The Formation of Large-scale Collaborative Resource Management Institutions: Clarifying the Roles of Stakeholders, Science, and Institutions

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This article explores the emergence of collaborative institutional arrangements for managing natural resources in large-scale and complex resource settings, among numerous political jurisdictions and stakeholders. It examines four regional institutions in the United States: the Northwest Power and Conservation Council's Fish and Wildlife Program, the Chesapeake Bay Program, the CALFED Bay-Delta Program, and the Comprehensive Everglades Restoration Plan. While a wealth of literature has looked at the emergence of smaller-scale resource management institutions, and some literature has begun to look at the characteristics and successes of these regional institutions, theory is lacking to explain the formation of these regional institutions. We first introduce three relevant streams of literature—on common pool resources management, on policy entrepreneurs and social capital, and on science and information in policy change—to frame our analysis. The comparisons of the cases point to the importance of integrating key insights from the literature for understanding the formation of collaborative resource governance. We emphasize how science, leadership, and prior organizational experience interact in facilitating institutional change, particularly in the process of raising awareness about resource management problems. In tracing the formation of these institutions, we also identify how external institutional triggers can help spur collaborative governance.

KEY WORDS: collaborative environmental governance, institutional change, scientific information, policy entrepreneurs, Northwest Power and Conservation Council, Chesapeake Bay Program, CALFED Bay-Delta Program, Comprehensive Everglades Restoration Plan

Collaborative resource management, sometimes called "comanagement," can be defined as a group of diverse stakeholders, including resource users and government agencies, working together to resolve shared dilemmas. This type of institutional arrangement is becoming an increasingly common alternative to centralized institutions to manage natural resources (Karkkainen, 2002; Koontz et al., 2004; Lubell, 2004; Wondolleck & Yaffee, 2000). Many scholars have examined the benefits of collaborative resource management, such as its capacity to adapt to the changing physical conditions of resources (Kenney, 1997), to promote public participation and policy dialogue (Connick & Innes, 2003; Leach, Pelkey, & Sabatier, 2002), and to enhance social capital (Leach et al., 2002). While the potential benefits of collaborative resource management offer obvious incentives for stakeholders to come together, this is no guarantee that collaboration will emerge around a particular

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resource management dilemma, especially in settings where actors have held traditionally adversarial relationships.

A number of scholars have examined the formation of institutions for managing natural resources, particularly local user-based arrangements, such as watershed management partnerships (Lubell et al., 2002), groundwater management institutions (Blomquist, 1992), irrigation associations, community forests groups, and inshore fisheries institutions (Ostrom, 1990; Ostrom, Gardner, & Walker, 1994). However, less attention has been paid to large-scale or regional institutions that may involve agencies, state governments, and local users collectively managing resources. Scholars who study large-scale collaborative efforts have focused more on defining the characteristics of collaboration and the factors that make them successful than on what brings actors together in the first place (Imperial, 2004; Karkkainen, 2002; Wondolleck & Yaffee, 2000). In other words, the factors that support the formation of these institutions are not well understood.

This article compares data on four regional governance institutions in the United States—the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program, the Chesapeake Bay Program (CBP), the CALFED Bay-Delta Program, and the Comprehensive Everglades Restoration Plan (CERP)—to explore why these institutions were created and how collaborative governance within these programs has developed. Each institution encompasses a watershed that spans thousands of square miles, with highly complex ecosystems and millions of people living in the region. With the vast physical scale of these regions, these institutions involve multiple-state and federal agencies, as well as local stakeholders collectively managing water quality, quantity, and habitat restoration. These institutions, thus, are of a greater scale and scope than those watershed or community-level institutions examined by scholars interested in collective action in environmental policy. These differences suggest that the incentives for collaboration in regional settings may differ from their smaller-scale counterparts.[1]

To better understand what factors might support institutional formation for large-scale or regional collaborative resource management, we review various bodies of policy literature, focusing on: (i) collective action in common pool resource (CPR) settings, (ii) policy entrepreneurs and social capital, and (iii) the role of science and information in institutional formation. First, we identify some of the key insights each might offer to the understanding of the formation of these institutions. Second, we compare the characteristics of the resource and stakeholders in the four case studies prior to institutional formation, and assess which of those features were instrumental in driving institutional change. Our analyses illustrate the value of integrating diverse streams of literature on institutional formation and change to understand the incentives underlying institutional design in these settings.

Collective Action in CPR Settings

One body of research that helps explain collective action in managing natural resources comes from institutional scholars of CPR, such as forests, fisheries, and

water basins. Over the past 20 years, CPR scholars have compiled numerous empirical examples of the emergence of self-governing resource institutions to control resource use and manage their supplies (Baland & Platteau, 1996; McCay, 2002; National Research Council, 1986; Ostrom, 2001; Ostrom et al., 1994). Based on this large body of empirical research, institutional scholars have identified the characteristics of the resource and those of the resource users that are likely to support collective action, or the emergence of these institutions (Ostrom, 2001). Among those characteristics of resource users identified by CPR studies that support collective action, trust and reciprocity are considered to be essential (Ostrom, 1998). In CPR settings, trust can work in concert with a number of other factors, such as when resource users have common preferences for resource use and when they share knowledge about the resource system (Libecap, 1994; Ostrom, 1990; Taylor & Singleton, 1993). In addition, institutional development is more likely (and trust is enhanced) when CPR users have experience working together directly (Ostrom, 1990; Taylor & Singleton, 1993).

The conditions of the resource are also important for supporting collective action among CPR users. For example, smaller or more predictable CPR settings make it easier for both physical and social boundaries to be defined around the resource (Ostrom, 1990, 2001). Such boundaries clarify who has access to resources, and thus help ensure that those individuals who invest in establishing rules to manage the resource will benefit from those investments. In addition, in smaller-scale CPR settings, or where resource flows are relatively stable and predictable, it is also easier to acquire accurate information about the conditions of the resource. This can increase the likelihood of actors devising CPR institutions (Ostrom, 1990), whereas differences in information about the resource can make it difficult to come to an agreement on new institutional arrangements.

The underlying reason why these variables are likely to support collective CPR governance comes from transaction cost theory. Transaction costs involve the time, money, and effort associated with searching for collective partners, bargaining with those partners, as well as monitoring and enforcing agreements (Taylor & Singleton, 1993). Most scholars of CPR institutions agree that certain characteristics of resource users and certain characteristics of the physical environment can reduce the transaction costs associated with collective action, and thus the likelihood that resource users will devise new institutional arrangements (Libecap, 1994; Lubell et al., 2002; Ostrom, 1990; Taylor & Singleton, 1993). While the transaction costs are important to consider, they must be weighed against the benefits of collaboration in a given setting.

The benefits of collective action depend largely on the severity of the problem and the extent to which actors depend on the resource for their livelihood (Ostrom, 1990; Ostrom et al., 1994). Even in small and stable CPR settings, it may be difficult to assess information, particularly because people have limited capacities to process and understand information (Blomquist, 1992). Not surprisingly, the failure to collectively work together might be related to the inability of actors to see the severity of the problems (McCay, 2002). Recognizing the extent of the problem is, thus, part of identifying the benefits of collective action. Libecap (1994, 567) labels such

benefits as the "size of the aggregate expected gains." More parties are likely to benefit, and thus, be interested in collaboration, in situations where problems are relatively severe (Lubell et al., 2002), yet where improvements are still feasible (Ostrom, 1990, 2001). Ostrom (1990, 2001) also finds that a shared long-term vision of how the resource benefits a community is important.

This body of literature is limited to the idea that many resource management situations do not conform to the characteristics of the small-scale settings with easily defined boundaries; stable resources; and homogenous, trusting resource users. In complex resource systems, the ecosystem may provide multiple and conflicting benefits (e.g., water supply, recreation, commerce) and various types of stakeholders, who may not even live near the resource, often use or have management authority over the resource. Logically, however, some of the characteristics of local CPR settings that support collective action can be applied to more complex settings. A history of interaction among actors, shared visions of the resource, and trust are factors that can help reduce the transaction costs of interactions among diverse stakeholders. Yet, other factors may also play a role in this process.

