used to do because they don't have the resources of revenue that was associated with the timber sales*" (Portland Water Bureau Representative. Personal Communication, June 13, 2016).

As a result, the City behaves as a de-facto manager of the land, "*we have this very challenging dynamic in which the Forest Service is responsible of 95% of the land area within this Unit, and yet, they have no income or budget to administer it. So they rely heavily on the City to help supplement and come up with and support the activities that are necessary to keep things going in a reasonable way to actually steward the landscape*" (Portland Water Bureau Representative. Personal Communication, June 13, 2016).

Following state regulations, every year the Oregon Health Authority (the State agency enforcing filtration avoidance regulations - OHA) performs on-site inspections in the watershed. After these inspections, OHA usually submit comments for PWB to address. Responses to these comments are included in Annual Watershed Reports produced by PWB. Annual Reports also summarize all watershed protection activities conducted in a given year. Inspections and Annual Reports are the main elements used by OHA to continue granting unfiltered status to the Bull Run water. With regards to the 2015 inspection, OHA concluded that: "*No significant deficiencies were noted [...] The Portland Water Bureau continues to meet all of the criteria for the exemption from filtration, and can therefore remain using an unfiltered surface water source as allowed in the Surface Water Treatment Rule.*" (Portland Water Bureau, 2015).

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<sup>51</sup> A more detailed discussion of the Sanitary Surveys is available in SFPUC's website: <http://sfwater.org/index.aspx?page=634>

Because the watershed is closed to other visitors, watershed protection actions focus mostly on water quality indicators. Examples include road maintenance, security and trespassing, fire protection, hazardous materials spills, wildlife, monitoring of water quality levels, among others. These actions are memorialized in the Annual Reports produced by the Portland Water Bureau.

### *Boston*

Boston differs from San Francisco or Portland in that its watersheds are located on open areas owned by local governments and private actors. However, decision-making in Boston only involves two actors: the Massachusetts Department of Conservation and Recreation (DCR) and the Massachusetts Water Resource Authority (MWRA). DCR is in charge of watershed protection and land management, whereas MWRA provides wholesale water services to the Boston metropolitan area. In addition, DCR's budget is completely funded by MWRA. Although funding comes from MWRA, allocations are decided by a Water Supply Protection Trust that includes representatives from MWRA, the Massachusetts Department of Energy and Environmental Affairs, one representative from watershed fishermen associations, one representative from a watershed Historical Society, and one representative from the MWRA's Advisory Board.<sup>52</sup> This organizational structure sets the tone of the relationship between both actors. In words of an MWRA representative, "*Overall, we [MWRA] have about 1200 staff and DCR has 150. So, it's the size of a department to us. We think of them as equals, but it doesn't feel that way. In particular because we fund them. Having said that, I would say that we're 98% in synchrony at a given time.*" (MWRA Representative. Personal communication, June 3, 2016).

Because of the existence of communities living in the area, watershed protection involves a wider array of activities. The presence of communities significantly increases the chances of contamination of the water supply, which demands for activities such as wastewater and stormwater management. DCR offers funding for infrastructure improvement on watershed lands, monitors water quality and quantity in the watershed, develops land management programs, and provides for security in the watershed, among other activities. However, a defining feature of Boston (and New York) is the existence of land acquisition programs and programs for Payments in Lieu of Taxes, through which DCR and MWRA (NYCDEP in New York) make payments to watershed communities for the land they own in the area.

Despite affecting more actors than the west-coast cases, formal decision-making in Massachusetts involves mostly DCR and MWRA. Local communities do not have a formal say, and their involvement is mostly on a case-by-case basis. The main form of involvement is "*usually to contact our [DCR] staff directly, or they will contact their legislators. And we'll hear from their legislators, they will call our Commissioner or they'll call the MWRA's Director and say 'hey, we got a problem with what DCR is doing here'*" (DCR Representative, Personal Communication, July 11, 2016). This does not mean that decisions overlook local interests. Communities are consulted by DCR, but "*there's no 'yay' or 'nay' vote by the cities or towns in the watersheds on any of these activities. Of all of the plans the DCR develops [...] all of those are required to be public documents in that they are drafted, public meetings are held, a draft then is released, comments are received, comments must be responded, and a public plan issued. So the communities out there have an opportunity, individually or as consortiums or as a regional planning agency or whatever, to weigh in on those documents*" (MWRA Representative. Personal Communication, June 3, 2016). In fact, multiple local interests and associations are represented through several advisory committees.

Advising DCR and MWRA are four committees. Two of which advise MWRA. The MWRA Advisory Board, a watchdog organization provides a venue for MWRA ratepayer communities to review MWRA's expenditures. Over 60 communities receiving services from MWRA are represented in the Advisory Board.<sup>53</sup> Also advising MWRA is the Water Supply Citizens Advisory Committee (WSCAC).

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<sup>52</sup> Massachusetts General Laws, c. 10, § 75

<sup>53</sup> Most of these communities are not located in the watersheds.

This is a non-statutory organization funded by MWRA that represents interests of the public (broadly defined). The role of WSCAC is to act as a “citizen advisory committee” to MWRA (WSCAC Representative. Personal communication, August 15, 2016).

On the DCR side there are two regional committees created by M.G.L. 92A ½. The committees are the Quabbin Watershed Advisory Committee and the Ware River Advisory Committee. The role of these organizations is to provide input regarding “fishing, boating, and other recreational activities and environmental, wildlife and habitat matters” within the watersheds (M.G.L. 92 A ½, Sections 13 and 14). Members of these committees are appointed by the Commissioner of DCR, from a list of candidates proposed by different local organizations. A particular feature of these committees is that they do not represent local governments, but rather local interests from hunters, anglers, and environmental organizations. Only representatives from four small communities in Worcester County are members of the Ware River Advisory Committee. Of all four committees, the MWRA Advisory Committee and WSCAC have a seat in the Water Supply Protection Trust.

Decisions in Boston are made in 5-year “Watershed Protection Plans” (WPP). These documents provide the parameters for all watershed protection actions and programs. WPPs are produced by DCR, with direct input from MWRA and State regulators (DCR Representative. Personal Communication, July 11, 2016). These plans are approved by the Massachusetts Department of Environmental Protection (MassDEP), and are used as one of the guidelines for their oversight of the DCR/MWRA water system. During the drafting of these plans, advisory committees provide input, but they do not have any veto authority.

The process for maintaining unfiltered status in Massachusetts is similar to San Francisco or Portland. Every year, MassDEP conducts on-site inspections and assesses WPP implementation (DCR Representative. Personal Communication, July 11, 2016). Also, just like San Francisco and Portland, annual reports and plans are produced by DCR and revised by MWRA and the Water Supply Protection Trust. The plans and reports are “*our mechanisms for internally allocating resources towards complying with promises we made in the watershed protection plan [...] each year, the regulators come out and they assess our performance against milestones that we agreed in the watershed protection plans, and against anything that has come up as an issue in the meantime [...] As long as they [MassDEP] are satisfied with watershed protection, and they’re satisfied that we meet the numeric criteria, turbidity, and so on, they issue us a document that says ‘you’re still in good shape’. We do not have like New York, a multi-year filtration avoidance determination document.*” (MWRA Representative, Personal Communication, June 3, 2016).

#### *New York*

Decision-making in New York involves more actors than the other cases. Like Boston, water in New York City is obtained from watersheds where multiple local governments and private actors own land. The main agreement for watershed management and protection, the 1997 Memorandum of Agreement, included the City of New York through the Department of Environmental Protection (NYCDEP), watershed communities (Local Governments and County Governments), the U.S. Environmental Protection Agency (U.S. EPA), the New York State Department of Environmental Conservation (NYSDEC), and environmental NGOs. This agreement defined the main mechanisms for decision-making and created venues for program implementation and conflict resolution. Of particular importance are the Catskills Watershed Corporation (CWC), a venue created to deal with program implementation in the western part of the watersheds, and the Watershed Protection and Partnership Council (WPPC), a conflict resolution venue. The CWC includes elected representatives from watershed communities, and it is in charge of designing and implementing many of the programs funded by the City.

However, big programmatic decisions are defined in Filtration Avoidance Determinations (FADs) issued originally by the U.S. EPA and later by the New York State Department of Health (NYSDOH) every 5 years. FADs are the formal documents authorizing the City to provide unfiltered

drinking water. FADs also define watershed protection activities required to maintain compliance with SWTR. Unlike Boston, Portland, or San Francisco, the unfiltered status of New York City's water is revised every 5 years. In addition to reporting to regulators (NYSDOH), the filtration avoidance determination granted to the City has always been, in a way, temporary. FADs were originally issued for a period of 5 years until 2007, where NYSDOH issued a 10-year FAD.

The reasons for these differences in the assessment of filtration avoidance status lays on the natural features present in New York, and most importantly, the history of the relationship between the parties involved. This was mentioned by a NYCDEP representative when comparing New York to other unfiltered cases: *"These [other] watersheds are sort of, if you want, forever wild land. So, therefore, the threats and or impacts to water quality is much less so than if you, say, compared to the New York City watershed. Now, even Boston doesn't have the same level of sort of human anthropogenic sort of activities going on"* (NYCDEP Representative. Personal Communication, July 12, 2016). This argument was also shared by a CWT representative, *"a lot of the factors that EPA or the delegated agencies were really looking at [in other unfiltered watersheds] was primarily monitoring the water quality. [...] NYC's is far bigger and it's truly a living and partially developed watershed. So it involves a lot more factors that had to be resolved. I think that may be the reason for the distinction, but it is interesting that ours is far more detailed than others."* (CWT Representative. Personal Communication, June 16, 2016).

The second reason why FADs are structured different in New York has to do with their history. New York is famous for the level of conflict between the parties (Galusha, 2016; Hanlon, 2015; Soll, 2013). In many aspects (such as land extension and types of actors involved), Boston's experience resembles New York. Yet, the process of showing and maintaining compliance in both cases is different. The difference lays in the historical paths taken in each case. When asked about this, an MWRA representative mentioned that *"By virtue of having been deep in the hole, when they [New York] first submitted the application for filtration avoidance determination, they included an enormous amount of detailed deliverables, and that set the stage, the framework for subsequent approvals. We [in Boston], I think, somewhat strategically and some by good luck, structured ours a bit more flexibly and with fewer deliverables"* (MWRA Representative, Personal Communication, June 3, 2016).

FADs are structured following a Long-Term Watershed Protection Program (LT-WPP) developed by the City every 5 years. The City has been developing LT-WPPs since 1991, in preparation for their first filtration waiver application. Each FAD is produced by NYSDOH, with direct input from U.S. EPA. The process of negotiating a FAD involves the City, NYSDOH, and U.S. EPA. It begins with the City submitting an assessment report where they line up activities for the next 5-year period. This report is assessed jointly by NYSDOH, NYSDEC, U.S. EPA, and the City. During these meetings, *"the City goes over the planning sheets at the meeting, explaining what their proposal is and why, we [NYSDOH, NYSDEC, U.S. EPA] ask questions, make some counter proposals if needed, and then a conversation ensues about the planning sheet [...]. Often the City will come back to us at a later date with a counter proposal or some additional information. After the Regulators and the City come to an agreement about the specifics of the program deliverables, the City revises their planning sheets accordingly, and then submits a Long-Term Plan report in December that will contain all the agreed-upon deliverables in the planning sheets.. In the Winter or Spring, DOH will take the Long-Term Plan Assessment report and incorporate that into the Draft FAD. The Draft FAD will also contain any other program revisions that have been made since the Long-Term plan was released."* (U.S. EPA Representative. Personal communication, August 15, 2016).

Although watershed communities and other relevant stakeholders do not participate in these meetings, they are consulted by NYSDOH. During the negotiation of a new FAD, *"In May and June we [NYSDOH, U.S. EPA, NYSDEC] hold stakeholder meetings with groups such as the CWC, WAC [Watershed Agricultural Council], Coalition of Watershed Towns, Environmental Groups, Soil and Water Conservation Districts, and East of Hudson Communities, so we can get their input on the current FAD programs and the ideas they have for the next FAD [...] we also hold four public information sessions around the watershed to get input from people who may not be part of stakeholder groups. In*

addition to that [...], the West of Hudson communities have also been meeting with the City and the regulators on a regular basis about the revisions for the Watershed Rules and Regulations. The FAD development process also includes a 45-day public comment period after the Draft 2017 FAD is officially released in the Spring/Summer of 2017.” (U.S. EPA Representative. Personal communication, August 15, 2016).

Like Boston, activities in New York involve a wider array of issues than Portland or San Francisco. However, the 1997 Memorandum of Agreement included a set of programs that go beyond watershed protection. The City also committed to fund programs for economic development in the watershed, as a condition for continuing acquiring land in the area.

In sum, the cases discussed involve different numbers of actors and have different scopes. Portland and San Francisco involve only two actors and, because their watersheds are mostly closed to the public, watershed activities focus mainly on biophysical indicators. Boston and New York, on the other hand, rely on watersheds where multiple actors and local governments are involved. The main differences between Boston and New York are that the participation of local governments is much more limited in the former. Also, New York focuses on a broader array of issues (including economic development) and does so through organizations like CWC. Table 6.1 provides a summary of the number of actors and the most important documents produced in each case.

**Table 6.1. Main features of each case**

<b>Case</b>	<b>Actors involved</b>	<b>Main document produced</b>	<b>Periodicity</b>
<b>Boston</b>	MWRA, DCR, MassDEP, Advisory Committees	Watershed Protection Plan	Every 5 years (approx.)
<b>New York</b>	NYSDOH, NYSDEC, City of New York, U.S. EPA, Watershed Communities	Filtration Avoidance Determination (FAD); LT-WPPs	10 years, revised every 5
<b>Portland</b>	City of Portland, U.S. Forest Service	Annual Plans	Annually
<b>San Francisco</b>	City of San Francisco, Yosemite National Park	Annual Plan & Report	Annually

### **Data and methods**

Formal documents in each case are analyzed. Since implementation and enforcement of the SWTR is delegated to State-level authorities, requirements for reporting and planning documentation vary. In Boston and New York, big policy decisions are documented in multi-year documents, whereas in Portland and San Francisco, decisions are made on an annual basis.

In Boston, the main documents guiding watershed protection are the Watershed Protection Plans (WPPs). WPPs existed even before the creation of DCR, with the first ones produced by a consulting company. In addition, different WPPs were developed for the three watersheds in the system, some of them at different points in time. The two main watersheds, Quabbin and Wachusett, were considered here. The third watershed, the Ware, is used only in situations of emergency and does not receive the same level of protection as the other two. For the Quabbin watershed, WPPs were produced in 1991, 2000, 2008, and 2013. For the Wachusett, reports were produced in 1991, 1998, 2003, 2008, and 2013. In total, 9 Watershed Protection Plans were coded, covering a period from 1991 to 2013.

As part of the evaluation of the filtration waiver, Annual Reports are also produced by DCR. These reports list the operational activities conducted in a 12-month period to implement the WPPs. Annual Reports do not rely much on a textual description of activities, but rather list the tasks conducted within a program. A total of 12 Annual Reports were obtained, covering the years 2005 through 2016.

In New York, Filtration Avoidance Determinations were produced in January of 1993, December 1993, January 1997, May 1997, November 2002, July 2007, and a revised FAD in May 2014. Due to issues accessing the FADs, Long-Term Watershed Protection Plans (LT-WPPs) were coded. LT-WPPs are produced by NYCDEP every 5 years as part of the FAD application process, and discussed with regulators through the mechanisms defined above. Every LT-WPP must incorporate mandates from their prior FADs, and their content and structure follows that of FADs. LT-WPPs were produced in 1993, 1996, 2001, 2006, 2011, and 2016. All but the 1996 document were obtained and analyzed. In addition, Annual Reports on the status of implementation of each LT-WPP were obtained and coded. Unfortunately, only 7 reports were available to the researcher, for years 2002, 2007, 2009, 2012, 2013, 2014, and 2016.

FADs and LT-WPPs describe big picture policy decisions on watershed protection. However, the 1997 MOA added a new organization: the Catskills Watershed Corporation (CWC). This organization is in charge of design and implementation of many FAD programs and other programs created directly by CWC. In the CWC, elected officials from communities West of Hudson join the City, State, and environmental organizations to make decisions on program creation and implementation. Most of the work done by CWC focuses on developing and implementing water quality and economic development programs in the western portion of the watersheds, with funding from the City. In this setting, the programs and mandates of the FAD and the 1997 MOA cannot survive without the CWC, and vice-versa.

Every year, an independent consultant audits the CWC and produces a report called Annual Financial Statement. These Annual Financial Statements list all cash flows from CWC, including a list of expenditures per CWC program. The financial statements provide an alternative source for measuring instances of broadening or thickening. A total of 19 financial statements were coded, covering the period 1997 – 2015.

In Portland and San Francisco there is no similar long-term documentation<sup>54</sup>. Instead, most decisions are incorporated in Annual Reports listing watershed protection activities. In San Francisco, reports are produced by the National Park, summarizing the watershed protection activities conducted by the Park with City funding. Although the first formal memorandum of agreement between San Francisco and Yosemite National Park was signed in 2005, 14 annual reports from 2002 to 2015 were obtained and coded.

Finally, the Portland Water Bureau also produces reports as part of their annual filtration waiver evaluation. These reports indicate the different activities conducted in the Bull Run Watershed Management Unit by PWB and the Forest Service. A total of 9 annual reports were coded, covering the years 2007 through 2015.

#### *Coding protocol*

Broadening and thickening capture two aspects of institutional change. Broadening reflects the taking of new responsibilities, and thickening refers to doing more of the same (Baumgartner and Jones, 2015). However, capturing those effects in small scope institutions imposes some challenges. First, the four arrangements studied here were created to address one goal: protection of water quality at the source (and economic development, in New York). This goal is rather specific when compared to the organizations studied by Baumgartner and Jones (2015) and the PET literature in general.

Second, as a consequence of the different type of arrangements studied here some of the analytical tools developed by Baumgartner and Jones (2015) are ill-prepared to capture instances of

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<sup>54</sup> MOAs in San Francisco provide descriptions of general areas of interest, but do not fully describe programs and their components.

broadening and thickening in these four institutional arrangements. PET is known for having produced one of the most developed research programs in the study of policy. Studies in this tradition rely on a series of commonly agreed documents and coding guidelines that ensure researchers can follow a consistent data collection process.<sup>55</sup> In particular, analyses within this literature follow a common codebook developed by multiple researchers (Bevan, 2014). This master codebook lists and defines 21 topics and 220 subtopics, useful in analyzing different sources of data.<sup>56</sup> However, this list of subtopics does not allow capturing more subtle variations in the cases studied here. For instance, within the Topic “Environment”, the PET Master Codebook identifies 11 subtopics, with some (for instance “Air pollution”) not applying to the cases studied here, and others (for instance “Drinking water”) encompassing most of the activities conducted in these watersheds. As a result, such a general classification may not capture specific nuances in the number and types of activities conducted by the parties to these agreements.

Third, this study relies on the comparison of documents structured differently. As a result of these factors, an alternative approach is required for capturing instances of broadening and thickening. The adopted coding scheme relies on defining broadening and thickening within the context of each document. This approach sacrificed depth in coding in order to obtain comparable data. The first step was to identify the structure of each report and plan.

In San Francisco, annual reports are structured around activities conducted by each Park Service division. Within each section, reports list the activities conducted by each division. The addition of a different Park Division was considered an indicator of broadening, since it indicates that a *new* division with a specific expertise was brought in to conduct watershed protection and maintenance activities. Also, the addition of an activity conducted by a Park Division was considered an indicator of *thickening*, since it denotes that a previously involved Division is conducting more activities in their area of expertise.

In Portland, annual reports are structured around themes that affect water quality. Within each theme, reports list and describe activities conducted to address those issues. Most activities are conducted by PWB. The addition of a new theme is considered as an indicator of *broadening*, since it represents the identification of an issue where the City and Forest Service had not previously been involved in. Within each theme, the addition of a new activity is an indicator of *thickening* for coding purposes.

Watershed Protection Plans (WPP) in Boston list and describe the programs to be conducted by DCR in the watersheds. An increase in the number of programs listed in a WPP is considered as an indicator of *broadening*. In addition, each WPP describes the components of each program and the activities to be conducted for its implementation. Likewise, an increase in the number of components of a program is coded as an increase in the level of *thickening*. The more subcomponents a program has, the *thicker* it is.

Finally, in New York, the structure of Long-Term Watershed Protection Plans (LT-WPPs) is similar to Boston’s WPPs. LT-WPPs are structured around programs to be implemented in the watersheds, with subheadings identifying program components. The inclusion of a new program is considered an indicator of *broadening*, whereas the inclusion of more components within a program is considered as an indicator of *thickening*.

The benefit of these measures is that they provide a context-specific way of measuring institutional change in each case. In all four cases, instances of broadening and thickening are measured relative to the structure of their own reports, providing an accurate depiction of patterns of adaptation in each case. However, care must be exercised when attempting any cross-case comparison between values in different cases. The case-specific approach for measuring broadening and thickening yields measurements with different scales and ranges, limiting the power of conclusions drawn from comparing the same concept across cases.

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<sup>55</sup> These documents and guidelines are available at <http://www.comparativeagendas.net/>

<sup>56</sup> The full list of topics is available at: <http://www.comparativeagendas.net/pages/master-codebook>

To provide additional leverage to the measures of thickening, an alternative measure that captures the extent of text devoted to explaining watershed protection activities was included. In their analysis of congressional legislative action, Baumgartner and Jones (2015) examined the cumulative number of pages of statutes passed over time as an indicator of *thickening*, capturing the rates at which law was accumulating in Congress over time. A similar approach was taken here. Each report and plan includes descriptions of each section. Aside from counting the number of components of each section, the extent of the text devoted to explain each program was considered. This was captured by counting the number of paragraphs used to define a given section.<sup>57</sup> Considered alongside the number of components of each section within a report or plan, the paragraph count measure is another indicator of how much detail is put into it. Although a rough and limited measure, paragraph counts provide a robustness measure to capture thickening. The average correlation coefficient between both thickening measures is 59%, with San Francisco having the highest correlation at 75% and Boston having the lowest at 36%.

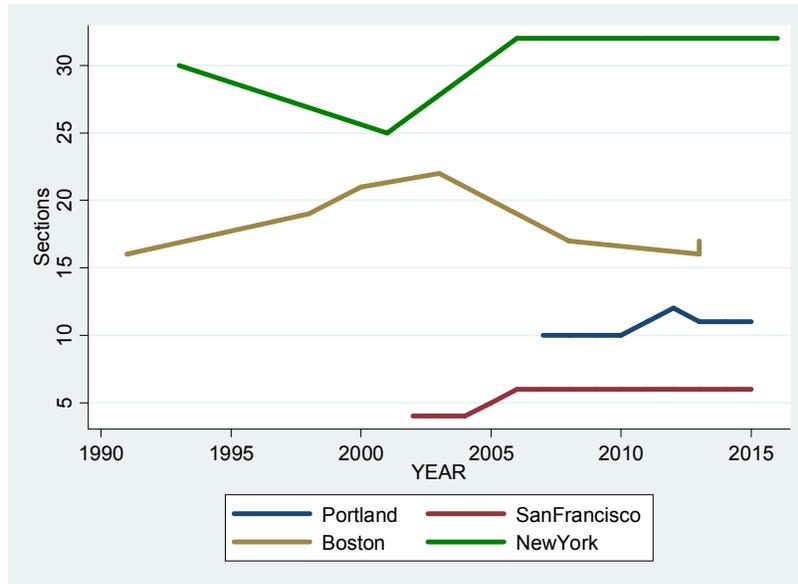
### **Broadening**

Hypothesis 2 posits that arrangements where decision-making involves multiple actors should present higher levels of broadening over time. Of the four cases studied, New York and Boston include more actors than Portland or San Francisco.

Although each arrangement has been in place for different lengths of time (for instance the Portland agreement was signed in 2007, whereas the New York MOA is from 1997), sufficient data was gathered to identify emerging trends. Figure 6.1 shows the extent of broadening identified in annual reports (Portland and San Francisco) and long term plans (Boston and New York) for every case. In San Francisco, the line graphs the number of divisions involved in watershed protection activities, in Portland it is the number of themes addressed for watershed protection, and in Boston and New York the lines represent the number of programs reported in a given WPP or LT-WPP.

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<sup>57</sup> Unfortunately, in 2011, the San Francisco reports changed the format of their text, including the same amount of text in fewer pages. Thus, including a page-count variable would not measure thickening consistently in San Francisco.

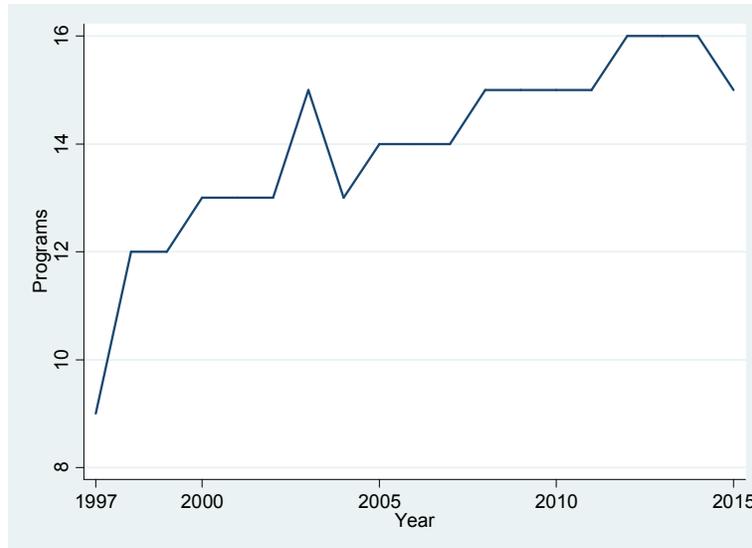


**Figure 6.1. Broadening over time**

Boston and New York show a mix of positive and negative changes in the number of programs, especially during the first couple of plans. San Francisco and Portland, on the other hand, show less variation over time. In New York, most changes took place in between the first LT-WPP (1993) and the fourth (2006). Two issues could explain this dip in the number of programs. First, the LT-WPP from 1996 is missing from this dataset.<sup>58</sup> However, the impact of this missing document should not have a significant effect on the trend observed here, especially considering that the 2001 LT-WPP was produced based on the 1996 plan. An alternative explanation has to do with institutional changes. The 1993 LT-WPP was produced prior to the 1997 MOA. During this era, the City underemphasized the interests of watershed communities, focusing exclusively on controlling biophysical indicators. With the signing of the MOA, new programs were included and many were removed as part of the negotiations between the City and watershed communities. The 2001 LT-WPP is the first plan post-MOA, and variations in the number of programs could be explained as an effort in balancing the demands included through the Memorandum of Agreement, balance that seemed to have found a stable point in the 2006 LT-WPP.

The 1997 MOA also created the Catskill Watershed Corporation, a regional actor with the ability to make decisions over program design and implementation, following FAD and LT-WPP mandates. Also, the CWC is the only venue where all stakeholders (City, State, Local Communities, and environmental parties) sit at the table in a level play field. Figure 6.2 presents the number of programs identified in each CWC Annual Financial Statement.

<sup>58</sup> Multiple contacts with the New York City Department of Environmental Protection and U.S. E.P.A proved unsuccessful in retrieving this document.



**Figure 6.2. Number of CWC Programs per year**

Figure 6.2 shows a clear increase in the number of programs over time, slowly declining after 2014. This increase in broadening is similar to the one observed in the post-MOA trend in Figure 6.1 However, CWC experienced a more constant level of broadening than LT-WPPs.

In Boston, decision-making also experienced some variation. The 1991 and 1998 WPPs were produced by a consulting agency hired by the Metropolitan District Commission (the predecessor of DCR) and MWRA. This was due to a lack of resources on the MDC side. According to an MWRA representative, *“the first couple of plans were funded and managed by the MWRA and MDC, but MDC didn’t really have the resources to get off the ground for the first couple of plans. So we did them using an external consultant. Once we sort of had that in place, then the DCR took over, built up capacity and took over doing that work”* (MWRA representative. Personal communication, June 3, 2016). This change, however, does not represent a change in decision-making but rather a change in the actor in charge of writing these plans. After this, the breadth of programs started to increase up until 2003, where the number of programs begins to decrease.

Portland and San Francisco show more typically incremental trends. Both cases show a small spike in the number of programs at a given point in time, followed by a period of stability. Changes in Portland took place in 2011 and 2012, with the incorporation of a theme addressing new federal regulations on water quality (LT2 Compliance Program) and a new theme regarding monitoring *Cryptosporidium* parasites in the water. The LT2 compliance program was in place for one year. In San Francisco, the increase was due to the incorporation of the Division of Resources Management & Science, which that year started receiving funding from SFPUC. The funding was aimed at studies assessing wilderness management issues, developing indicators of user impacts on water quality, and studies on management of cultural resources in the area.