Policy Entrepreneurs and Social Capital

Much of the literature on collaboration and collective action in natural resource management has recognized the importance of concerted efforts by policy entrepreneurs and leaders in facilitating institutional change. As Blomquist (1992) has shown in a study of groundwater governance in Southern CA, strong leaders, or policy entrepreneurs, can help establish such efforts and thus may provide a vital spark for collective action in CPR settings. Similarly, a recent experimental research by sociologists studying collective action indicates that "mobilizers" play an important role in spreading persuasive messages to actors about the benefits of participation (Vasi & Macy, 2003). In addition to bringing individual resource users together, policy entrepreneurs and leaders have been shown to play a key role in agency-level collaboration in managing natural resources and ecosystems (Thomas, 2003).

Arguably, the efforts of policy entrepreneurs enhance the likelihood of collective action when they work in conjunction with other factors, such as experience working together, trust, and frequent communication. Together, such variables constitute what scholars of collective action refer to as *social capital* (Lubell & Scholz, 2001). Policy entrepreneurs and leaders with experience working on resource management can provide the initial social capital needed for those actors who do not have experience in collaborative management, from which trust and further experience build. Lubell (2004) finds that this is especially true when agencies collaborate with individual resource users. In studying a watershed management partnership in Florida, Lubell (2004, 353) notes that, "the interaction between local government representatives and grassroots stakeholders is the crucible in which social capital is formed. Local government officials are the bearers of policy promises, who communicate expectations about political agreements." In other words,

leadership and policy entrepreneurs can support and enhance the other factors that reduce the transaction costs of collective action among heterogeneous actors.

As the CPR literature points out, reducing the costs of collective action is just one part of the equation; the actors must also know that the benefits of collective action are substantially high. If policy entrepreneurs or leaders are important in driving institutional formation by providing social capital, what is the benefit to these policy entrepreneurs and how do they ensure that other actors understand those benefits? Certainly, the benefits of institutional formation can largely be attributed to the fact that a public good will be provided to resolve an existing problem. Recognizing the value of that collective good or new institution, however, may not be immediately apparent.

The Role of Science and Information in Institutional Formation

The literature on policy change offers some guidance in understanding how actors come to acknowledge the benefits of collective action and institutional formation. Scientific and technical information, in particular, can play a key role in bringing diverse stakeholders together by acting as a neutralizing force for value differences. Sabatier and Jenkins-Smith (1993) have pointed out that developing a common understanding of policy problems across stakeholders or interest groups is contingent upon the types of core beliefs or values the groups hold. Just as the CPR literature points to the importance of trust, Sabatier and Jenkins-Smith (1993) find that when core values of different stakeholders are more closely aligned, stakeholders are more likely to work together toward policy change. Although stakeholder groups may be likely to ignore or resist information that conflicts with their core beliefs, new information can lead to gradual changes in belief systems and eventual change in the policies reflected by those altered beliefs (Sabatier & Jenkins-Smith, 1993). In addition, this research shows that learning across stakeholder groups is more likely to occur in a professional setting or forum, where the issues are not highly divisive, and where participating coalitions have access to technical information for debate.

A range of empirical research on institutional formation and collective action supports the theoretical importance of technical information. Political scientists, for instance, have identified the significance of scientific breakthroughs as triggering events for issues to gain public attention (Cobb & Elder, 1972; Kingdon, 1995). The aggregation of reliable and abundant scientific information over a period of time in a specific policy arena also helps policymakers identify problems (Kingdon, 1995; Walker, 1977). Thus, the benefits of forming new policies or institutional arrangements (or the cost of not acting) become easier to communicate to policymakers when critical information about problems has amassed. These findings can be linked back to the role of policy entrepreneurs in spreading technical information to stakeholders and decision makers. Research on the formation of international environmental regimes that looks at the influence of epistemic communities—or "transnational networks of groups with special expertise in the issue area" (Breitmeier, 1997, 91)—suggests that experts in epistemic communities are

often responsible for facilitating new institutions by supplying new ideas and information to decision makers (Haas, 1992).

In addition to providing a common understanding across stakeholders, technical and scientific information provides another advantage to large and diverse communities faced with the high transaction costs of institutional change. Just as the CPR studies show that well-defined boundaries and limited physical extents help reduce the transaction costs of collective action in CPR settings by clarifying resource management responsibilities, so too can well-established problems. In other words, coming to a clear consensus (although not accurate) of the extent of the problem, who that it affects, and who or what is its source can help establish who benefits from the investments made in managing the resource, or who benefits from institutional change. When these benefits are evident, and substantially higher than the costs of organizing, change is more likely. Empirical studies of collaborative resource management efforts, in fact, have shown that collective agreement among stakeholders on problem definition supports the development of these institutions (Koontz et al., 2004; Wondolleck & Yaffee, 2000).

In considering the insights from a range of literature on environmental institutions and policy change, we have identified factors that are likely to support the emergence of collaborative large-scale ecosystem-management institutions. We argue that aspects of the theory of collective action in smaller-scale CPR settings can be useful for understanding the emergence of large-scale collaborative resource management institutions, but this requires integrating insights from other policy formation theories. First, we expect that, problem definition, and adequate technical information on that problem, and its affected stakeholders are likely to support the emergence of collaborative institutions in large scale settings. In addition, we expect that in defining problems, policy leaders and entrepreneurs can be integral to communicating across stakeholders, encouraging policy trials or formulation, and fostering a history of groups working together, factors that can facilitate institutional change according to CPR literature. In studying the four cases outlined later, we see how these factors vary across the different physical environments and how these factors interact.

Methods and Case Descriptions

To examine the emergence of collaboration in large-scale resource settings, we have selected four cases from major watersheds in the United States for our analyses. By large scale, we are referring to those institutions that are not only large in geographic scope, but are also broad in institutional scope—bringing together numerous federal and state agencies, local agencies, academics, industry, conservation groups, and other resource users. Indeed, the mission and the collaborative nature of these institutions are often quite similar to smaller-scale watershed partnerships—addressing problems that typical command-and-control approaches fail to solve such as habitat destruction and nonpoint source pollution (Lubell et al., 2002). The scope of the missions of the regional institutions, however, as discussed later, reflects their extensive scale, often aiming for widespread ecosystem restora-

tion. They also differ from many of the local partnerships with respect to the overarching organizational structures that support them, typically authorized or funded by federal and state governments.

While the four cases we selected involve distinct problems and stakeholders, they are similar in that the mission of each program emphasizes the restoration and protection of the region's watershed and its surrounding aquatic ecosystem (see Table 1). One reason for choosing these particular cases is that two of them—the CBP and the NPCC's Fish and Wildlife Program—are well established, operating for over 20 years, while the CERP and the CALFED Bay-Delta Program are relatively young. Thus, they provide useful settings for drawing comparisons. We also chose these four cases because they are all "high profile" resource management programs, and they have received much attention in the academic and popular press. Despite their prominence, no direct comparisons have yet been made across these cases to evaluate collaboration *per se*.[2] Given that much of the recent scholarship on collaborative environmental movements has been limited either to individual case studies (Koontz et al., 2004) or quantitative studies within a single-case setting (Lubell, 2004), we feel that a comparative approach to studying collaborative institutions provides a valuable addition to the literature. It allows us to explore the effects that different resource features and community variables have on the formation of governance arrangements.[3]

The oldest of the four programs, the NPCC's Fish and Wildlife Program, was born out of the Pacific Northwest Electric Power Planning and Conservation Act (known as the "Northwest Power Act") (1980). Passed to address problems with hydropower and salmon habitat in the Columbia River Basin. The Act provided the authorization for Oregon, Washington, Idaho, and Montana to set up an interstate council to manage these problems. The Act required that the Council devise "a program to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries" (h)(1)(A), while ensuring the availability of an "efficient, economical, and reliable power supply" (h)(5). The NPCC's decision-making structure consists of two representatives from each of the four member states. The Council appoints a staff of professionals with expertise in energy or fisheries. In developing the fish and wildlife plan, the Council must seek recommendations from tribal, state, and federal fish and wildlife agencies, and hold hearings in each member state before the adoption of the plans. Plans are updated every 5 years. The federal agencies involved in managing the dams and hydropower are responsible for acting in accordance with the program devised by the Council. Various other federal, state, and local agencies also work with the Council to implement the plans.