To summarize, some within-case differences emerge in Boston and New York. In Boston, WPPs tended to become broader immediately after they became a DCR product. However, the breadth of WPPs started declining shortly after. After the 1997 MOA in New York, watershed communities started having a more important role in the discussion of LT-WPPs and FADs. As a result, LT-WPPs went through a period of adaptation post-MOA, which resulted in an initial decline in the number of programs, later increasing by 2005. Compared to LT-WPPs, CWC experienced higher and more constant rates of broadening. The continuous extent of broadening experienced by this organization indicates that other

aspects may be affecting this pattern. Of importance to this chapter are the number of actors with a say in decision-making, and the nature of the new organization

In CWC, members from small communities in the West of Hudson region sit at the table face to face with City and State representatives. Decisions in the CWC are made through vote, and all actors have a vote. This puts representatives from local communities and environmental groups in an equal position when negotiating new programs with the City and State. On the contrary, although these actors participate in the drafting of new LT-WPPs and FADs, their role in these processes is consultative.

A second aspect is the novelty that CWC represented. This organization was created from scratch by signatories of the agreement. As such, it was devoid of any path-dependent trends that could constrain the nature of the decisions made by its members. This may explain the freedom that CWC members had at the time of expanding the breadth of their actions. Portland and San Francisco also present slight increases in the number of programs over time, but of a smaller intensity than the East Coast cases, and not attributed to changes in decision-making procedures. Therefore, some evidence may favor the broadening argument in Boston and New York. However, the observed trends point at the existence of a more nuanced relation between the number of actors involved in decision-making and the breadth of the activities they conduct.

### **Thickening**

Thickening is defined as “doing more of the same” (Baumgartner and Jones, 2015:177). In the context of this paper, thickening is defined as increasing the involvement in pre-existing activities. Thickening is operationalized, first, by counting the number of components within the sections in a report or plan. All reports and plans studied here list a series of themes, main programs, or main actors conducting watershed protection activities. Thickening was measured by looking at the components within each section. For instance, WPPs in Boston include a section called “Water Quantity”. Within this section, the 2013 Quabbin WPP identifies three subcomponents: Meteorological Monitoring, USGS Stream Gauges, and Climate Change Monitoring. The addition of a component to the Water Quality section would count as thickening. Because reports and plans often change their structure, the coder analyzed all sections and section components in each case for changes in the way they were reported or changes in their names, to avoid omitting a component that was moved to a different section.

Within every report or long-term plan, some sections have more components and, by extension, are described more than others. To account for this variation and obtain aggregate parameters for each point in time, a Locally Weighted Scatterplot Smoothing (LOWESS) technique was applied. LOWESS is a non-parametric smoothing approach used to identify trends without making assumptions about the shape of the observed distribution. LOWESS produces local averages within a pre-determined “slice” of the data. The local averages are produced through weighted least-square regression that assigns more weight to observations that are closer to the pre-selected slice (Fox, 2008). The benefit of LOWESS is that it provides a visual representation of trends over time, in this case, regarding the number and percentage changes of program components and paragraphs. Figure 6.3 presents the cumulative number of components in each case.



**Figure 6.3. Cumulative Program Components**

Over time, the number of program components increased at higher rates in Portland and San Francisco than in Boston and New York. In New York, however, thickening rates increase after 2001. Notwithstanding, observed patterns of cumulative programs go in line with the expectation from Hypothesis 1. The comparison between these rates of thickening serves to assess the rates at which activities are accumulating within each case. Because the way in which this concept is measured, plotting all four lines in a single graph, or modifying the scales of each graph could significantly affect the slope of these lines. All four graphs in Figures 6.3 and 6.4 are presented with a default scale that is appropriate for each case. Nevertheless, these values must be interpreted with care.

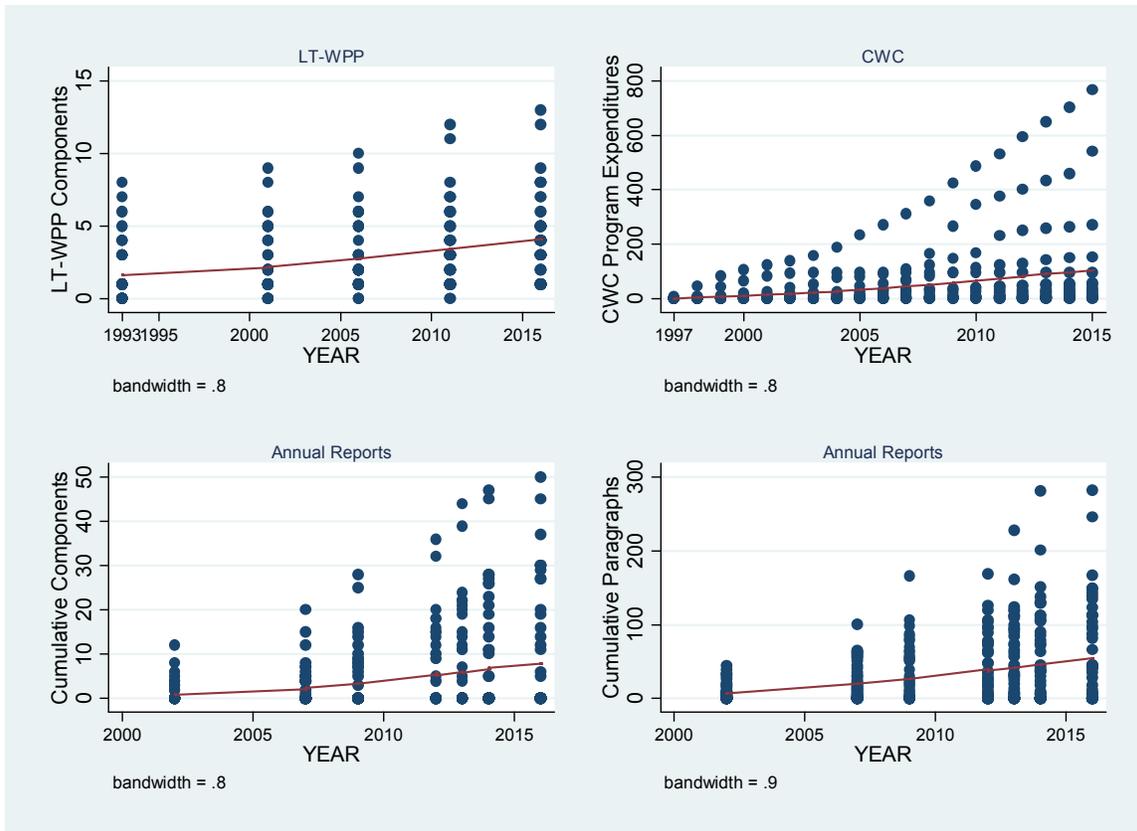
Another measure of thickening applied is the number of paragraphs used to describe a program. Counting the length of a section within a report or plan provides a rough measure of the length of activities within a report or plan. Figure 6.4 shows graphs of cumulative paragraphs over time.



**Figure 6.4. Cumulative Number of Paragraphs**

The measure of paragraph count does not provide sufficient evidence to support Hypothesis 1. Portland shows the steepest rates of increase in paragraphs over time, whereas San Francisco does not seem to differ from Boston and New York. Overall, the observed trends in number of program components and paragraph counts support Hypothesis 1 only for the case of Portland. San Francisco, the other case with few actors, does not present consistent measures across the two measures.

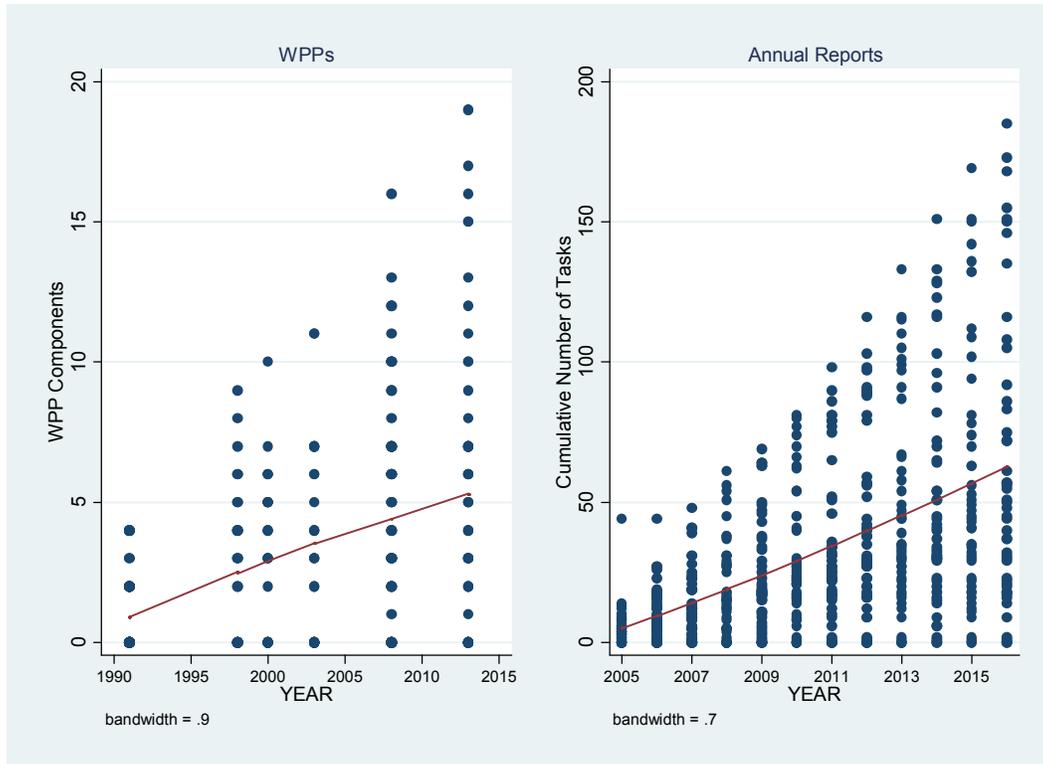
To address issues regarding the different nature of the plans in New York and Boston, data from their annual reports and from CWC expenditures is also analyzed. In New York, annual reports were coded identifying the number of section components and the number of paragraphs within each section. In addition, data from CWC’s Annual Financial statements was coded. Financial statements show variations in program expenditures over time. In doing so, they provide a different source of thickening. Figure 6.5 compares rates of thickening between LT-WPPs, Annual Reports, and CWC expenditures over time.



**Figure 6.5. Comparison of Thickening measures in New York**

Rates of thickening in LT-WPPs are similar to measures of program components (lower left graph) and paragraph counts (lower right graph) in Annual Reports, providing a robustness check to the findings in Figure 6.2. However, trends in CWC expenditures differ from LT-WPPs and Annual Reports. The top right graph displays CWC’s cumulative expenditures, measured in hundreds of thousands of dollars. This low level of broadening hints at a different dynamic within CWC, which will be discussed in the next section.

Boston is the other case that relies on long-term plans to guide watershed protection activities. As part of their FAD evaluation process, DCR must also produce Annual Reports detailing the implementation of WPPs over a 12-month period. However, Annual Reports have a different structure than WPPs. DCR’s Annual Reports list the numbers of tasks conducted during a calendar year within each WPP program. As a result, measures of components (as the number of sub-sections in the text) or paragraph counts were not possible to obtain for these reports. Instead, thickening was measured as the number of tasks reported for a program. Figure 6.6 compares the cumulative number of tasks conducted per program per year with the rates of thickening presented in Figure 6.3. Figure 6.6 shows that thickening rates in Boston WPPs and in Annual Reports share similar slopes.



**Figure 6.6. Cumulative Components and Paragraphs in Boston Annual Reports**

Results so far indicate that thickening seems to be higher in Portland and partially higher in San Francisco when compared to New York and Boston. However, due to the limitations of these measurements, findings do not single out whether the observed dynamics are product of the way in which these values are presented. To provide a more accurate definition of the relative levels of broadening and thickening in each case, the next section provides a within-case comparison of broadening and thickening rates.

*Assessing thickening and broadening within cases*

Patterns of thickening and broadening can be compared to each other within cases. Hypotheses 1 and 2 argue that rates of broadening should be higher in arrangements that incorporate more actors to their decision-making processes, whereas thickening should be higher in arrangements incorporating fewer actors. Figure 6.7 displays LOWESS lines for the cumulative broadening measures and cumulative number of program components *within* each case.<sup>59</sup> Although the lines are in different scales, plotting them together can help assess whether rates of cumulative programs and program components follow different trends within a single case.

[FIGURE 6.7 ABOUT HERE]

This graph unveils a pattern: expansionary periods where an institution broadens its scope of action are followed by new actions created to “fill” those new areas. This process, identified in the case of the U.S. Government (Baumgartner and Jones, 2015), is also present in New York, San Francisco, and

<sup>59</sup> The same graph was plotted for the broadening measures and cumulative paragraphs, yielding similar results.

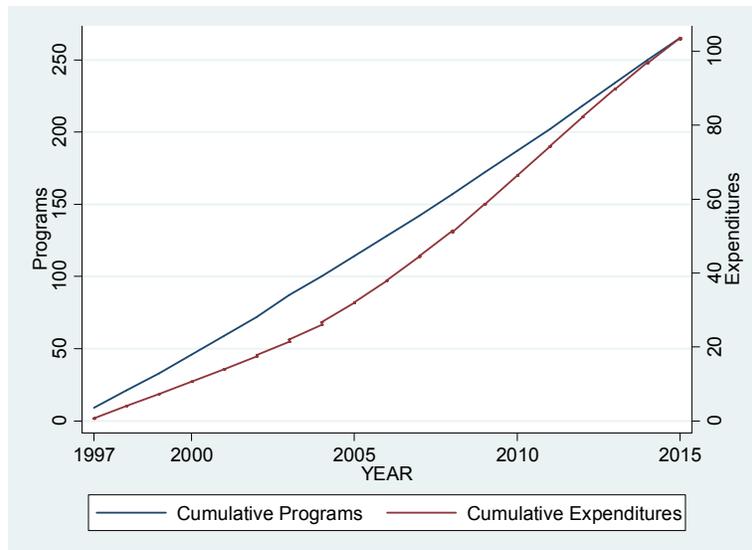
Portland. In these cases, rates of growth for thickening at some point surpass the broadening rates. The exception is Boston. In there, thickening rates seem to always grow at constant rates, with broadening growing at a higher rate during the period 1998-2003, after which it starts declining.

Aside from the differences identified in Figures 6.3 and 6.4, rates of thickening do not experience large variations over time relative to broadening. Instead, most changes seem to occur in the rates of broadening, and only for Boston and New York. Within-case variations in their decision-making processes can once again explain these variations. The graph above shows considerably flatter rates of broadening for 1991 and 1998, taking off after 2000, year in which MDC (predecessor of DCR) took charge of writing the WPPs. In New York City, the effects of the 1997 Memorandum of Agreement are also present. The first post-MOA LT-WPP was produced in 2001, point at which the rate of broadening and thickening begin to increase.

These pre and post comparisons show the effects of changes in decision-making within a single case. Changes in New York’s decision-making mechanisms seem to have affected their rates of broadening, in line with Hypothesis 2. In Boston, the evidence seems to point in the same direction. However, in this case, the change was not so much on the processes for decision-making and writing of the WPPs, but rather in changing the actor in charge of writing those plans.

After these changes, trends of broadening start resembling those of Portland and San Francisco, hinting that broadening may not be driven entirely by the original decision-making structure of an institution, but may also respond to disturbances in decision-making processes. That seems to be the case at least for the long-term programs in Boston and New York.

In the case of CWC, rates of broadening and thickening follow the hypothesized relationship. Figure 6.8 displays LOWESS lines for broadening and thickening in CWC’s Annual Financial Statements.



**Figure 6.8. Broadening and Thickening in CWC Financial Statements**

The larger amount of actors involved in decision-making, and the fact that the opinion of every CWC member carries the same weight has produced patterns that follow Hypothesis 2. From 1998 to 2014, CWC has been extending their scope of involvement at higher rates than its levels of thickening. This may be the product of two factors: first, the significantly larger number of actors involved in making decisions in the CWC when compared to those involved in decisions over FADs or LT-WPPs. The

second factor is related to the nature of CWC. By being a creation of the MOA, it was not tied to any form of decision-making or actions conducted pre-MOA. In that sense, the CWC provided a new arena in which parties can make decisions from scratch. To understand these findings in context, the next section will discuss qualitative evidence provided by members of these arrangements.

#### *What are the perceptions of decision-makers?*

Relying exclusively on documental evidence may obscure changes in perception regarding the implementation of watershed protection activities. To assess this, representatives from the main organizations in the four cases were asked about the evolution of watershed protection activities since the granting of a filtration waiver.

The qualitative evidence identifies two issues affecting broadening and thickening: on one hand, the limited goal of these arrangements. The second one is learning. Although actors in these arrangements have been protecting their watersheds for several decades, all their arrangements are relatively young. This imposed a learning curve regarding how to govern the resource in partnership with others.

The goal of these agreements was identified as a major reason limiting expansion. In words of a Portland Water Bureau representative: *“Conservation is the same thing. I don’t think there has been much change, we’ve established the general parameters and the issues we are trying to deal within them”* (Portland Water Bureau representative. Personal Communication, June 13, 2016). Other actors also recognized the cost aspect of broadening: *we’d [SFPUC] prefer not to have core programs expand every year, at some point it gets too expensive and we can’t, despite staff interest, we can’t fund everything”* (San Francisco Public Utilities Commission representative. Personal Communication, April 11, 2016).

Also, learning about socio-ecological dynamics played an important role in the types of activities conducted. As one MWRA representative puts it, *“early on we had a lot more remediation. [...] In the 20 or so years a lot of those things have been resolved [...] The kind of activities have changed because we’ve gotten smarter, you know, we’ve been using more science and more knowledge, and also because we’ve gotten rid of some of the most pressing issues”* (MWRA representative. Personal communication, June 3, 2016). A similar sentiment is also present among New York respondents, who recognize that after a certain level of control is achieved, activities should focus on maintaining a level of quality. In the interviewee words, *“I would say that we have not gotten into the maintenance load or status quo. I still think there are things that need to be done, and will continue to be done, and adding on to those things, to try to continue to improve the programs. Now, other certain things have wrapped up, for instance, the wastewater treatment upgrade program, the community wastewater management, that stuff will sort of come to an end. [...] So you see sort of a shifting of programmatic responsibilities. You’re getting out of sort of the capital building construction kind of phase, and now you get in sort of the ‘well, let’s make sure this thing is maintained properly over the next 20 years, 20 plus years going forward.”* (New York State Department of Environmental Conservation representative. Personal communication, July 12, 2016).

#### **Discussion**

The evidence provides partial support to the broadening hypothesis, and no consistent support for the thickening hypothesis. Hypothesis 2 posited that arrangements involving multiple actors in their decision-making processes should broaden their scope of involvement. This is true for the CWC in New York. This new organization involving myriad actors with decision-making authority has shown consistent levels of broadening over time, higher than its thickening rates.

Notwithstanding, differences are also present between Boston and New York when compared with Portland or San Francisco. Boston and New York (the two cases involving more actors) show differences with Portland and San Francisco (the two cases involving only two actors) in their rates of broadening. Yet, the effect of these variations is different than hypothesized. In Boston, this did not lead

to a constant increase in broadening, but rather to more variation. WPPs experienced a short expansionary period followed by a period of shrinking. In New York, the involvement of more actors post-MOA did not lead to constant broadening in terms of big picture watershed decisions, but rather led to a short expansionary period. Portland and San Francisco also show some degree of broadening, albeit less extreme (hence more incremental) than the other two cases.

Why does CWC shows higher levels of broadening than the big-picture decisions made in New York or Boston? LT-WPPs and WPPs involve more actors than Portland and San Francisco. However, the involvement of a majority of actors in WPPs and LT-WPPs is mostly as consultants, with only a handful of actors having the final say on these plans. On the other hand, in the CWC, multiple actors are involved in decision-making, and all of them have the same level of authority. This could explain the differences in broadening between the CWC, LT-WPPS and WPPs.

This raises three issues affecting variations in broadening in special-purpose institutions: modifications in decision-making structures or processes, the limited scope of special-purpose institutions, and the extent of participation granted to multiple interests. First, the extent of institutional change and innovation seems to play a role in fostering broadening. For different reasons, both Boston and New York experienced higher rates of broadening after their decision-making structures experienced some modifications. In Boston this occurred when WPPs switched from a product of a consulting agency, to being produced by MDC (later DCR). However, this expansion was short-lived. In New York, most changes occurred after the signing of the 1997 MOA. Notwithstanding, after those changes, patterns of broadening stalled (New York) or even decreased (Boston). This may indicate that changes were not significantly abrupt to break path dependency patterns initiated by the previous way of doing things. In these cases, changes in the number of actors involved in decision-making or shifting of responsibilities lead to variations or short increases rather than to constant broadening. This finding opens up new questions regarding the length of broadening processes in special-purpose institutions. Future research should address which factors affect the length of expansionary periods in these types of institutions.

Although programs in New York changed post-MOA, LT-WPPs continued to involve the City and regulators, this time with the communities playing a more active consultative role. With the creation of the CWC, however, a new decision-making structure was created free from ties to the past, allowing it to extend its scope of involvement more (and at higher rates) than the LT-WPPs. In Portland and San Francisco, the changes brought by the 2005 Memorandum of Agreement (in San Francisco) and the 2007 Bull Run Watershed Agreement (Portland) formalized, rather than changed their decision-making structures. This may explain their more incremental rates of broadening, where the experimentation with different programs may have occurred outside of the timeframe studied here.

The second factor is the nature of these “special purpose” institutions. Adaptive institutions are “those that actors are able to adjust to encourage individuals to act in ways that maintain or improve to a desirable state” (Koontz et al, 2015:141). Actors in these arrangements must adapt to fewer issues than in the institutions studied by Baumgartner and Jones (2015). Moreover, as programs get completed, actors seem to turn to a maintenance stage of watershed protection. This indicates a potentially unique aspect of issue expansion in smaller scope institutions, where the original goals of the arrangement constrain the extent to which actors can expand the breadth of their activities. What is left to know is whether the switch to that stage will be powerful enough to shrink the breadth of programs. The evidence indicates that this seems to be the case in Boston’s WPPs and in CWC’s programs.

These findings provide a more nuanced understanding of the dynamics of broadening within PET. In particular, by highlighting that the intensity of institutional change, as well as the scope of the issues addressed by actors in an institution may mediate the effects that variations in mechanisms of “problemistic search” may have on broadening and thickening.

The literature on Adaptive Governance has emphasized the role that representation of multiple interests plays in fostering (or hindering) adaptation. The purpose of this paper was to address how variations in representation may affect the extent of expansion in adaptive institutions. Findings have shown that including more actors does seem to affect rates of broadening. However, the analysis also

indicated that the way in which multiple interests are involved does affect the rates of broadening. Decision-making processes granting multiple actors a vote in decision-making do seem to broaden more than those involving fewer actors. Consequently, processes involving multiple actors, but where most of them are consulted, seem to show more variation, rather than high broadening rates.

An important caveat of these findings relates to the nature of the data used. Relying on reports and plans produced by different actors in different settings imposes limitations. First, the disparity of reports and the nature of the special-purpose institutions make it difficult to rely on a universal coding strategy. Instead, this requires defining broadening and thickening in terms of the logic of each document. Second, these documents, with the exception of Boston's Annual Reports, rarely provide direct quantitative measures of activities. In consequence, alternative measures such as the number of components within a section or counts of paragraphs are required, with their own weaknesses. These two factors limit the possibilities for cross-case comparisons.

### **Conclusion**

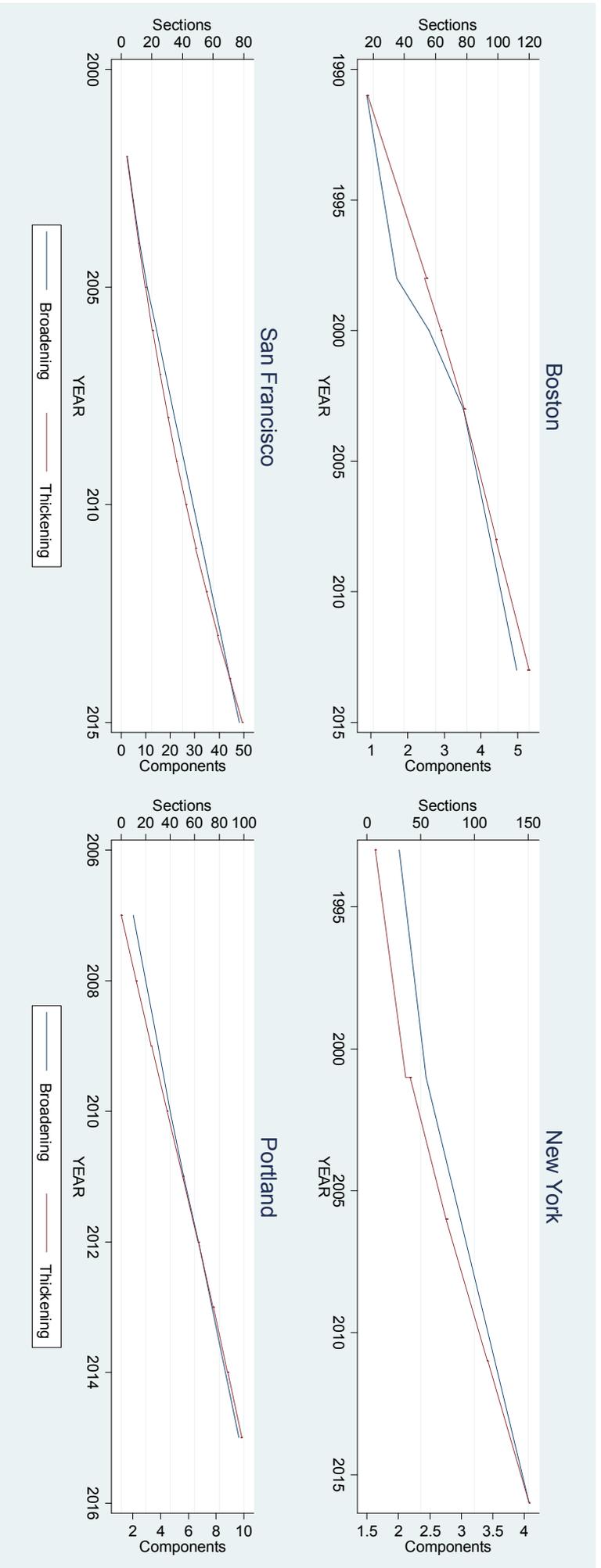
This chapter combined insights from recent developments on theories of information processing in public policy with arguments from the literature in adaptive governance to better understand the effects of institutional design on the outputs produced by an institutional arrangement. The main contribution of this paper is in providing a different look at adaptation processes in the governance of shared natural resources. In particular, notions of institutional change developed in the literature on punctuated equilibrium theory are applied to better understand the effects of institutional design on adaptive institutions. The goal was to assess whether different decision-making structures produce different patterns of outputs. The four cases are institutions designed to protect water quality at the source that vary on the number and type of actors involved.

The literature on Adaptive Governance focuses largely on the role of learning in the way institutions adjust to changes in their environments. Approaches within this literature have emphasized the challenge that involves including multiple viewpoints and actors in decision-making structures (Scholz and Stiftel, 2005). However, so far no study had paid attention at how variations in representations in decision-making structures affect the patterns of outputs produced by adaptive institutions. By combining these arguments with recent developments in Punctuated Equilibrium Theory (Baumgartner and Jones, 2015), this paper assessed adaptation dynamics not in term of whether they couple with the demands of the environment, but rather on terms of their ability to extend the depth or breadth of activities conducted by actors in the arrangement.

Findings have provided some initial support for the broadening argument posited by Baumgartner and Jones (2015): institutions that include representatives from multiple sectors in their decision-making structures are characterized by higher rates of broadening. However, this seems to be affected by three aspects that were not hypothesized: the occurrence of changes in decision-making processes, the extent of the involvement of multiple actors in decision-making, and the nature of the institutional arrangement.

This study contributes to the literature on adaptive governance by taking a broader approach to adaptation and by showing the existence of how variations in the incorporation of multiple stakeholders affect the patterns of outputs produced by adaptive institutions. The findings also open up new questions for future research. First, whether the observed dynamics are also present in other types of adaptive institutions. This will require, for instance, examining arrangements addressing issues of ecosystem management or emergency response management. And second, which other factors may constrain the temporal aspect of broadening periods in special purpose institutions.

Figure 6.7. Cumulative Broadening and Thickening



## Chapter 7: Conclusion

The cases studied in these papers are examples where governments have learned to coexist with their natural environments, with other governments, and with individuals in a way that societies and nature can coexist. This learning took place in different contexts, where actors faced varying levels of collective action problems and transaction costs. Affected by their contexts, actors in these cases devised different institutional arrangements to organize collective action. The first two empirical papers (Chapters 4 and 5) in this dissertation have assessed how context (in the form of types of collective-action problems or transaction costs) has affected the design of institutional arrangements for governing shared natural resources. The third empirical chapter (Chapter 6) studied how variations in the design of decision-making structures can affect the patterns of institutional change through which these institutions adapt to their environments. Findings in these chapters contribute to understanding the design of arrangements involving governmental actors at regional scales.

Chapter 4 combined arguments from the literature on policy networks, the Institutional Collective Action approach (Feiock, 2013), and tools from the Institutional Analysis and Development Framework (Ostrom, 2005) to analyze the role of collective action dilemmas in shaping the design of institutions. One of the contributions of chapter 4 is in presenting a novel approach to measure institutional design. This approach, termed Networks of Prescribed Interactions (NPIs), helps capture the interdependent nature of relationships between actors in an institutional arrangement. Rather than showing these interactions as self-reported linkages between actors, NPIs identify the relationships mandated by each formal rule. This is done by relying on the Institutional Grammar Tool (IGT) (Crawford and Ostrom 1995; 2005) to measure and code formal rules.