The CBP started in 1983 out of a relatively simple three-page agreement among Virginia, Maryland, Pennsylvania, Washington DC, and the U.S. Environmental Protection Agency (EPA). The agreement was updated in 1987 and in 2000, expanding the goals of the program each time. The 2000 agreement was developed in 3 years, with extensive input from stakeholders, including more than 300 scientists, resource managers, policymakers, and citizens from all parts of the Bay watershed (Chesapeake Bay Program, 1999a). Unlike the NPCC program, the CBP does not

Table 1. Overview of the Cases

	Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program	Chesapeake Bay Program (CBP)	CALFED Bay-Delta Program	Comprehensive Everglades Restoration Plan
Mission	Develop plans every 5 years to protect and rebuild fish and wildlife affected by hydropower in the Columbia Basin and tributaries	Improve and protect water quality, fish, plants, and other aquatic resources in the bay's estuarine system	Improve water supply and effectively implement environmental protections in California Bay-Delta	Restore, preserve, and protect the South Florida ecosystem as well as for flood protection and water supply
Authorizing policy and year	Northwest Power Act (1980)	Chesapeake Bay Agreements (1983, 1987, and 2000)	Record of Decision and Final Environmental Impact Report and Statement (2000)	Water Resources Development Act (2000)
Decision-making body	NPCC	CBP Executive Council	California Bay-Delta Authority	South Florida Ecosystem Restoration Task Force
Structure of decision-making body	Two representatives are appointed by governors from each state (OR, WA, ID, and MT)	Governors of VA, PA, MD; mayor of DC; EPA representative; and the Chair of the Chesapeake Bay Commission	Representatives from six state and six federal agencies; five regional, public members appointed by the governor; a member of the Bay-Delta Public Advisory Committee; and two at-large public members appointed by chairs of the Assembly and Senate water committees	Seven members are appointed by federal agencies, two state members recommended by the governor, one member from the South Florida Water Management District (SFWMD), two members from local governments recommended by the governor, and two tribal members
	Council hires professional staff for research and planning	Executive Council appoints staff and implementation committees	Authority hires 65 professional staff (state employees) and 15 federal staff (under Bureau of Reclamation)	Task force hires Executive Director who may appoint staff or borrow staff from member agencies
Implementing agencies	NPCC; various state, federal, and local agencies	CBP committees and working groups, U.S. Environmental Protection Agency, and state agencies	CALFED Bay-Delta Authority; various state, federal, and local agencies	South Florida Ecosystem Restoration Task Force, U.S. Army Corps of Engineers and SFWMD

NPCC, Northwest Power and Conservation Council; CBP, Chesapeake Bay Program; SFWMD, South Florida Water Management District.

have any formal federal or state legislative authorization, nor is it a formal interstate agency like the NPCC. The primary mission of the program is to improve the water quality of the bay to support its plants and animals, specifically through nutrient and sediment reduction. The program is administered by an executive council, comprised of the governors of the member states and the mayor of Washington DC, as well as representatives from the EPA and the Chair of the Chesapeake Bay Commission (CBC) (an advisory authority for the program's member states). Twenty-two different agencies and departments within the member states and federal government serve as program partners. In 2000, the headwater states of Delaware and New York joined as program partners, with WV coming on board in 2002. These program partners work to implement the program's goals by facilitating voluntary programs to improve resource conditions, monitoring and studying the ecosystem, educating stakeholders, and supporting legislation by state and federal partners.

CALFED began in 1994 as a forum in which federal and state agencies could develop a single, comprehensive plan for the region surrounding the San Francisco Bay and San Joaquin–Sacramento River Delta. As a plan developed, CALFED evolved into a forum where agencies can coordinate their actions. Today, it is a collaborative policymaking and water management process among 23 state and federal agencies with responsibilities for managing water supplies and protecting natural resources. The mission of the CALFED Bay-Delta Program is "to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta State" (California Bay Delta Authority, 2005). When the CALFED Program put forth its Record of Decision in 2000, it completed the first phase of its development—problem identification and establishment of action strategies for state and federal agency members. The program is organized by function including water use efficiency, ecosystem restoration, water transfers, watershed management, environmental water quality, drinking water quality, levees, water storage, conveyance, and science program. To support the program, the California Bay-Delta Authority, a consortium of federal and state agencies charged with managing water supplies and ecosystems within the Sacramento–San Joaquin Delta, was established through state legislation in 2003. Members of the Authority include representatives from state, federal, and regional agencies as well as public representatives. The program implementation occurs when local agencies and organizations submit proposals to develop specific programs and projects that meet CALFED goals, such as the construction of a fish screen on a particular diversion facility.

Similar to CALFED, the CERP is a joint federal–state restoration effort. Thought to be one of the most ambitious ecosystem restoration projects in terms of its scope, the details of this plan span some four thousand pages. Congress authorized funds for the first 10 years of the 25-year plan with the Water Resources Development Act (2000). The CERP is the result of the Central and Southern Florida Project Comprehensive Restudy, a full review of the region's water management scheme conducted by the U.S. Army Corps of Engineers (ACE) as mandated by Congress beginning in the early 1990s. The overarching objective of the plan is the "restoration, preservation, and protection of the South Florida ecosystem while providing for other water-

related needs of the region, including water supply and flood protection" (U.S. Army Corps of Engineers and the South Florida Water Management District, 2003). Essentially, the plan is aimed at getting the water right: restoring more natural hydrologic functions of the ecosystem while still providing adequate water supply and flood control. The South Florida Ecosystem Restoration Task Force, composed of federal, state, local, and tribal representatives, is charged with coordinating and facilitating the overall restoration effort. The ACE is responsible for the development and implementation of the projects, and traditional areas of state control are delegated to the South Florida Water Management District (SFWMD), including individual project design, cost sharing, furnishing lands, easements, rights of way, relocation, and disposal areas.

Analyzing the Factors that Support the Emergence of the Programs

In general, the underlying goal of each of the four institutional arrangements is to improve or enhance the quality of the ecosystem and its component resources. The basis for each of these new institutions is problems with the quality and availability of the resource, which existing institutional arrangements in these regions have not adequately addressed. Here, we describe the resource conditions and problems, as well as the available scientific information on these problems, prior to each program's inception. Second, we compare the characteristics of the stakeholders in each of the four cases leading up to the creation of the new institutions, looking at the role of policy entrepreneurs in particular and the degree to which social capital (evidenced by prior organizational efforts) is present in these settings.

Resource Conditions and Information

As mentioned earlier, studies of collective action among CPR users show that certain characteristics of the resource can facilitate collective action (e.g., small physical extent, stationary resource flows). In these four cases, many of these conditions are not likely to apply. One factor that does apply to these settings is the salience of the resource to local inhabitants. By comparing the importance of the resource, as well as the extent to which information was available on the problems of the resource, we can better understand the benefits of collaboration in these settings.