The NPIs approach provides three methodological contributions: first, it relies on a theoretically-grounded coding strategy to identify interactions mandated by formal rules. This is possible by relying on a carefully-developed method for measuring institutional design like the IGT (Crawford and Ostrom 1995; 2005; Basurto et al, 2010; Sidikki et al, 2011). Second, by identifying the full array of interactions mandated by formal rules, NPIs identify all formally-involved actors in a network, overcoming boundary specification issues common in studies of social networks (Marsden, 1990).<sup>60</sup> Third, NPIs provide a useful approach to compare interactions mandated by formal rules from observed behavioral interactions (Olivier and Schlager, 2016). NPIs reflect a different type of linkages between actors: those prescribed by a group of formal rules. This allows measuring institutional design as a network and comparing the patterns of linkages prescribed by an existing institutional arrangement with those actually occurring in the behavioral world (e.g. linkages captured by asking individuals who they interact with). Analyzing interactions mandated by formal rules may help better understand the decisions actors make when interacting with others in a policy setting, as well as the coevolution of patterns of behavior and institutional design over time.

Building on this, Chapter 4 showed how network structure in NPIs present specific patterns in response to cooperation problems, as observed on behavioral networks (Berardo and Scholz, 2010). These results reveal how actors rely on similar logics for partner selection and rule design when dealing with the same collective-action problems. Overall, Chapter 4 provides two main contributions. First, the empirical analysis shows the usefulness of the NPI approach as a tool for measuring institutional design. Second, the chapter shows how interactions mandated by formal rules are affected by the presence of cooperation dilemmas. NPIs respond to cooperation problems by mandating more closed and overlapping interactions among actors, just as observed in behavioral networks. This finding provides an initial step in analyzing the relationship between rules and behavior. By showing how NPIs react to

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<sup>60</sup> The main limitation of the NPI approach, however, is in that it does not discriminate between interdependent actors (e.g. a division within a government agency and the agency itself) who may be related beyond the ties mandated (or not) by the formal rules in the arrangement studied.

cooperation problems, Chapter 4 opens the door to future studies analyzing the coevolution of institutional design and behavior over time.

Chapter 5 addressed the role of contextual variables in the design of three specific features of an institutional arrangement: monitoring, conflict resolution, and sanctions for noncompliant behavior. These features have been identified as important in the design of institutions governing common-pool resources (Ostrom, 1990; Dietz et al, 2003). However, only recently the literature has addressed how these features are present in larger scale arrangements (Cash and Moser, 2000; Young, 2002, 2006; Berkes 2002; Heikkila et al, 2011; Fleischman et al, 2014; Epstein et al, 2014). Chapter 5 contributes to these endeavors by analyzing design features at regional scales.

The contribution of this chapter is twofold. First, it analyzed the presence of these design features on institutions governing shared natural resources at regional scales. A large part of the CPR literature started studying small-scale arrangements where the parties are individual resource users. From these studies, the literature identified several aspects of institutional design that are often present in robust CPR arrangements (Ostrom, 1990; 2005). However, as the scale of the resources increase, the types of actors and their prerogatives change. This chapter analyzed aspects of institutional design that are present in robust, small-scale arrangements and that the literature argues should also be present at larger scales. Second, Chapter 5 contributes to our understanding of regional-scale institutions by identifying not only whether certain features are present and how they are designed, but also by indicating the effects that contextual variables have in their design. Transaction costs, particularly those generated by variations in the number and type of actors involved in an arrangement, play a role in the design of these types of institutions. Results indicate that bilateral agreements including state or federal agencies are less likely to rely on redundant monitoring mechanisms and on different types of consequence mechanisms. On the other hand, when transaction costs are higher, institutional arrangements tend to include more and different mechanisms for monitoring and sanctioning of noncompliant behavior. These findings contribute to recent studies on the design of CPR institutions (Baggio et al, 2016) that highlight how choices in the design of CPR institutions are situational.

Contrary to the expected, the analysis failed to identify similar effects for the design of conflict resolution mechanisms. This finding indicates the existence of common design strategies for addressing conflict in the governance of shared natural resources, regardless of the bargaining costs of designing and implementing a governing agreement. Future research should assess whether differences in the design of conflict resolution mechanisms are likely to occur in other types of regional arrangements, or if the design of such mechanisms adopts similar forms regardless of context. In addition, future work should address the linkages between variations in the design of mechanisms and their effectiveness in sustaining collective action. The four cases studied have maintained their filtration waiver, showing that these arrangements managed to foster collaboration and that the collaboration provided useful in maintaining water quality indicators. Future studies should extend this analysis to unsuccessful cases of the governance of a shared natural resource, to identify whether differences in the design of these mechanisms play a role in ensuring success.

Chapter 5 focused on the role that transaction costs have on institutional design. Chapter 6, on the other hand, focuses on the role that decision costs have on the outputs produced by actors in an institutional arrangement (Jones and Baumgartner, 2005). Building on the attention to decision costs paid by the literature on Punctuated Equilibrium and its theory of information processing, Chapter 6 addressed the patterns of outputs produced by these four institutional arrangements.

The main contribution of this chapter is in combining insights from the literature on adaptive governance with the literature on Punctuated Equilibrium Theory (Baumgartner and Jones, 1993, 2015; Jones and Baumgartner, 2005). In both literatures, design variables play a key role. In the governance of natural resources, institutions help groups of individuals manage resources over long periods of time (Dietz et al, 2003). The adaptive governance literature has focused on how institutional arrangements for

managing such resources can adapt to environmental changes, as well as help improve the quality of the resources being managed (Koontz et al, 2015). In doing so, this literature has identified several variables that are important in designing adaptive institutions (see for instance Dietz et al, 2003; Scholz and Stiftel, 2005; Koontz et al, 2015). Chapter 6 zooms in on one of such variables: the representation of multiple interests in decision-making procedures.

Rather than arguing about the benefits or costs of incorporating too many or too few actors, this chapter takes on to understand how variations in representation can affect institutional change. This is done by bringing in arguments from Punctuated Equilibrium Theory. The theory of information processing stemming out of PET has analyzed how variations in the design of decision-making and information processing within governmental organizations can affect their outputs (Robinson et al, 2007; Workman et al, 2009; Baumgartner and Jones, 2015). Chapter 6 incorporates these arguments to understand patterns of institutional change in adaptive institutions.

The first contribution of this chapter is in the application of this theory to the study of adaptation dynamics in the governance of shared natural resources. The PET literature has devoted large amounts of attention to the study of policy agendas and outputs produced by National and State Governments, bureaucratic agencies, and school districts. However, by studying arrangements created for the governance of shared natural resources, Chapter 6 opens up a new area of application for PET: the study of intergovernmental arrangements. Institutions designed for governing a natural resource possess a different range of activities than institutions like Congress, the Executive, or bureaucratic agencies. Special purpose institutions are more constrained in their scope of activities, and are also more limited in the amount of resources they can count on. These constraints may lead to different dynamics of institutional change. Second, this chapter offers new insights to the understanding of adaptive institutions by showing the specific adaptation processes that take place when multiple (or few) stakeholders are included in decision-making processes. Findings provide more nuance to these dynamics by showing how adaptation (understood as changes in the breadth and depth of activities for governing a resource), works in the context of intergovernmental arrangements. Third, findings in this chapter generate new questions for the study of government expansion within the literature in PET. For instance, when institutions experience changes in their decision-making structures, this seems to have an effect in their rates of broadening immediately after the change has been implemented. Findings in this Chapter also show that broadening processes are affected by the extent to which multiple interests can influence decision-making. Allowing multiple actors to provide comments on joint decisions may not be enough to generate long-lasting broadening processes. This opens new avenues for research focusing on the effect that incorporating more and different actors in decision-making may have on the extent of broadening periods.

In sum, all three empirical chapters provide new insights for understanding the design of institutional arrangements governing shared natural resources. These findings show the effects that contextual factors, in the form of transaction costs or different collective action dilemmas have on the design features of these types of institutions. Also, these findings show how changes in the decision-making structure of an institution can affect patterns of adaptation.

By focusing on regional institutions, unlike institutions involving individuals (small scale) or institutions involving national governments, international organizations, and nongovernmental actors (large scales), these papers helped identify nuances in the design of institutional arrangements for governing shared natural resources. However, the findings discussed in these papers must be circumscribed to cases of arrangements for the production of water quality, which have some unique characteristics. Of particular interest are two limitations that demand future research. First, in Chapters 4 and 5, the New York case stands out for having salient cooperation problems and high relative transaction costs, when compared to the other three cases. As discussed earlier, having a case with extreme values in the independent variables is useful when the purpose is to assess hypotheses as

plausibility probes, testing whether future research is necessary. In the near future, findings from Chapters 4 and 5 should be assessed against cases sharing similar values to the New York one. A study like this has the potential to improve our knowledge of institutional design in the face of cooperation problems and high transaction costs. A second limitation is the type of arrangements studied. All four cases are successful arrangements created to govern a shared natural resource and to provide the good of water quality. A next step would be to compare these findings to analyses of other types of institutional arrangements (for instance, for the provision, rather than the production of a public good), or to similar arrangements taking place in different contexts. In the immediate future, my research will center on the latter.

In recent decades, water providers throughout the world have begun implementing similar alternatives to maintain water quality through the use of market mechanisms that are both environmentally conscious and cost-effective (Hayes, 2012). In the case of water management and water quality, some of these mechanisms have received the name of “payment for watershed services” (PWS). Many of these approaches have been successfully implemented throughout the world, with some authors considering the New York City or San Francisco cases as examples of successful PWS arrangements (see, for instance Bennet et al, 2014 or Huber-Stearns et al, 2015). Even though the cases studied in this dissertation include more than just payments for watershed services,<sup>61</sup> they also share several characteristics with PWS experiences throughout the world.

In recent years, over 30 PWS experiences have been developed and implemented throughout Latin America. Spearheaded by the NGO The Nature Conservancy, these PWS experiences called “Water Funds” have developed in cities that source their water from forested areas. Water funds provide a mechanism for water providers to fund forest protection activities upstream to maintain water quality. A particular feature of water funds is that funding allocations are made mostly through a trust fund system, with independent authority, composed by representatives of key stakeholder groups (Goldman et al, 2010; Goldman-Benner et al, 2012). As part of my future research, I will study issues of institutional design on arrangements created to provide watershed services. My research will study these institutions with the goal of identifying commonalities that lead to successful arrangements, and assessing the feasibility of implementing a PWS scheme in the Argentine Patagonia.

#### **A brief note on the role of agency and the future of these arrangements**

This project analyzes causes and effects of institutional variation in the design of intergovernmental agreements for maintaining water quality. Although the theoretical discussion and empirical analysis have focused exclusively on issues of institutional design, this by no means should be understood as a rejection of the role that specific individuals play in these arrangements.

The evidence collected through interviews shows that certain individuals play (and have played) central roles in devising and maintaining these agreements. Furthermore, the replacement of some of these individuals (many of which are close to retire) may posit important challenges for the future of some of the agreements. The 1997 New York City Memorandum of Agreement, for instance, would have not been possible without the political will of then Governor George Pataki and New York City Department of Environmental Conservation’s Commissioner Marilyn Gelbert (Galusha, 2016; Soll, 2013). These actors were fundamental not only in bringing the parties to the negotiating table, but also influenced some of the decisions on the design of the agreement. Governor Pataki, for instance, is credited for suggesting the creation of the Watershed Protection and Partnership Council, the main conflict resolution venue in the agreement (CWT Representative. Personal communication, June 16<sup>th</sup>, 2016).

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<sup>61</sup> The cases studied here create governing arrangements defining how the entire shared resource will be governed, instead of only providing for the funding of watershed protection activities.

Key individuals also played a role in the generation of trust between the parties. In Boston, the good working relationship between MWRA and DCR is largely based on the long-lasting connections between managerial staff from both agencies. Personnel often move from one agency to the other, facilitating the generation and maintenance of trust between agencies (MWRA Representative. Personal communication, July 11<sup>th</sup>, 2016). As one interviewee mentioned, these connections are important because they occur at the top-levels of these agencies. Early on, these key actors had a role in defining the relationship between both agencies, and in a way, determined the nature of the good working relationship between MWRA and DCR (WSCAC Representative. Personal communication, August 15<sup>th</sup>, 2016).

In San Francisco, individuals and the broader political context have been important. Key representatives from the City and the National Park Service were fundamental in spearheading the draft and design of their first agreement, in 2005. During those times, Park representatives spent a large amount of time building trust with City representatives (Yosemite National Park Division Ranger. Personal communication, July 29, 2016). Also, a unique aspect of the San Francisco case is the high political visibility of the case. Unlike other settings, both the City and the National Park Service have to navigate a highly politicized environment regarding the existence of a dam in Hetch Hetchy. Discussions around the dam have existed since before the dam was built, and have remained ever since. In this environment, two equally important perspectives clash: on one hand, those who defend the existence of the dam as the main source of clean water for millions of people, and on the other hand, those who advocate for the removal of the dam. In a context like this, where multiple outside interests are vested in the maintenance and also in the removal of the dam, the City and the Park must be able to “play nice” to each other to avoid stirring a conflict that can negatively affect both parties (Yosemite National Park Division Ranger. Personal communication, March 24, 2016).

Finally, the Portland arrangement also benefitted from the role of key individuals. Starting with the role of Dr. Joseph J. Miller, a retired physician who filed a lawsuit against the Forest Service in 1973 for violations of the Bull Run Trespass Act (Short, 2011), to the role that Forest and City managers played in the drafting of the 2007 agreement (Larsen, 2006).

These few examples show that agency played (and plays) a role in the design and ulterior implementation of these agreements. Furthermore, the role of these actors may also pose some challenges in the near future. Many of these agreements were created and implemented relying on key figures representing different watershed interests. The challenge will increase when some of these individuals retire. This issue seems to be of most concern in New York, where a handful of actors from the City and the watershed communities have been fundamental to develop a sense of collaboration between both sectors. As one CWC representative mentioned, “*the biggest problem that we seem to face is the City personnel come and go to some extent. And so the political leaders down there change, but they forget about the MOA and what they really signed being a true partnership. And the City wants to control, micromanage everything, instead of looking at that this is a process that we put in place that is volunteer. And you certainly get a larger and better program if you voluntarily enter into it than when it's mandated [...] I worry about the day I retire, I worry about the day [...] the Deputy Commissioner retires. I don't believe you can have the regulators and the stream people, and the people of DEP in Kingston or Valhalla dictating what happens up here. I think we need to be integrated into one building in the watersheds [...] And I think DEP needs to be part of that, they need to be inside the watershed and not dictating from outside the watershed*” (CWC Representative. Personal communication, June 17<sup>th</sup>, 2016).

A similar feeling, although perhaps less fatalistic, is also present in Boston. For some interviewees, the relationships built by key managers in both DCR and MWRA may become challenging in the absence of these strong figures. Because of these individuals, both DCR and MWRA were able to maintain an excellent working relationship, even when DCR depends exclusively on MWRA. In the

future, this horizontal relationship between both agencies may not be there (WSCAC Representative. Personal communication, August 15<sup>th</sup>, 2016). In the case of Portland and San Francisco, some of this turnover already happened, particularly on the side of the federal agencies. And the changes seemed to have not affected the good working relationship between the parties.

APPENDIX A – Goodness of Fit Plots

Figure A1. GOF Plot Boston NPI  
Goodness-of-fit diagnostics

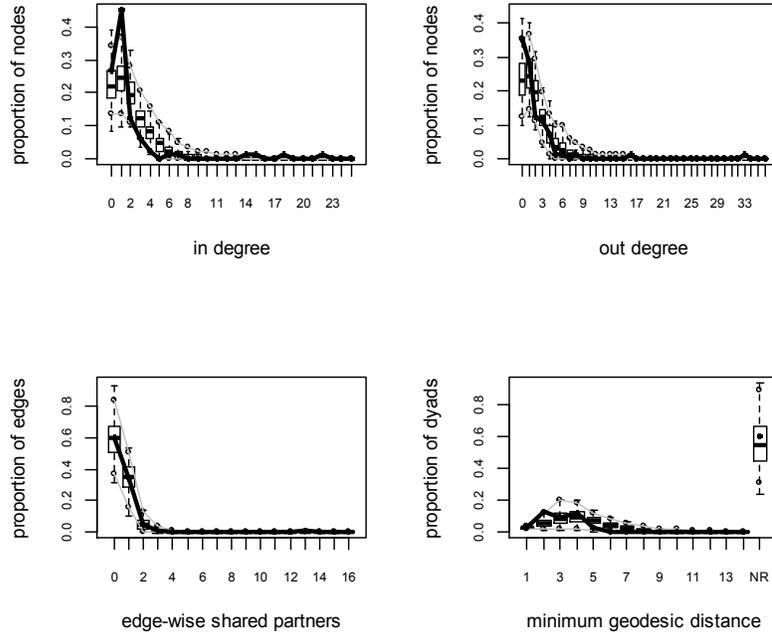
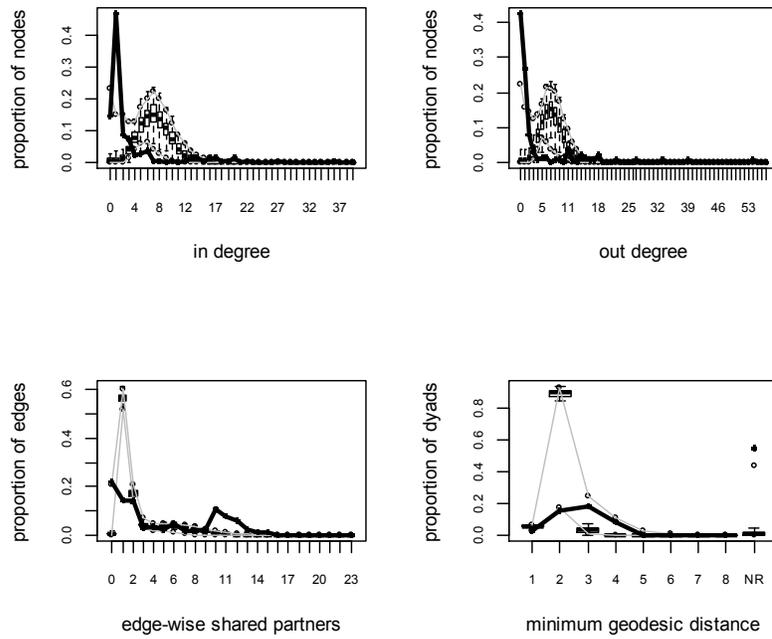
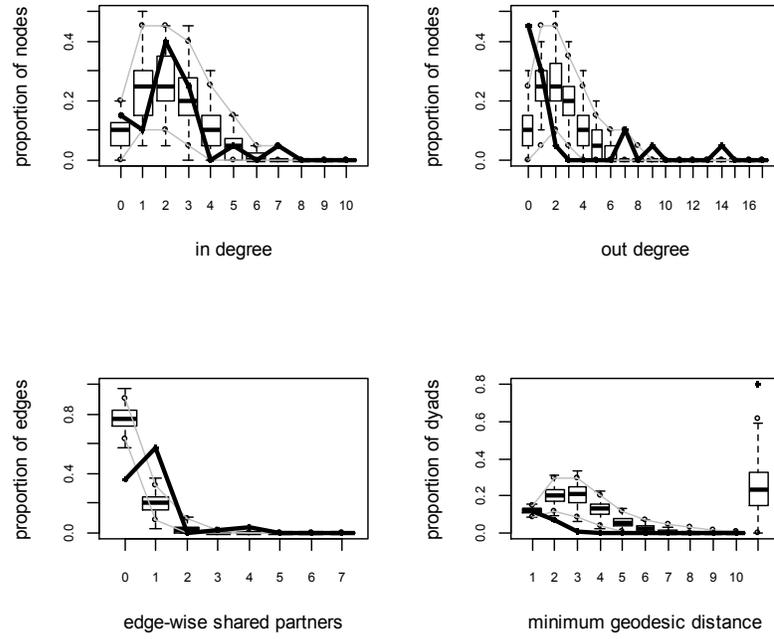


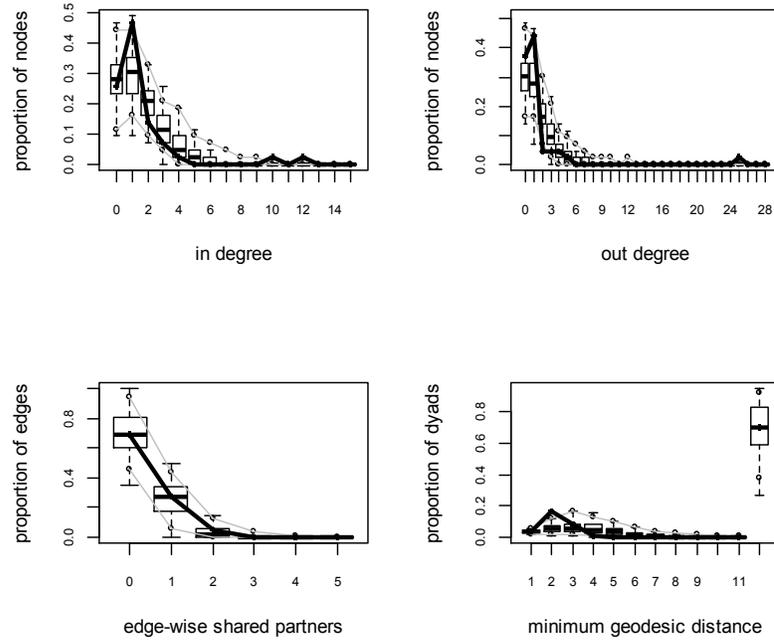
Figure A2. GOF Plot New York NPI  
Goodness-of-fit diagnostics



**Figure A3. GOF Plot Portland NPI**  
 Goodness-of-fit diagnostics



**Figure A4. GOF Plot San Francisco NPI**  
 Goodness-of-fit diagnostics



**APPENDIX B – ERGM models using alternative NPIs**

**Table B1. ERGM Coefficients using ALL formal documents**

	<b>Boston</b>	<b>New York</b>	<b>Portland</b>	<b>San Francisco</b>
Edges	-4.4252***	-5.308***	-2.1887***	-4.11699***
Mutual	1.1431**	2.704***	-1.2073	2.44993***
Transitive ties	1.5541***	1.899***	No Convergence	0.85873***
Nodeofactor City	0.4882*	0.1318e	0.7225*	0.82692***
Nodeifactor City	-0.2017	7.825e-05	0.2198	-0.04781

‘\*\*\*’ p < 0.001; ‘\*\*’ p < 0.01; ‘\*’ p < 0.05

**Table B2. ERGM Coefficients using only MOAs**

	<b>Boston</b>	<b>New York</b>	<b>Portland</b>	<b>San Francisco</b>
Edges	-3.7303***	-5.1929***	-1.8665***	-3.5937***
Mutual	-1.7315*	2.586***	-0.8416	1.5353*
Transitive ties	1.5909***	1.8474***	No Convergence	1.1205***
Nodeofactor City	0.6733**	0.1315	0.8624^	0.3359
Nodeifactor City	-0.0045	-0.0629	0.0798	-0.2606

‘\*\*\*’ p < 0.001; ‘\*\*’ p < 0.01; ‘\*’ p < 0.05; ‘^’ p < 0.1

## APPENDIX C – Coding Protocol for identification of institutional mechanisms

Developed by Edella Schlager, Tomás Olivier, and Jeffrey W. Hanlon<sup>62</sup>

The purpose of this coding protocol is to guide and standardize identification of institutional statements that create or condition 1) a monitoring mechanism / responsibility / authority, 2) a compliance mechanism / responsibility / authority, 3) a consequence mechanism / responsibility / authority.

1. The rule types to be examined are: Information, Payoff, Choice, Aggregation, Position, Boundary, Constitutive
2. Coding statements
  - i. Always read each statement **in context**. To properly identify the monitoring/enforcement nature of a statement it is necessary to analyze it in terms of the role it plays within the context of the prior/subsequent rules. Also, the portion of the statement that contains the Attribute, Deontic, Aim, and Object indicates the mechanism. Any “mechanisms” that show up in the conditions will be not coded as such. [If a mechanism shows up in a condition, it should not be coded as a mechanism, unless the statements before or after clearly relate to that mechanism.]
  - ii. Copy the institutional statement to the proper spreadsheet, and record variables in the appropriate cells.
3. Coding **monitoring** rules
  - a. Definitions: Refers to gathering data, reporting data, or reviewing data that has been reported to determine whether someone has behaved according to the rules or whether rule following behavior is having the desired effect on the biophysical system. Monitoring ≠ information rules, if the information shared is about whether someone is complying with the rules, then code it as a monitoring rule. Otherwise, code it as something else. Monitoring is the foundation for determining compliance.
  - b. Inspections count as a form of monitoring.

**Monitoring** is the act of collecting data or information regarding the behaviors and activities of an actor or a biophysical or a social condition (i.e. flooding, socioeconomic issues). Monitoring is a shared act. A single actor collecting information for its own purposes only is not monitoring. The single fact of requiring that an action should be conducted in consultation with other actor/s is not considered monitoring.
  - c. Identifying monitoring statements
    - i. **Monitoring statements** (satisfies any of the following):

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<sup>62</sup> Reproduced with permission from the authors.

1. The statement prescribes an actor to collect data on its own or other actors' behaviors, or identifies data to be collected and shared. Information sharing in the form of advice or best practices is *not* monitoring.

Example 1: *The City shall inspect any property burdened by a Watershed Conservation Easement at least twice each year. (From MOA II).*

Example 2: *(e) For any Project proposed, the Project sponsor shall create and maintain, for the duration of the project, a repository of information regarding the Project. Such repository shall be in reasonable proximity to the area affected by the proposed Project and shall contain all documents necessary for a fair public assessment of the Project. (From MOA IV).*

2. The statement prescribes a means of gathering/collecting data and/or receiving/reviewing data.

Example 1: *“Each party receiving a payment shall submit an annual written accounting together with appropriate back-up documentation to the City, by not later than each July 15th (commencing with July 15, 1997 and continuing until all Good Neighbor Payments received by such Party have been expended), itemizing the expenditure of all Good Neighbor Payments by such Party during the previous fiscal year, including a description of the public works or public improvements funded through such expenditures.”*

Example 1: *(b) The State will submit annual progress reports on its Croton land acquisition program within thirty (30) days of the end of each State fiscal year to the Watershed Protection and Partnership Council. (From MOA II)*

Example 2: *The Executive Committee shall review the draft Croton Plan prepared in accordance with Section 18-82(d)(1) of the Watershed Rules and Regulations, (From MOA IV)*

Example 3: *At least once every five years the Council shall review and assess the activities and status of the Catskill Fund, with particular emphasis on whether the Catskill Fund has*

*served its intended purpose and has encouraged responsible, environmentally sensitive economic development compatible with protection of the City's water supply."*

d. Coding statements

- i. Always read each statement **in context**. To properly identify the monitoring nature of a statement it is necessary to analyze it in terms of the role it plays within the context of the prior/subsequent rules.
- ii. Copy the institutional statement to the proper spreadsheet, and record variables in the appropriate cells with a "1".

4. Coding **compliance** rules

a. Definition:

- i. **Compliance** is the means of encouraging or maintaining rule following behavior by creating processes through which actors may question the actions of others or have those actions reviewed.

Compliance determines the means and methods by which an actor determines if another actor has complied with a rule. This definition includes, but is not limited to, those statements prescribing mechanisms to address disagreements among actors (i.e. processes of arbitration to solve a dispute between two or more actors).

If the statement defines circumstances in which an action will not be considered a violation of the rule and doesn't mention any punishment, then code it as compliance.

Compliance involves always a process through which actors determine what it is noncompliant behavior.

If a statement forbids an actor to challenge another actor's compliance with a rule, then that statement is defining a compliance mechanism and should be coded as such.

A statement that tells an actor to "follow the rules" does not define compliance.

b. Identifying compliance statements

- i. **Compliance** (satisfies any of the following):
  1. The statement determines the means/criteria/process by which an actor (or group of) determines another actor is out of compliance with a rule. The statement identifies a compliance process, triggering of review, means/criteria of review.