As summarized in Table 2, each of the four collaborative governance programs covers thousands of miles of ecologically diverse watersheds, where millions of people also live. The natural resources from these ecosystems provide a major source of economic and social well being in the regions. The key resource demands in these regions often involve competing needs. Along the Columbia River, salmon fishing has provided food and economic support to local communities for hundreds of years, while hydropower offers the principal source of low-cost electricity in the region. It is also an important source of irrigation and industrial water supply. The Chesapeake Bay is a major area for shipping, commerce, and commercial fisheries, which produce over 500 million pounds of seafood per year. Irrigation is of primary importance in California's Bay-Delta, supplying water to over 4 million acres of

Table 2. Resource Characteristics

	Northwest Power and Conservation Council's Fish and Wildlife Program	Chesapeake Bay Program	CALFED Bay-Delta Program	Comprehensive Everglades Restoration Plan
Physical extent	1,214-mile long Columbia River main stem and its tributaries; covers a 259,000-square mile drainage basin	193-mile long bay and drainage basin; covers six states and 64,000 square miles	Sacramento and San Joaquin Rivers Delta and San Francisco Bay Estuary; covers 61,000 square miles	Southern FL water resources; covers 16 counties and 18,000 square miles
Population in region	11 million	15 million	27 million	6.3 million
Primary resource uses	Salmon fishing, hydropower, irrigation and urban water supply	Oyster, crab, and other commercial fisheries; shipping; recreation	Irrigation, urban water supply, commercial fisheries, shipping	Irrigation, urban supply, agriculture, commercial fisheries
Resource problems	Blockage of salmon passage, species decline, habitat loss	Poor water quality, species decline, habitat loss	Water supply shortages, poor water quality, species decline, habitat loss, high risk of levee, breaches	Water supply shortages, poor water quality, species decline, habitat loss, invasive species and exotic plants
Identified causes of the problems	Dam construction, hydropower, extractive industries	Nitrogen pollution from cities, industry, and agriculture; other toxins and sediments runoff	Dam construction, agricultural runoff, population growth and urbanization, drought conditions, diversions to Southern CA	Dam and levee construction, agricultural runoff, population growth and urbanization
Indicators of problem severity	Dramatic decline in salmon populations and habitat	Dramatic drop in oyster, crab, and striped bass populations; loss of thousands of acres of wetlands	Dramatic decline in migratory waterfowl; decline in fish populations, particularly chinook salmon and delta smelt; saltwater intrusion; poor water quality	Decline in wading bird populations, decline in fisheries production, inland and coastal water degradation, rise of invasive species

farmland, producing approximately 45 percent of the nation's fruits and vegetables. In South Central Florida, sugar is the main product. Almost half a million acres of land is devoted to sugarcane plantations in the Everglades Agricultural Area just south of Lake Okeechobee. In addition to the economic activities, water supplies from each of these ecosystems are vital to growing urban communities.

The competing demands for resources in all four regions have led to serious ecological dilemmas that threaten many of the resource-dependent communities and industries (Vigmostad et al., 2005). Most notably, each of these ecosystems has water quality problems, endangered species, and depleted fisheries that are widespread across the ecosystem. In the Columbia River Basin, the major ecological crises

have been the loss of habitat and the inadequate flows for salmon and steelhead populations. The Chesapeake Bay's high nutrient content and sedimentation have created polluted habitats for the numerous fish and plant species that live in the estuary. California Bay-Delta faces similar issues: Fisheries are declining in the watershed at alarming rates, migratory bird populations have significantly decreased, and saltwater intrusion and diversions of water from the Bay and Delta have negatively impacted the estuary's ecosystem and water quality. The vulnerability of the delta's levee system has resulted in considerable flood damage and increased salinity in the bay. In the Florida Everglades, reduced southward flows have caused hypersalinity in the southern estuaries, which has devastated valuable fisheries and marine breeding grounds. Saltwater intrusion into groundwater basins in the region also threatens urban water supplies.

These problems and their identified causes as shown in Table 2 are multidimensional and often interrelated. The source of much of the problems in these regions has been those communities who are mostly dependent on the resource: agriculture, utilities, industry, and growing cities. In the Chesapeake Bay, runoff from both industry and agriculture has increased nitrogen and phosphorus levels in the watershed, and urban development has led to tremendous sedimentation (Ernst, 2003). While agriculture and urban runoff has played a role in affecting the water quality conditions in the other three cases, it differs slightly from the Chesapeake case in that large-scale water development projects (dams and levees), which provide water supply to industry and agriculture, are major problem sources. In response to serious hurricane flooding in the 1940s, the U.S. ACE constructed the Central and Southern Florida Project, a complicated system of levees that resulted in large-scale drainage of the Everglades. As one commentator put it: "The four 'D's' characterized the day: Dike it, Dam it, Divert it, and Drain it" (Hinrichsen, 1995, 25). For over 100 years, the Columbia River Basin has been increasingly managed and controlled for hydropower and irrigation. The Columbia River and Snake River (its major tributary) alone have 18 dams, at least 250 reservoirs, and about 150 hydroelectric projects. Likewise, the California Bay-Delta's 700-square mile maze of islands and channels serves as the hub of the state's two largest water distribution systems, the Central Valley Project and the State Water Project, which provide some 7 million acre–feet of water for agricultural and municipal use throughout CA. Because these problems are tied to competing resource users, the ways in which these problems have been defined have been subject to some debate in each region. Although, at the time these programs started at least, we find that the sources of information on these problems—from basic science to agency science to news reports—provided widespread concurrence about the existence and magnitude of the problems facing these regions.

In the oldest of the four programs, the problems leading up to the formation of the NPCC in 1980 focused on the need for improved salmon habitat, while retaining low-cost hydropower in the Columbia River Basin. Data on salmon populations have been monitored in the Columbia River Basin through harvest records and the various state and federal agencies managing the fisheries since the late 1800s. In the 1970s, there was little argument among scientists, resource managers, and the public

that Columbia River salmon stocks were undergoing a precipitous decline. Data on salmon run at the time indicated that only about 2.5 million salmon were running in the Columbia River Basin, compared to about 10–16 million salmon a hundred years earlier, and most were hatchery fish, not native species (Northwest Power Planning Council, 2003). This issue appeared in regional and national newspapers as the decline in salmon stocks led to the closures of commercial fishing seasons in Oregon and Washington in the late 1970s and early 1980s (Associated Press, 1979; Turner, 1981). Attention to the problem, however, also focused on the importance of saving salmon without sacrificing one of the principal causes of salmon mortality—the dams that block the migration of spawning and juvenile salmon. Dams in the Columbia River Basin provide a major source of the region's power. In the 1970s, the energy demand began to precipitously rise in the Pacific Northwest, calling for an increasing reliability and lower costs by relying on the Columbia River's hydropower system (Lee, 1995). Thus, much of the public discussion and government analyses leading up to the Act focused on balancing the competing needs of hydropower and fisheries (United States Congress, 1980). Witnesses testifying in the numerous Congressional Hearings on the House and Senate bills that led to the Act, including Bonneville Power Administration (BPA), representatives from environmental groups, Columbia River Fisheries Council, and U.S. Fish and Wildlife, presented widespread concurrence about the need to improve power system operations while minimizing the damage to fisheries.

Like the Columbia River Basin, in the decade prior to the CBP's inception, awareness grew about the conditions of the resource—especially its declining water quality. Although scientists have been studying the Chesapeake Bay for well over 100 years, until the mid-1970s, few studies had assessed the ecosystem as a whole (Hammond, 1971). As a result, information on the overall health of the bay was not clearly established and was debated by some scientists in the early 1970s (Holden, 1971; Schubel & Pritchard, 1971). The federal government's efforts to study the Chesapeake Bay's ecosystem in the mid-1970s began to raise awareness about the declining health of the bay. The ACE did one of the first studies in 1965, which was funded under the River and Harbor Act. The study cumulated in "a seven-volume report in 1973 that provided an unprecedented account of the existing state of the Chesapeake Bay and its resources" (Ernst, 2003, 13). While the ACE was conducting this research, the National Science Foundation also reported in 1971 that a bay-wide research program and a coordinating agency were needed to facilitate more ecosystem-wide research. Then, in the late 1970s, the EPA conducted a 5-year study, which confirmed that the health of the ecosystem had vastly eroded and that nutrients, toxins, and heavy metals entering the bay were a major source of environmental degradation. In 1981, a team of scientists was established to summarize some 40 individual studies. The final report came out in 1983, identifying phosphorus and nitrogen as major sources of algal blooms, which hindered oxygen supplies to the ecosystem (Hennessey, 1997). While the study did not offer specific solutions, it pointed to the complex causes of these problems from various interrelated sources including wastewater disposal, runoff from agricultural fertilizers and animal waste, and runoff from urban toxins (Costanza & Greer, 1995). This information also

coincided with increasing data on the symptoms of ecosystem degradation, such as dramatic declines in key commercial fish stocks in the 1970s and 1980s, particularly striped bass and Atlantic croaker (Ernst, 2003).

Like the other cases, data on declining resource conditions were prominent on the agenda for a number of years leading up to the 1994 California Bay-Delta Accord. An article in *Science* (Nichols et al., 1986) noted that the disposal of toxic wastes in the bay, major reductions in freshwater inflow, and dredging and filling of wetlands had substantially altered the estuary's water quality and biotic communities (Nichols et al., 1986). Drought conditions and growing attention to endangered species listings in the late 1980s and early 1990s further helped to escalate concerns among the scientific community. By the early 1990s, major newspapers in the region were reporting on the dismal conditions of the water quality in the bay, the loss of wetlands in the bay, and the declining number of fish species, which were largely attributed to water diversions pulled from the Sacramento and San Joaquin Rivers to irrigate farms and supply the people with drinking water (Martin, 1992a, 1992b). In 1987, the EPA-funded San Francisco Estuary Project facilitated a group of scientists who collaboratively developed a salinity measure for monitoring estuarine health. It was the basis for EPA's standards that were applied to the system prior to the 1994 Bay-Delta Accord.

Evidence about the problems with water quality and resource degradation in the Florida Everglades also amassed in the decade prior to the inception of the CERP. For example, scientists began researching and forming collaborative partnerships to try to solve the mercury-contamination problem in the Everglades in the 1980s (Frederick et al., 2005). A wading bird-population collapse in the 1980s also helped to attract attention to ecological concerns in the region (Bancroft, 1989). In 1987, a group of scientists became concerned that research findings about the Everglades ecosystem were not being published and that no synthesis that could provide guidelines for restoration had surfaced. Their "white paper" turned into a symposium that evolved into workshops, simulation modeling, and publishable manuscripts (Light, Gunderson, & Holling, 1995). By the late 1980s and early 1990s, problems like wetland loss, species decline in number, and fish contamination in the Everglades attracted national attention (*The Economist*, 1989; Moreau, 1986; *New York Times*, 1989; Satchall, 1990). Congress would respond in 1992 by directing the ACE to initiate a comprehensive review of the Central and South Florida Project, paving the way for restoration of the Everglades.

In all four cases, data and information on the existence of resource problems—particularly species decline in number and water-quality degradation—were relatively widespread in the years leading up to the inception of the programs. In each case, data and information were filtered through various sources: the media, Congress, and agency reports. Yet, each case shows relative concurrence across the various sources of information about the severity of these problems. Notably, in all cases, the initial awareness of the prevalence of resource management problems and species degradation did not mean that consensus existed on the precise cause of the problems or the solutions to these problems. As seen in the institutional design for each case, scientific advisory boards and various scientific committees have been

created to assist these programs in developing management programs that can adapt to changing scientific information (Vigmostad et al., 2005). This adaptive management approach has led to iterations and updates of program plans, and in essence, new policies for addressing the problem. It has also provided a way to institutionalize greater collaboration with the scientific community and with stakeholders in the older cases.

In the NPCC case, growing awareness about the myriad sources of species decline in number—from overfishing to habitat destruction as a result of logging and poor land use—has coincided with the Council altering its management strategies as it updates its plans every 5 years. For example, by the early 1990s, the Council had become increasingly criticized for not adequately addressing the need for adequate spills over dams for fish passage and for ignoring some of the negative effects that hatchery fish have genetically on native salmon (Blumm and Bodi, 1996). In the mid-1990s, the Council formed two independent scientific review boards, which have been integral in assessing its subsequent plans. Based on scientific reviews of the Council's plans in the 1990s, the program turned its focus in 2000 to subbasin plans, trying to link water management and salmon recovery efforts throughout the entire basin. These subbasin plans have also involved extensive citizen input and collaborative decision making at a broader level than under prior plans. This does not mean that science has provided the answers for decision making; open public debates over the best management strategies among citizens, scientists, and the Council continue for these plans.

Similarly, in the CBP, as part of its mission, extensive research on water-quality problems and habitat degradation is ongoing. Various state and federal agencies work together in monitoring water quality (i.e., monitoring the pH, dissolved oxygen, salinity, and temperature of the water); fish and shellfish; grasses; waterfowl; and other indicators, with citizen monitoring, through voluntary organizations, to complement agency efforts. This research has raised awareness about the complex causes of water-quality problems and loss of species, which have been increasingly articulated through the goals of each of the program's agreements in 1983, 1987, and 2000. Similar to the NPCC program, this adaptive approach has not meant that the program participants have always agreed on how to interpret science for management solutions or how to best meet its goals (Richard Batiuk, interview, June 15, 2005). For example, member states were slow to adopt mandates for agriculture to reduce runoff from nitrogen fertilizers, despite widespread scientific concurrence on nitrogen loading in the bay, until major fish kills in the late 1990s brought media attention to the problem (Ernst, 2003).

The two newer programs have also attempted to institutionalize an adaptive management approach and a structure for continued scientific input into decision making to help identify and clarify appropriate solutions. CALFED's Science Program, established by the 2000 Record of Decision, serves to assist state agencies by developing the science necessary to support their work. The program staff do not actually conduct science but rather direct and integrate science and management activities with a focus on the "big picture" (CALFED Bay-Delta Program, 2000: Attachment E). According to one participant in the process, "Prior to the Science

Program, there was little broad exposure to scientific issues related to the Delta" (Pitzer, 2005, 10). In 2003, the Science Program helped establish an Independent Science Board with world-renowned scientists who provide external peer review on the various program elements. In the Florida Everglades, the Science Coordination Team has worked on issues of water flow and sustainable agriculture since 1997. The REstoration COordination and VERification Team, an interdisciplinary, interagency team designed to develop tools to evaluate, monitor, and improve restoration, is charged with applying scientific and technical information to ensure the success of the Everglades restoration program.

Like the older programs, there is debate concerning scientific research and its integration with decision making. In California Bay-Delta, some have raised concerns that the fisheries agencies control the science too much; others have pointed to an inability to translate the latest science into management decisions (Pitzer, 2005, 10). In an examination of restoration efforts in the Everglades, journalist Michael Grunwald of *The Washington Post* found many government officials and scientists who expressed serious concerns about the restoration plan and its impact on the ecosystem (Grunwald, 2002, A01). Scientific critics have argued that too much attention has been paid to restoring historical depths of water with far too little attention paid to patterns of water flow (Schrope, 2001, 128). A recent U.S. General Accounting Office (2003) report found gaps in scientific information that could hinder the success of restoration.

Despite the ongoing debates about how best to resolve the problems in these regions, we see that widespread information and awareness about the nature and extent of the environmental problems in these four cases are closely linked to institutional formation and evolution. This point has theoretical and empirical support from the literatures on policy change, epistemic communities, and collaborative environmental management discussed earlier. Moreover, by integrating this with the theory of collective action from the CPR literature, it is clear that this information plays a role in confirming the benefits of collective action to affected resource users and stakeholders. Where the cases provide slight divergence from the theory is in the extent to which actual problem–definition effected institutional change. The data and information indicating the presence of problems in these ecosystems and the potential severity of these problems were widespread, yet concurrence on the causes of the problems or the solutions was not—as we have seen years of continued efforts and extensive institutional energy placed on continuing to advance science and information for these programs.

Stakeholder and Institutional Characteristics

Information about the problems and indicators of resource degradation alone does not guarantee institutional change, as suggested by the literature review. Science and information can bring issues to stakeholders' attention, can facilitate a common understanding about the problem, and can clarify the causes of the problem and the likely beneficiaries of resolving the problem. However, the formation of collaborative institutions can also be supported by a history of communica-

tion, trust, and leadership among interested parties. Prior to the formation of these institutions, much of the responsibility for managing the various dilemmas in the four regions fell upon state and federal agencies, which in each of these cases are quite numerous, as noted in Table 3. Thus, resource management agencies are important stakeholders in these regions because they are responsible for ensuring that endangered species and water quality are protected, and that the rights to water of citizens and communities are upheld. Traditionally, one of the major obstacles facing the various agency stakeholders in these regions is that their missions and regulatory standards often conflict—making it clear that they do not share common interests and goals, which are factors known to support collective action and collaboration. For example, in California Bay-Delta, the Bureau of Reclamation's water-delivery mission clashes with the U.S. Fish and Wildlife's protection of endangered species. In the Everglades, the water-development mission of the ACE conflicts with the habitat protection and recreation mission of the Park Service. In the Pacific Northwest, the BPA's goal for providing low-cost power to the region conflicts with the U.S. Fish and Wildlife's goals for providing more water to protect endangered salmon species.