Example: *"Whenever a Party to this Agreement believes that another Party to this Agreement has acted in bad faith with respect to any of the terms of this Agreement, such Party may*

*send a written notice to the Executive Committee setting forth the basis for such belief [TRIGGER]. The Executive Committee shall review such notice, along with any additional information submitted to the Executive Committee, and may make a recommendation regarding the actions in question [REVIEW PROCESS].”*

Example 2: *NYSDEC retains final authority to resolve any dispute under this special condition between the City and Town or Village using the process as set forth in Special Condition 12.h. (From WSP)*

2. The statement defines the authority of one actor (or group of) to correct another actor’s noncomplying behavior.

Example: *[This statement follows the above example] “The decision-maker may not expend funds provided pursuant to this Agreement to fund a proposed project which is subject to the right of objection under this Agreement until it has complied with the provisions of this paragraph.”*

Example 2: *Such agreement will grant each such third party beneficiary the right to enforce against the tax exempt entity and obtain specific performance as a remedy as well as shall run with the land and apply to future grantees or assignees. (From WSP).*

3. When a rule forbids an actor from challenging another actor’s behavior.  
Example:

*The City will not challenge the initial assessed value or adjustments to the assessed value of parcels to be acquired pursuant to the land acquisition program set forth in this permit provided the initial assessed or adjusted value for such parcel does not exceed the fair market value of the parcel multiplied by the applicable equalization rate or a special equalization rate for that assessing unit. (From WSP)*

## 5. Coding **consequence** rules:

**a. definition:** Consequence determines a penalty (either a created penalty such as a fine or an inherent penalty such as a loss of a benefit realized by compliance of rules in effect) for an act of noncompliance or the nullification of rules. Consequences do not necessarily (or often) show up in the “or else” portion of an institutional statement, but are more likely to be defined broadly, and serve as the “or else” consequence for noncompliance with some or all of the other rules in the set or as a consequence of rule nullification. Enforcement may refer to specific sanctioning authorities such as levying fines for noncompliance, or it may be a loss of a benefit or a desirable action given a failure to act.

b. identifying consequence statements:

i. Consequence (satisfies any of the following):

1. The statement generally defines a consequence for rule noncompliance, inactivity, or nullification.

*Example: “[I]f the water supply permit for the City's land acquisition program described in Article II is voided or suspended by a court of competent jurisdiction such that the City is no longer authorized to purchase land or Watershed Conservation Easements under the permit, but the Watershed Regulations remain in effect, the City's obligation under this Agreement and the program contracts to fund the programs listed in subparagraph (b) below will be suspended and the Catskill Fund will be restricted as set forth in subparagraph (c) below.”*

*Example 2: (h) In the event the Executive Committee does not issue a recommendation within thirty (30) days, the decisionmaker may proceed to expend funds provided pursuant to this Agreement on the proposed Project. (From MOA IV)*

*Example 3: (k) A Party may lose its right to raise objections to future proposed Projects in the event the Executive Committee determines such Party has repeatedly misused such right by raising frivolous objections to proposed Projects. (From MOA IV)*

*Example 4: “If a Village or Town does not execute the PILOT agreement within ninety (90) days of submission of a signed PILOT agreement by the City, the City may acquire Watershed*

*Conservation Easements in such Village or Town  
notwithstanding the absence of an executed PILOT agreement.”*

5. Coding “clusters” of statements as mechanisms

Mechanisms only sometimes occur in isolation. Often, individual statements are part of a larger set or “cluster” of statements that comprise the mechanism of interest. To capture this, statements should additionally be coded according to the larger mechanism to which they belong. If a statement exists by itself and is not related to directly adjacent monitoring, compliance, consequence, and rule making statements, it is a mechanism in and of itself. However, individual statements may be part of a larger monitoring, compliance, or consequence mechanism that is comprised of many institutional statements.

i. Identifying a single-statement mechanism

If a statement is coded as a monitoring, compliance, or consequence statement and has no other monitoring, compliance, or consequence statements directly preceding or following, it is coded alone as a mechanism.

ii. Identifying a multiple-statement mechanism

If a set of adjacent statements are coded as monitoring, or enforcement statements and refer, for instance, to the same compliance goal, they are coded together as a mechanism. A multiple-statement mechanism may be comprised of all of the same type of statement (i.e. all monitoring) or mixes of types (i.e. several monitoring and a compliance enforcement, or any other combination).

iii. Coding mechanisms

The coding scheme for mechanisms accounts for the possible combinations of multiple statements.

To illustrate, consider a cluster of 4 adjacent statements. The first two refer to one party monitoring another, and the second two refer to an enforcement of compliance action that may or must be taken given the results of the monitoring. All four individual statements would be coded individually as monitoring OR enforcement-compliance. All four would also be coded in the “mechanism” column with the same identifier MMXXX, indicating that they are all part of the same monitoring mechanism. If they comprise the first MM mechanism in the rule set, they would each be coded MM001. If they comprise the 27<sup>th</sup> MM mechanism in the rule set, they would each be coded MM027. The end result is that each monitoring, compliance, or consequence statement has an individual identifier, and is identified as part of a unique *mechanism* of monitoring, compliance, consequence.

## References

- Agrawal, Arun. 2002. "Common Resources and Institutional Sustainability." In *The Drama of the Commons*, eds. Elinor Ostrom, Thomas Dietz, Nives Dolsak, Paul C. Stern, Susan Stonich, and Elke U. Weber. Washington, DC: National Academy Press, 41–86.
- Agrawal, Arun, and Sanjeev Goyal. 2001. "Group Size and Collective Action: Third-Party monitoring in Common-Pool Resources." *Comparative Political Studies*, 34(1): 63-93.
- Alcott, Emily; Mark S. Ashton, and Bradford S. Gentry (Eds.). 2013. *Natural and Engineered Solutions for Drinking Water Supplies: Lessons from the Northwestern United States and Directions for Global Watershed Management*. Boca Raton, FL: CRC Press.
- Anderies, John M., Marco A. Janssen, and Elinor Ostrom. 2004. "A Framework to Analyze the Robustness of Social-ecological Systems from an Institutional Perspective." *Ecology and Society*, 9(1): 18.
- Anderson, Brigham S., Carter Butts, and Kathleen Carley. "The interaction of size and density with graph-level indices". *Social Networks*, 21(3): 239-267.
- Andrew, Simon. 2010. "Adaptive versus Restrictive Contracts: Can They Resolve Different Risk Problems?" In Feiock, Richard C., and John T. Scholz (Eds.) *Self-Organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action Dilemmas* (pp. 91-113). New York, NY: Cambridge University Press.
- Armitage, Derek, Melissa Marschke, and Ryan Plummer. 2008. "Adaptive co-management and the paradox of learning". *Global Environmental Change*, 18(1): 86-98.
- Baggio, Jacopo A., Allain J. Barnett, Irene Perez-Ibarra, Ute Brady, Elicia Ratajczyk, Nathan Rollins, Cathy Rubiños, Hoon C. Shin, David J. Yu, Rimjhim Aggarwal, John M. Anderies, and Marco A. Janssen. 2016. "Explaining success and failure in the commons: the configural nature of Ostrom's institutional design principles". *International Journal of the Commons*, 10(2):417-439.
- Banks, Jeffrey S., and Randall L. Calvert. 1992. "A Battle-of-the-Sexes Game with Incomplete Information." *Games and Economic Behavior*, 4:347-372.
- Basurto, Xavier, Gordon Kingsley, Kelly McQueen, Mshadoni Smith, and Christopher M. Weible. 2010. "A Systematic Approach to Institutional Analysis: Applying Crawford and Ostrom's Grammatical Syntax." *Political Research Quarterly* 63: 523–37.
- Baumgartner Frank R., and Bryan D. Jones. 1991. "Agenda Dynamics and Policy Subsystems." *The Journal of Politics*, 53(4):1044-1074.
- Baumgartner, Frank R., and Bryan D. Jones. 1993. *Agendas and Instability in American Politics*. Chicago, IL: University of Chicago Press.
- Baumgartner Frank R., and Bryan D. Jones. 2015. *The Politics of Information: Problem Definition and the Course of Public Policy in America*. Chicago, IL: The University of Chicago Press.
- Baumgartner, Frank R., Bryan D. Jones, and Peter B. Mortensen. 2014. "Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking." In Sabatier, Paul A, and Christopher M. Weible (Eds.) *Theories of the Policy Process* (pp. 59 - 103). Boulder, CO: Westview Press.
- Bednar, Jenna. 2009. *The Robust Federation: Principles of Design*. New York, NY: Cambridge University Press.
- Benjamini, Yoav, and Yosef Hochberg. 1995. "Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing". *Journal of the Royal Statistical Society*, 57(1):289-300.
- Berardo, Ramiro, and John T. Scholz. 2010. "Self-Organizing Policy Networks: Risk, Partner Selection, and Cooperation in Estuaries." *American Journal of Political Science* 54(3): 632-649.
- Berardo, Ramiro, Tomás Olivier, and Marcos Meyer. 2013. "Adaptive Governance and Integrated Water Resources Management in Argentina." *International Journal of Water Governance* 1(3/4):219-236.

- Berardo, Ramiro. 2010. "Sustaining joint ventures: The Role of Resource Exchange and the Strength of Interorganizational Relationships". In Feiock, Richard C., and John T. Scholz (Eds.) *Self-Organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action Dilemmas* (pp. 204-228). New York, NY: Cambridge University Press.
- Berardo, Ramiro. 2014. "The evolution of self-organizing communication networks in high-risk social-ecological systems." *International Journal of the Commons*, 8(1): 236-258.
- Berkes, Fikret. 2002. "Cross-Scale Institutional Linkages: Perspectives from the Bottom Up." In *The Drama of the Commons*, eds. Elinor Ostrom, Thomas Dietz, Nives Dolsak, Paul C. Stern, Susan Stonich, and Elke U. Weber. Washington, DC: National Academy Press, 293–322.
- Bevan, Shaun. 2014. "Gone Fishing: The Creation of the Comparative Agendas Project Master Codebook." Technical Report [online]. Last retrieved June 12, 2017. Available at: <http://sbevan.com/cap-master-codebook.html>
- Birkland, Thomas. 2006. *Lessons of Disaster: Policy Change after Catastrophic Events*. Washington DC: Georgetown University Press.
- Brown, Trevor L., and Matthew Potoski. 2003. "Contract-Management Capacity in Municipal and County Governments." *Public Administration Review*, 63(2): 156-164.
- Brown, Trevor L., Matthew Potoski, and David Van Slyke. 2016. "Managing Complex Contracts: A Theoretical Approach." *Journal of Public Administration Research and Theory*, 26(2): 294-308.
- Brunner, Ronald D., Toddi A. Steelman, Lindy Coe-Juell, Christina M. Cromley, Christine M. Edwards, and Donna W. Tucker. 2013. *Adaptive Governance: Integrating Science, Policy, and Decision Making*. New York, NY: Columbia University Press.
- Calvert, Randall L. 1995. "The Rational Choice Theory of Institutions: Implications for Design." In Weimer, David L. (Ed) *Institutional Design*. Boston, MA: Kluwer Academic Publishers.
- Carr, Jered B., and Christopher V. Hawkins. 2013. "The Costs of Cooperation: What the Research Tells Us about Managing the Risks of Service Collaborations in the U.S." *State and Local Government Review*, 45(4): 224-239.
- Carter, David P., Christopher M. Weible, Saba N. Siddiki, and Xavier Basurto. 2016. "Integrating core concepts from the institutional analysis and development framework for the systematic analysis of policy designs: An illustration from the US National Organic Program regulation." *Journal of Theoretical Politics*, 28(1): 159-185.
- Cash, David W, W. Neil Adger, Fikret Berkes, Po Garden, Louis Lebel, Per Olsson, Lowell Pritchard, and Oran Young. 2006. "Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World". *Ecology and Society*, 11(2): 8.
- Chaffin, Brian C., Hannah Gosnell, and Barbara A. Cosens. 2014. "A decade of adaptive governance scholarship: synthesis and future directions." *Ecology and Society*, 19(3):56.
- Coase, Ronald. 1937. The Nature of the Firm. *Economica*, 4(16): 386-405.
- Collier, David. "Understanding Process Tracing." *PS: Political Science and Politics*, 4: 828-830.
- Cox, Michael, Gwen Arnold, Sergio Villamayor-Tomás. 2010. "A Review of Design Principles for Community-based Natural Resource Management". *Ecology and Society*, 15(4): 38.
- Crawford, Sue E., and Elinor Ostrom. 1995. "A grammar of Institutions". *American Political Science Review* 89(03): 582-600.
- Crawford, Sue E., and Elinor Ostrom. 2005. "A grammar of Institutions". In Ostrom, Elinor, *Understanding Institutional Diversity*, Elinor Ostrom (pp. 137-174). Princeton, NJ: Princeton University Press.
- Dietz, Thomas, Elinor Ostrom, and Paul C. Stern. 2003. "The Struggle to Govern the Commons." *Science*, 302(5652): 1907-1912.

Dunlap, David W. (2015, May 8). As a Plant Nears Completion, Croton Water Flows Again to New York City. *The New York Times*, Retrieved from <https://www.nytimes.com/2015/05/09/nyregion/croton-water-is-once-again-flowing-to-new-york.html?mcubz=0>

Eckstein, Harry. 2009. "Case Study and Theory in Political Science". In Gomm, Roger, Martyn Hammersley, and Peter Foster. *Case study method* (pp. 118-164). SAGE Publications Ltd.

Egan, Michael J. 2013. *Public Water Supply Systems in New York City, Boston, and Seattle: The policy choice of conservation over filtration*. Unpublished Master's Thesis, Empire State College, State University of New York.

Epstein, Graham, Irene Pérez, Michael Schoon, and Chanda L. Meek. 2014. "Governing the invisible commons: Ozone regulation and the Montreal Protocol." *International Journal of the Commons*, 8(2): 337–360.

Feiock, Richard C. 2007. "Rational Choice and Regional Governance." *Journal of Urban Affairs*, 29(1): 47-63.

Feiock, Richard C. 2009. "Metropolitan Governance and Institutional Collective Action." *Urban Affairs Review*, 44(3): 356-377.

Feiock, Richard C. 2013. "The institutional collective action framework." *Policy Studies Journal*, 41(3): 397-425.

Feiock, Richard C., and John Scholz (Eds.). 2010. *Self-Organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action Dilemmas*. New York, NY: Cambridge University Press.

Fleischman, Forrest, Natalie C. Ban, Louisa S. Evans, Graham Epstein, Gustavo García-Lopez, and Sergio Villamayor-Tomás. 2014. "Governing large-scale social-ecological systems: Lessons from five cases". *International Journal of the Commons*, 8(2): 428–456.

Foerster, Anita. 2011. "Developing purposeful and Adaptive Institutions for Effective Environmental Water Governance." *Water Resources Management*, 25(15):4005-4018.

Folke, Carl, Thomas Hahn, Per Olsson, and Jon Norberg. 2005. "Adaptive Governance of Social-Ecological Systems." *Annual Review of Environment and Resources*, 30: 441-473.

Fox, John. 2008. *Applied Regression Analysis and Generalized Linear Models*. 2<sup>nd</sup> Edition. Thousand Oaks, CA: SAGE Publications.

Galusha, Diane. 2016. *Liquid Assets: A History of New York City's Water System. Expanded Edition*. Fleischmanns, NY: Purple Mountain Press.

George, Alexander L., and Andrew Bennett. 2005. *Case Studies and Theory Development in the Social Sciences*. Cambridge, MA: MIT Press.