Table 3 also indicates that in addition to the government stakeholders, heterogeneous communities of multiple and diverse resource users and interest groups characterize all four regions. Traditionally, powerful economic interests, such as agriculture and fishing, are present in all four regions. As a result of these competing interests, stakeholders have not always been known for facilitating collaborative resource management. For example, in the Columbia Basin in the 1970s, groups were quite fragmented, with a long history of politically contentious and divisive claims to water resources (Volkman, 1997). In the Chesapeake Bay case, stakeholders have quite divergent interests for the bay: federal, state, and local resource managers; recreation groups; and industry have all had historically divergent interests. Likewise in California Bay-Delta, "each of the major interest groups have been powerful enough to block each other, in court or at the ballot box, but none have been powerful enough to enact their own agenda" (Wright, 2001, 332). In Florida, "[d]isputation is endemic to relations among agencies and people connected to the Everglades" (Doyle, 2001, 62).

Despite the fact that fragmentation and conflict have characterized resource management in these regions, stakeholders in these cases have made various efforts toward collectively managing these ecosystems that set the stage for the institutions today. For instance, although the Northwest Power Planning Council (NPPC) was born out of an act of Congress, a number of prior organizational efforts provided institutional capital, at least at the state level, for devising the collaborative management efforts seen in the program today. Prior attempts at addressing basin-wide fisheries and water planning included the 1915 Columbia River Fish Compact between Oregon and Washington, the proposed Columbia Valley Authority in 1937, negotiations for an interstate river allocation compact between the 1940s and 1960s, and the 1964 Northwest Coordination Agreement governing power operations in the basin (Volkman, 1997). Then in 1968, the governors of Oregon, Washington, and Idaho created the Columbia Basin Fish and Wildlife Authority, which now collabo-

Table 3. Stakeholder Characteristics

	Northwest Power and Conservation Council's Fish and Wildlife Program	Chesapeake Bay Program	CALFED Bay-Delta Program	Comprehensive Everglades Restoration Plan
Types of stakeholders	Federal agencies, Bonneville Power Administration, state agencies, agriculture, fishers, tribes	Federal agencies, state agencies, municipalities, agriculture, fishers, environmentalists	Federal agencies, state agencies, agriculture, fishers, urban interests, environmentalists, shipping	Federal agencies, state agencies, agriculture, tribes, urban interests, environmentalists
Prior efforts	OR/WA Columbia River Compact (1915), proposed Columbia Valley Authority (1937), 1940s–60s negotiations for interstate river compact (failed), Pacific Northwest Coordination Agreement (1964), Columbia Basin Fish and Wildlife Authority (1968)	Interstate Conference on the Bay (1933), "Save the Bay" campaign (1966), Alliance for the Chesapeake Bay (1972), Governor's Conference on the Chesapeake Bay (1968), VA–MD Legislative Chesapeake Bay Advisory Commission (1978), Chesapeake Bay Commission (1980)	San Francisco Estuary Program (1987), Bay-Delta Oversight Council (1992), Club FED (1993), CALFED Framework Agreement (1994), CALFED Bay Delta Accord (1994)	Save Our Everglades Program (1985), Lake Okeechobee Technical Advisory Council (1986), South Florida Ecosystem Restoration Task Force (1993), Governor's Commission for a Sustainable South Florida (1994)
Leaders of institutional design	Former Senators Jackson (WA), Magnuson (WA), and Church (ID); former Congressman Weaver (OR); former Governor Evans (WA)	State governors (especially former Governor Hughes [MD]), former Senators Fowler (MD) and Mathias (MD), Environmental Protection Agency (EPA)	U.S. Department of Interior (especially former Secretary Babbitt and former Assistant Secretary Rieke), former Senator Feinstein (CA), Congressman Pombo (CA), EPA, former Governor Wilson (CA)	Senator Graham (FL), Congressman Shaw (FL), Senator Pettigrew (FL), FL Governor's Commission
External institutional triggers	Lawsuits by tribes in 1980s, Endangered Species Act (ESA), electricity shortages	U.S. Army Corps studies in 1960s and EPA studies in 1970s, Chesapeake Bay Research Coordination Act (1980), Amendments to federal Clean Water Act (CWA)	ESA, Central Valley Project Improvement Act (1992), CWA	Everglades National Park Protection and Expansion Act (1989), scientific collaborative efforts such as the Water Resources Development Act's (1992) Army Corps study, federal lawsuit over CWA, ESA

rates with the NPCC in basin-management efforts. In line with these interstate efforts were numerous policy and administrative developments at the state level throughout the twentieth century to manage fisheries in the basin as well as collaborative governance by the tribes that fish in the basin through the 1977 Intertribal Fish Commission.

One of the earliest organizational efforts to restore the Chesapeake Bay came from private resource stakeholders in the region. In 1966, the Chesapeake Bay Foundation, a nonprofit conservation group, was established by a group of fishermen, hunters, and sailors. The motto of the foundation was "SAVE THE BAY." They

printed and distributed bumper stickers throughout the region and helped raise much of the initial awareness and political support for the program (Oxnam & Williams, 2001). In addition, a number of legislative efforts by the participant states and concurrent organizational efforts at the federal level precipitated the creation of the program. In 1978, the governors of MD and VA created the Chesapeake Bay Legislative Advisory Commission formed to evaluate existing and proposed management resource structures and to make recommendations for strengthening interstate ties to better coordinate the management of the bay (Hennessey, 1997). Following the formation of the Commission, MD and VA's general assemblies established the 1980 CBC, with PA joining in 1985. Concurrent with the formation of the Commission, federal actors began to discuss the need for a more comprehensive decision-making structure governing the bay. Congress had directed the EPA to identify the appropriate agencies for managing bay quality. Between 1979 and 1983, consulting reports by Resources for the Future and the EPA helped identify and evaluate the institutional arrangements in the bay (Hennessey, 1997).

In California Bay-Delta, federal agencies began to coordinate their activities in the bay with the San Francisco Estuary Project (1987). This 5-year collaborative effort involved multiple stakeholders from real estate and development interests to farmers and environmentalists (Connick & Innes, 2003, 182). In December 1992, amid a standoff over water-quality standards and increasing calls for attention to the flows issue, former Governor Pete Wilson appointed new committees, the Bay Delta Oversight Council and the Water Council, to accommodate the numerous stakeholders and to coordinate state efforts. The Department of Interior's former Assistant Secretary Betsy Rieke led the federal agencies in forming "Club FED" in 1993 to better coordinate federal activities. Federal and state officials signed a Framework Agreement in June 1994, agreeing to work together to develop new state standards that would satisfy the Clean Water Act (CWA) and Endangered Species Act (ESA), and to coordinate the operations of state and federal water projects. The Bay-Delta Accord (1994) established a set of principles for addressing water-quality standards, endangered species requirements, water operations, and environmental restoration (Rieke, 1996). The Accord paved the way for the CALFED Program by solidifying a high level of agency coordination in decision making, and by highlighting the need for stakeholder participation (Wright, 2001, 335).

Like the CALFED process, the institutional design of the CERP began with a number of reform attempts in the decade leading up to the CERP. Although efforts to save the Everglades have been long running in Florida (dating back to the creation of the Everglades National Park in 1947), one of the main precursors to the CERP was Florida's "Save Our Everglades" Program in 1985, which included an experimental program allowing the unregulated flow of water into the national park. In 1986, former Governor Daniel Robert Graham established the Lake Okeechobee Technical Advisory Council that made a host of recommendations including the reduction of phosphorus and the nutrient-removal program. The federal government's launching of the South Florida Ecosystem Restoration Task Force in 1993 helped coordinate federal actors and eventually expanded to include the active participation of many state and regional agencies. At the state level, the governor's

Commission for a Sustainable South Florida (1994) produced over 100 recommendations for improving the South FL ecosystem, and has been considered instrumental in achieving broad support for the restoration plan (Doyle, 2001, 64).

A history of prior organizational efforts did precede the formation of new institutions in these cases, but the data do not specifically support the types of factors identified by the literature on CPR institutions, which points to a long history of trust and communication, or clear instances of social capital formation, as precursors to institutional design. In general, these efforts were incremental and piecemeal. However, these prior organizational efforts gave the various stakeholders experience in working together and in many ways allowed leadership to crystallize in the regions, paving the way for the modern collaborative arrangements.

In tune with the prior organizational efforts, much of the leadership and institutional entrepreneurship initially came from the top down. Congress, state governors, and federal agencies have largely taken the lead in forming the structure of these new institutions, as shown in Table 3. The authorization for the NPCC's Fish and Wildlife Program came from federal legislation through the Northwest Power Act. Congressional testimony and participants in the process suggest that leadership came largely from the bill's sponsor former Senator Henry Jackson of WA, as well as former Senator Frank Forrester Church of Idaho, former Senator Warren Magnuson of Washington, and former Congressman Jim Weaver of Oregon (Center for Columbia River History, 1998; Lee, 1991). Although these leaders were focused largely on resolving power issues, once the Council was established (and the power crisis began to lessen), leadership for planning fish and wildlife management came from the Council itself. One of the most influential leaders in fish and wildlife planning for the Council was former Governor Dan Evans of Washington, who raised awareness about fish-hatchery issues that were critical to tribes and successfully negotiated a water budget with the ACE and utilities that would increase spring flows from dams to facilitate juvenile fish runs (Lee, 1993).

In the CBP, leadership for the design came from the governors, the EPA, and the DC mayor. Former Senator Bernie Fowler of MD was known for raising awareness about water-quality degradation in the bay, and former Senator Charles Mathias of Maryland provided substantial leadership in the creation of the program through his support of the EPA research on the bay in the 1970s (Costanza & Greer, 1995; Vigmostad et al., 2005). After the EPA report came out, former Governor Harry Hughes of Maryland was also cited as playing a key role in personally bringing the other governors on board (Vigmostad et al., 2005).

In both the modern collaborative models, the federal government significantly shaped the institutional arrangements. While both the CALFED and Everglades efforts represent joint federal–state initiatives, the development of federal task forces (that later welcomed state representation) first marked coordination in the regions. Former Secretary Bruce Babbitt's Interior Department played a significant role in jump-starting the collaborative processes and laying the groundwork for the institutions and processes that would later develop in both regions (Hayes, 2001–02). Fearing federal supremacy and attracted by the promise of federal funding, the states joined the federal government's efforts. In both cases, federal and state

legislative leaders played significant roles in mobilizing legislative support and the necessary authorizations regardless of political party affiliation. Former Senator Dianne Feinstein and Congressman Richard Pombo of California worked tirelessly to ensure federal authorizations for the CALFED Bay-Delta Program (Epstein, 2004). Similarly, Senator Graham and Congressman E. Clay Shaw, Jr. of Florida played important roles in the passage of the congressional legislation authorizing the Everglades plan, and Senator Richard Pettigrew of Florida is commonly applauded for his efforts in guiding state consensus through his leadership on the governor's Commission (Joe R. Miller, personal communication, May 17, 2005; Vigmostad et al., 2005, 27–9).

Presumably, the reason that the leadership for these institutions has come largely from the top down is that these institutions must address such large-scale problems with multistate and federal interests. This lack of bottom-up collective action and policy entrepreneurship certainly underscores our point that the context of these settings differs widely from the cases studied by much of the collective action and CPR literature. In exploring the role of leadership in these cases, we found that another potentially important factor in the formation of these institutions is the external policy environment, or institutional triggers, which have heightened the awareness among leaders about the benefits of and opportunities for collaboration (or the costs of inaction). In three of the four cases, these triggers have come from the ESA and CWA requirements.

For example, a U.S. lawyer in Miami, Florida sued the state itself and the SFWMD in 1988 for violation of the CWA by failing to stop the flow of eutrophic waters into the Everglades National Park. This lawsuit stimulated modern action in the region. In response, former Governor Lawton Chiles settled the action in 1991 by agreeing to launch a comprehensive ecosystem restoration and protection plan for South FL. Similarly, in the Bay Delta in the early 1990s, concerns over CWA violations as well as listings of several fish species under the ESA alerted stakeholders to the likely costs of inaction. Lawsuits over endangered species have also played an important role in forcing the NPPC to change the way it uses collaboration and updates its plans. In 1992, after certain salmon runs had been recently listed as endangered, the Council developed the "Strategy for Salmon" to deal with the endangered-species issues, but lawsuits were brought against the Council by environmental groups. Then in 1994, the Council was forced to revise the way it had been developing plans when a federal appeals court required it to give a "high degree of deference" to the fish and wildlife agencies and tribes (Northwest Power Planning Council, 2003). While threats from CWA and ESA violations were not formal triggers to collaboration in the Chesapeake Bay, the addition of Section 117 to the CWA in 1987 was used as a vehicle for Congress to formally authorize the EPA's participation in the program and its creation of an EPA CBP Office. These legal actions can be viewed as focusing events, which in these cases, helped to stimulate state attention to environmental concerns and eventually significant institutional formation and policy change (Birkland, 1998).

In addition to the CWA and ESA, the newer programs also have been facilitated by key congressional legislation that has made the restoration efforts under these

plans more feasible. In the California Bay-Delta, the Central Valley Project Improvement Act (1992) allowed for the transfer of 800,000 acre–feet of Central Valley Project water from farmers to restoration activities. This Act provided the basis for modern CALFED efforts to transfer water between users in the region, and presumably make the program itself more palatable to stakeholders. Congressional acts in Florida also have challenged the status quo in the Everglades region and provided triggers for collaboration. The Everglades National Park Protection and Expansion Act (1989) authorized the ACE to improve water deliveries to the park and authorized the purchase of more park land—some 107,000 acres. With the Water Resources Development Act (1992), Congress directed the ACE to initiate a comprehensive review of the Central and South Florida Project. This led to the establishment of a commission and the development of several task forces and working groups, and eventually, federal authority for a comprehensive restoration plan with the Water Resources Development Act (1996). For the final plan, the CERP received federal authorization with the Water Resources Development Act (2000).

As suggested in the Florida case, these external institutional triggers also provide an important link to the availability of information and data on the problems, discussed in the previous section. In the newer programs, the scientific process, driven by federal regulations, has become an important part of deciding the program missions. For example, in the more recent restoration efforts in the Everglades and Bay-Delta, the environmental impact process mandated by the National Environmental Policy Act (NEPA) has produced scientific analyses that have helped shape the institutional arrangements and goals. In the Everglades, it was the development of the Central and Southern Florida Project Comprehensive Restudy that initiated a collaborative process in that region. The Restudy, a full review of the original water-management scheme that was begun by the ACE in the 1940s and continued through the 1970s, included more than 60 water-management projects, and ultimately culminated in the adoption of the CERP. Similarly, California Bay-Delta Authority was created after the Environmental Impact Statement/Environmental Impact Report process was complete and a Record of Decision was passed.

In the older programs, external institutional triggers have played a key role in establishing the basis for expanding the availability of information and data to the programs and shaping how collaboration works. The program plan that the NPPC developed in 1994, for example, included recommendations by the federal court ruling and regional input from federal and state water and land managers, and numerous tribes (Northwest Power Planning Council, 1994). To support such efforts, in 1996, the Council and National Marine Fisheries Service jointly formed an Independent Scientific Advisory Board, with support from the National Academy of Sciences (Volkman, 1997). In the Chesapeake Bay case, the Chesapeake Bay Research Coordination Act (1980) created an office for Chesapeake Bay Research Coordination through the secretary of Commerce, and also established the Chesapeake Bay Research Board. More recently, external institutional triggers have prompted new organizational arrangements in the Chesapeake Bay among federal agencies. In 1998, 20 federal agencies and departments involved in the bay signed the Federal Agencies' Chesapeake Ecosystem Unified Plan, which expanded the

restoration efforts and goals of these agencies in line with the CBP. Federal legislation was also signed in 2000 that amended the CWA's federal CBP (Palmer, 2004), expanding the EPA's oversight and adding requirements for all federal agencies operating within the bay to comply with the Chesapeake Bay Agreement and participate in subbasin planning.