Greenfield, Thomas K., Lorraine T. Midanik, and John D. Rogers. 2000. "Effects of telephone versus face-to-face interview modes on reports of alcohol consumption." *Addiction*, 95(2): 277-284.

Handcock Mark S., David R. Hunter, Carter T. Butts, Steven M. Goodreau, Pavel Krivitsky, and Martina Morris. 2016. *\_ergm: Fit, Simulate and Diagnose Exponential-Family Models for Networks\_*. The Statnet Project (<URL: <http://www.statnet.org>>). R package version 3.6.0, <URL: <http://CRAN.R-project.org/package=ergm>>.

Hanlon, Jeffrey W. 2015. *Maintaining Robust Resource Governance: Mechanisms of Formal Institutional Change in a Federal Bargain*. PhD Dissertation, University of Arizona.

Hardin, Garret. 1968. "The Tragedy of the Commons." *Science*, 162(3859):1243-1248.

Heikkila, Tanya, Edella Schlager, and Mark W. Davis. 2011. "The Role of Cross-Scale Institutional Linkages in Common Pool Resource Management: Assessing Interstate River Compacts." *Policy Studies Journal* 39(1): 121-145.

Henry, Adam D. 2011. "Ideology, Power, and the Structure of Policy Networks." *Policy Studies Journal*, 39(3): 361-383.

- Hunter David R, Mark S. Handcock, Carter T. Butts, Steven M. Goodreau, and Martina Morris. (2008). "ergm: A Package to Fit, Simulate and Diagnose Exponential-Family Models for Networks." *Journal of Statistical Software*, 24(3): 1-29.
- Jones, Bryan D., and Frank R. Baumgartner. 2005. *The Politics of Attention: How Government Prioritizes Problems*. Chicago, IL: Chicago University Press.
- Jones, Bryan D., and Frank R. Baumgartner. 2012. "From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing." *Policy Studies Journal*, 40(1): 1-19.
- Jones, Bryan D., Tracy Sulkin, and Heather A. Larsen. 2003. "Policy Punctuations in American Political Institutions." *American Political Science Review*, 97(1):151-169.
- Karpouzoglou, Timothy, Art Dewulf, and Julian Clark. 2016. "Advancing adaptive governance of social-ecological systems through theoretical multiplicity." *Environmental Science and Policy*, 57: 1-9
- Kavanaugh, James. 1999. "To Filter or Not to Filter: A Discussion and Analysis of the Massachusetts Filtration Conflict in the Context of the Safe Drinking Water Act." *Boston College Environmental Affairs Law Review*. 26(4): 809 – 856.
- Koontz, Thomas M., Divya Gupta, Pranietha Mudliar, Pranay Ranjan. 2015. "Adaptive institutions in social-ecological systems governance: a synthesis framework." *Environmental Science and Policy*, 53, Part B: 139-151.
- Larson, Douglas W. 2009. "The Battle of Bull Run." *American Scientist*, 97(3): 182-184.
- Lee, Kai N. 1993. *Compass and Gyroscope: Integrating Science and Politics for the Environment*. Washington, D.C.: Island Press.
- Lee, Michael D. 2002. Enhancing and Maintaining Water Service Quality for Metropolises: A Case Study of the City and County of San Francisco, California, USA. *International Journal of Urban Sciences* 6(1):23-45.
- Leifeld, Philip, and Volker Schneider. 2012. "Information Exchange in Policy Networks". *American Journal of Political Science*, 56(3): 731-744.
- Libecap, Gary D. 1989. *Contracting for Property Rights*. New York, NY: Cambridge University Press.
- Lindblom, Charles E. 1959. "The Science of 'Muddling Through'." *Public Administration Review*, 19(2): 79-88.
- Low, Bobbi, Elinor Ostrom, Carl Simon, and James Wilson. 2003. "Redundancy and diversity: do they influence optimal management?" In Berkes, Fikret, Johan Colding, and Carl Folke (Eds.). *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change* (pp 83-114).
- Lubell, Mark, Jack M. Mewhirter, Ramiro Berardo, and John T. Scholz. 2016. "Transaction Costs and the Perceived Effectiveness of Complex Institutional Systems." *Public Administration Review*, doi:10.1111/puar.12622.
- Lusher, Dean, Johan Koskinen, and Garry Robins (Eds.). 2013. *Exponential Random Graph Models for Social Networks: Theory, Methods, and Applications*. New York, NY: Cambridge University Press.
- Maser, Steven M. 1998. "Constitutions as Relational Contracts: Explaining Procedural Safeguards in Municipal Charters". *Journal of Public Administration Research and Theory*, 8(4):527-564.
- May, Peter J., Samuel Workman, and Bryan D. Jones. 2012. "Organizing Attention: Responses of the Bureaucracy to Agenda Disruption". *Journal of Public Administration Research and Theory*, 18(4): 517-541.
- Metropolitan District Commission. 1984. "A history of the development of the Metropolitan District Commission Water Supply System". [Online]. Retrieved June 2, 2017. Available at: <http://www.mwra.com/04water/pdf/ws1984book.pdf>

- Miller, Carol. 1995. "In-depth interviewing by telephone: Some practical considerations." *Evaluation & Research in Education*, 9(1): 29-38.
- Miller, Gary. 1992. *Managerial Dilemmas: The Political Economy of Hierarchy*. New York, NY: Cambridge University Press.
- Nesson, Fern L. 1983. *Great Waters: A History of Boston's Water Supply*. Hanover, New Hampshire: University Press of New England.
- North, Douglass. 1990. *Institutions, Institutional Change, and Economic Performance*. New York, NY: Cambridge University Press.
- NYC Department of Environmental Protection. (2016). *Long-Term Watershed Protection Plan*. (online). Available at: [http://www.nyc.gov/html/dep/pdf/reports/2016\\_long-term\\_watershed\\_protection\\_program\\_plan.pdf](http://www.nyc.gov/html/dep/pdf/reports/2016_long-term_watershed_protection_program_plan.pdf). Last accessed May 9<sup>th</sup>, 2016.
- Oakerson, Ronald J., and Roger B. Parks. 1989. "Local Government Constitutions: A Different View of Metropolitan Governance." *Annual Review of Public Administration*, 19(4):279-294.
- Oakerson, Ronald J., and Roger B. Parks. 2011. "The Study of Local Public Economies: Multi-organizational, Multi-level Institutional Analysis and Development." *Policy Studies Journal*, 39(1):147-167.
- Oakerson, Ronald. 1999. *Governing Local Public Economies: Creating the Civic Metropolis*. ICS Press: Oakland, CA.
- Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. New York, NY: Cambridge University Press.
- Ostrom, Elinor. 2005. "Understanding Institutional Diversity". Princeton, NJ: Princeton University Press.
- Ostrom, Elinor. 2007. "A Diagnostic Approach for Going Beyond Panaceas." *Proceedings of the National Academy of Sciences*, 104(39):15181-15187
- Ostrom, Elinor. 2008. "Design Principles of Robust Property-Rights Institutions: What have we learned?" In Ingram, Gregory K. and Yu-Hung Hong (Eds.). *Property Rights and Land Policies*. Cambridge, MA: Lincoln Institute of Land Policy.
- Ostrom, Elinor. 2009a. "Collective Action Theory." In Boix, Carles and Susan Stokes (Eds.) *The Oxford Handbook of Comparative Politics*, 186-208. Oxford: Oxford University Press.
- Ostrom, Elinor. 2009b. "A General Framework for Analyzing Sustainability of Social-Ecological Systems." *Science*, 325: 419-422.
- Ostrom, Vincent, Charles M. Tiebout, and Robert Warren. 1961. "The organization of government in metropolitan areas: a theoretical inquiry". *American Political Science Review*, 55(4): 831-842.
- Portland Water Bureau. 2015. Annual Watershed Control Program Report for Water Year 2015.
- Righter, Robert W. 2005. *The Battle Over Hetch Hetchy: America's Most Controversial Dam and the Birth of Modern Environmentalism*. Oxford: Oxford University Press.
- Robins, Garry, Philippa Pattison, Yuval Kalish, and Dean Lusher. 2007. "An Introduction to Exponential Random Graph (p\*) Models for Social Networks." *Social Networks* 29(2): 173-91.
- Robinson, Scott E. 2004. "Punctuated Equilibrium, Bureaucratization, and Budgetary Changes in Schools." *Policy Studies Journal*, 32(1): 25-39.
- Robinson, Scott E., Floun'say Caver, Kenneth J. Meier, Laurence J. O'Toole, Jr. 2007. "Explaining Policy Punctuations: Bureaucratization and Budget Change." *American Journal of Political Science*, 51(1):140-150.
- Rodrigues, Miguel, Antonio F. Tavares, and J. Filipe Araújo. 2012. "Municipal Service Delivery: The Role of Transaction Costs in the Choice between Alternative Governance Mechanisms." *Local Government Studies*, 38(5): 615-618.

Sabatier, Paul, and Hank Jenkins-Smith. 1999. "The Advocacy Coalitions Framework: An Assessment." In *Theories of the Policy Making Process*, 1<sup>st</sup> Edition, edited by Paul Sabatier. Westview Press.

Scharpf, Fritz W. 1997. *Games Real Actors Play: Actor-Centered Institutionalism in Policy Research*. Boulder, CO: Westview Press.

Schlager, Edella. 2016. "Editorial: Introducing the 'The importance of context, scale, and interdependencies in understanding and applying Ostrom's design principles for successful governance of the commons.'" *International Journal of the Commons*, 10(2): 405-416.

Schlager, Edella, Jeffrey W. Hanlon, and Tomás Olivier. 2015. "Suspicious Collaborators: How Governments and Citizens Monitor Each Other and Enforce the Rules of Regional Common-Pool Resource Use." 73rd Annual Conference, Midwest Political Science Association. April 16th-19th. Chicago, IL.

Schlager, Edella, Laura Bakkensen, Tomás Olivier, and Jeffrey W. Hanlon. 2017. "Institutional Design and Public Goods: Variations in design for the management of Simple and Complex Public Goods." WORKING PAPER.

Scholz, John T., and Bruce Stiftel (Eds.). 2005. *Adaptive Governance and Water Conflict: New Institutions for Collaborative Planning*. Washington, DC: Resources for the Future.

Seawright, Jason. 2016. "The case for selecting cases that are deviant of extreme on the independent variable." *Sociological Methods and Research*, 45(3): 493-525.

Short, Casey. 2011. *Water: Portland's Precious Heritage*. Portland, OR: City of Portland, Oregon.

Siddiki, Saba N., Christopher M. Weible, Xavier Basurto, and John Calanni. 2011. "Dissecting policy designs: An application of the institutional Grammar tool". *Policy Studies Journal*, 39(1), 79-103.

Siddiki, Saba N., Chris Koski, Julia L. Carboni, and Abdul-Akeem Sadiq. 2015. "How Policy Rules Shape the Structure and Performance of Collaborative Governance Arrangements." *Public Administration Review*, 75(4): 536-547.

Simpson, John Warfield. 2005. *Dam!*. New York, NY: Pantheon Books.

Soll, David. 2013. *Empire of Water: An Environmental and Political History of the New York City Water Supply*. Ithaca, NY: Cornell University Press.

Stearns, D.J. 2000. "Memorandum and Order on a Motion by the United States for an order of injunctive relief." Court decision on the case United States of America vs Massachusetts Water Resources Authority, and Metropolitan District Commission.

Steinacker, Annette. 2004. "Game-Theoretic Models of Metropolitan Cooperation." In ed. Feiock, Richard C, *Metropolitan Governance: Conflict, Competition, and Cooperation* (pp. 46-66). Washington, DC: Georgetown University Press.

Steinberg, Philip E., and George E. Clark. 1999. "Troubled water? Acquiescence, conflict, and the politics of place in watershed management." *Political Geography*, 18: 477- 508.

Stern, Paul C., Thomas Dietz, Nives Dolšak, Elinor Ostrom, and Susan Stonich. 2000. "Knowledge and Questions After 15 Years of Research". In Elinor Ostrom, Thomas Dietz, Nives Dolšak, Paul C. Stern, Susan Stonich, and Elke U. Weber (Eds.), *The Drama of the Commons* (pp. 445-486). Washington, DC: National Academy Press.

Sturges, Judith E., and Kathleen J. Hanrahan. 2004. "Comparing telephone and face-to-face qualitative interviewing: a research note." *Qualitative Research*, 4(1): 107-118.

Subirana, Isaac, Héctor Sanz, and Joan Vila. 2014. "Building Bivariate Tables: The compareGroups Package for R." *Journal of Statistical Software* 57(12): 1-16. URL <http://www.jstatsoft.org/v57/i12/>.

Surface Water Treatment Rule, 40 C.F.R §141.71. 1989.

True, James L., Bryan D. Jones, and Frank R. Baumgartner. 2007. "Punctuated-Equilibrium Theory: Explaining Stability and Change in Public Policymaking." In Sabatier, Paul A. (Ed.) *Theories of the Policy Process* (pp. 155 – 187). Boulder, CO: Westview Press.

U.S. Environmental Protection Agency. 1999. "Protecting Sources of Drinking Water: Selected Case Studies in Watershed Management." (On line). Retrieved July 27, 2016. Available at: <http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000271X.txt>

USDA Forest Service, Mt Hood National Forest, and Portland Water Bureau. 2007. "Report to the community Regarding a new Bull Run Watershed Management Unit Agreement." (On line). Retrieved June 2, 2017. Available at: [https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/fsbdev3\\_036333.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_036333.pdf)

USDA Forest Service, Mt. Hood National Forest and Portland Water Bureau. 2007. Bull Run Watershed Management Unit Agreement. [online]. Last retrieved June 2, 2017. Available at: <https://www.portlandoregon.gov/water/article/403933>

Van Evera, Stephen. 1997. *Guide to methods for students of political science*. Ithaca, NY: Cornell University Press.

Williamson, Oliver E. 1981. "The Economics of Organization: The Transaction Cost Approach." *American Journal of Sociology*, 87:548-577.

Williamson, Oliver E. 1996. *The Mechanisms of Governance*. Oxford: Oxford University Press.

Workman, Samuel, Bryan D. Jones, and Ashley E. Jochim. 2009. "Information Processing and Policy Dynamics." *Policy Studies Journal*, 37(1): 75-92.

Young, Oran. 2002. "Institutional Interplay: The Environmental Consequences of Cross-Scale Interactions." In Ostrom, Elinor, Thomas Dietz, Nives Dolsak, Paul C. Stern, Susan Stonich, and Elke U. Weber (Eds.), *The Drama of the Commons* (pp. 263-292). Washington, DC: National Academy Press.

Young, Oran. 2006. "Vertical Interplay among Scale-Dependent Environmental and Resource Regimes." *Ecology and Society* 11 (1): 27.