Theoretical Implications and Conclusions

We argue that the explanatory factors for institutional formation in these large-scale ecosystems should be examined from multiple theoretical lenses. In evaluating the literature on collective action in CPR settings, we expect that certain conditions supporting collective action among resource users, such as a history of communication and trust, would need to be facilitated by policy entrepreneurs and strong leadership. In addition, we expected that in order to ensure that diverse stakeholders and/or resource users would collectively see the benefits of collaborating in large-scale settings, information and awareness about the existence of the problem and affected parties should be abundant and relatively widespread.

By analyzing the cases with this theoretical frame in mind, we find that problem severity is well documented, even if only focused initially on a limited extent of the issue prior to institutional formation. Although a variety of indicators are available from the four programs that identify the problems, the science on the two older programs focused on specific data early on, with additional information coming out after the programs started that has then shaped later modifications to the programs. The difference with the newer cases is that they have been using the scientific process to try to come to an agreement on the institutional goals, whereas the older programs came to terms on the broader goals, formed the institutions, and then modified those goals over time as new information became available. More science has been available in the planning of the newer projects, in part, because of the external institutional triggers from the ESA, CWA, and EPA. Institutional adaptation in the two newer cases may come to mirror that of the older cases as the programs mature.

Understanding the process of how information supports institutional formation has direct theoretical implications for institutional change theories and research on collaborative governance. Knowledge and concurrence about the ecological problems facing each region, combined with leadership, have paved the way for collaboration. In doing so, actors in these regions have organized around the most salient issues affecting stakeholders in the region. This finding certainly supports the epistemic community literature looking at international environmental policy institutions and the advocacy-coalition theory of policy change, but with the caveat that it is not problem definition *per se* that supports policy action, rather the concurrence on problem salience that widespread technical and scientific information supports. It is important to note that science and information in these cases also do not necessarily come from a single neutral source or forum—it is filtered through a range of forums in these cases, from the media to agency reports to congressional hearings. Thus, awareness about the problem may be facilitated by the multitude of

sources, in conjunction with the leaders who were pushing public responses to this information.

In pointing to the importance of problem identification and leadership, our case analyses also can contribute to the literature by clarifying key ways that the various characteristics supporting collective action might interact. The available indicators about the salient problems in each case can depend on the types of leaders and stakeholders in a region, as well as on the larger institutional setting or policy issues that trigger agency actions. Information on the problem can also spur policy entrepreneurship or leadership—albeit top-down leadership in these cases. Leadership and prior organizational experience across the agencies responsible for managing these regions obviously work together as well. None of these institutional arrangements emerged spontaneously or organically—they evolved on the heels of prior attempts, with concerted efforts by national and state leaders. The older cases also demonstrate how collaboration can continue to evolve over time with the integration of new forums for clarifying problems, such as scientific advisory councils.

The continued adaptation of each of these programs is, of course, dependent on their financial and political support. Each of the four programs costs millions of dollars per year to implement. The endurance of the Columbia Basin Program and the CBP can, in many ways, be attributed to the fact that funding each year for a large portion of the programs' expenses is earmarked by budget allocations from the BPA and the EPA, respectively. The two newer programs have been dependent upon congressional and state authorization, and the CALFED in particular has been mired in political wrangling about budgetary allocation (Shaw, 2005). Recent disputes over project financing and scheduling in the Everglades illustrate threats to collaboration and implementation there (Powers, 2005). While we have indirectly discussed the outcomes of these programs in terms of their institutional evolution, we have not examined their successes in terms of meeting their ecosystem-restoration goals. Some emerging research on these institutions indicates that this financial support, as well as continued leadership and scientific monitoring play a role in their longevity (Vigmostad et al., 2005), and thus possibly their successes as well.

In conclusion, these four cases provide valuable examples of regional collaboration that contrasts with the smaller-scale watershed or local resource management efforts. These regions are characterized by broad spatial scales, heterogeneous stakeholders, and fragmented management responsibility. The factors that supported the emergence of collaborative institutions to manage the resources in these regions point to the importance of widely acknowledged problems, leadership among the federal and state actors, practice and experience working together, and external institutional triggers.

Understanding the factors that support the emergence of these institutions, however, is just an initial step in the process of analyzing collaborative resource governance. Because this study has not assessed the success of these institutions, we believe it is essential to examine the performance and robustness of these institutions over time. One of the implications of the older cases in this article is that science and information must be updated and reviewed and must be open to a wide variety

of sources to ensure that collaboration and stakeholder commitment to the process continue. How the decision-making structures of these institutions sustain collaborative efforts and ensure adequate representation in the collaborative process are certainly questions for further exploration. Finally, without a long-term analysis of the impacts of these institutions on the environment and their communities, we cannot be certain that the collaboration taking place today is even beneficial. Thus, we recognize that many of the preliminary assumptions in this article about the benefits of collaboration are open to empirical analysis. Given the history of these programs, we feel they will continue to be excellent research settings for examining those questions.

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Notes

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1. It is important to note that this article does not compare the successes or failures of these institutional arrangements; thus, we do not claim that the cases represent ideal institutional arrangements for resource management. Instead, we make the assumption, based on the existing literature, that these institutions at least have the potential to help address collective resource management dilemmas that cross diverse institutional and social boundaries.
2. Given the prominence and scope of these institutions, a wide variety of both primary and secondary resources are available on these cases, which we have used for this analysis. All four programs have extensive data on the history and structure of the program on their Web sites (see Chesapeake Bay Program, 2005; Northwest Power and Conservation Council, 2005; California Bay Delta Authority, 2005; and Comprehensive Everglades Restoration Plan, 2005). Each of these programs also has a variety of secondary references on their history and/or the conflicts in the regions leading up to their formation. For the NPCC case, see Cone (1995); Lee (1993, 1995); Northwest Power Planning Council (2001, 2003); Northwest Power and Conservation Council (2004); Volkman (1997). For the CBP case, see Alliance for the Chesapeake Bay (2003); Chesapeake Bay Program (1983; 1999a, 1999b); Costanza and Greer (1995); Ernst (2003); Hennessey (1997); Horton (2003); Karkkainen (2002); Oxnam and Williams (2001); and Palmer (2004). For the CALFED case, see Connick and Innes (2003); Connick (2003); McClurg (2004); Pitzer (2004, 2005); Record of Decision/EIR (2000); Rieke (1996); Taylor, Jacobs, and Luoma (2003); and Wright (2001). Resources for the Everglades case include Clarke and Dalrymple (2003); Doyle (2001); Light et al. (1995); National Research Council (2003); South Florida Water Management District (2003); U.S. Army Corps of Engineers and the South Florida Water Management District (1999, 2003); U.S. General Accounting Office (2001); and Voss (2000). Some recent works have made comparisons across these programs, such as Roe and van Eeten's (2002) assessment of management styles in CALFED, Columbia River Basin, and Everglades. The Northeast–Midwest Institute also provides information relevant to these four programs on their Web site, as part of their study of "Large-scale Ecosystem Restoration Initiatives" and their final report by Vigmostad et al. (2005). Similarly, the Save San Francisco Bay Association recently completed a report to analyze California Bay-Delta issues, which include analyses of the CBP, the NWPCC, and the Everglades CERP see, Koehler, 2001. To supplement these sources, we also rely on primary data from the legislation supporting these programs and on interviews with program participants.

3. We agree with Thomas (2003) who has argued that qualitative research to study cooperation is a necessary precursor to quantitative research for developing theory, particularly in empirical settings where comparable quantifiable data sets are difficult to acquire.

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