Defining Co-management:

Levels of Collaboration in Fisheries Management

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Marine Affairs

University of Washington

2014

Committee:

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Program Authorized to Offer Degree:

School of Marine and Environmental Affairs

University of Washington

Abstract

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Involving stakeholders in natural resource management offers both normative and objective benefits, and co-management is a much-studied topic. However, the definition of 'co-management' remains vague and incomplete. This thesis develops a definition of co-management that is specific enough to be analytically rigorous and useful, while still maintaining the flexibility necessary to accommodate the diversity of co-management arrangements that can exist. Analysis of the literature on co-management and case studies of collaborative management allowed the development of a matrix containing sixteen variables, each along a spectrum from consultation to co-management, that describe the elements of a co-management arrangement. Testing the matrix on three cases studies labeled as 'co-management' revealed the utility of the matrix in testing for the presence or lack thereof of co-management and demonstrated the ways the matrix can be used in the future to compare cases and categorize the level of intensity and completeness of a co-management arrangement.

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Chapter 1. Introduction

1.1 Outline of Thesis

Co-management is a much talked about concept in natural resource management, but the extant definitions of co-management are vague and confusing. In the following sections, I examine the literature on co-management in order to identify crucial variables, and then use those variables to create a matrix that consolidates the extant typologies of co-management. The matrix can be used to describe co-management in detail, offering a more specific and flexible way of defining and analyzing co-management, and allowing cross-comparison of co-management in practice.

Chapter 1 begins with an introduction to co-management as a concept, exploring the reasons it is a popular concept in the field of natural resources management. This is followed by the problem statement of the thesis, making a case for the usefulness of a complete, analytically rigorous definition of co-management.

Chapter 2 contains a literature review, starting with the definitions of co-management in common use, and extending to the various contexts in which co-management is placed. The study of participatory management, stakeholder theory, and decentralization, among others, influenced the development of co-management as a concept and combine to inform the vague outline of co-management's shape in the literature. Finally, the literature review concludes with an analysis of five schemes for understanding co-management, highlighting the strengths and weaknesses of each of the typologies.

Chapter 3 identifies the sixteen variables that are the building blocks of a co-management arrangement, and builds a matrix out of those sixteen variables that can serve as a tool for analyzing case studies of alleged co-management. Testing the matrix on three case studies serves as a first-test of the validity of the matrix, and serves as a demonstration of how the matrix can be used in the future to

enhance the study of co-management. Finally, Chapter 4 identifies the next steps for research using the matrix, and highlights future work that needs to be done.

1.2 Why Co-Management?

Co-management is a popular concept in natural resource management because of the many benefits ascribed to it. When used appropriately, involving resource users and stakeholders in natural resource management offers both normative and objective benefits. These can be difficult to differentiate, as the normative benefits support the objective ones and vice versa. Many of the prospective benefits of co-management have yet to be empirically studied, but they are backed by strong theory, and what research has been done tends to support the theories.

Objectively, co-management is believed to lead to more effective resource conservation and less costly management when used to manage a fishery (Pinkerton 1989). This outcome works through several different mechanisms. These include improved management due to incorporation of better data and local ecological knowledge (Berkes et al. 2001; Degnbol 2003; Ebbin 2009, 2011; Pinkerton 1989); more appropriate rules and regulations that can respond rapidly to changing conditions (Berkes et al. 2001; Ebbin 2002; Hernes, Jentoft and Mikalsen 2005; McCay 1996); and more effective and efficient enforcement due to increased legitimacy of the management structures (Berkes et al. 2001; Hanna 2003; Ostrom, Walker, and Gardner 1994; Pinkerton and John 2008; Rettig, Berkes, and Pinkerton 1989).

In addition to the objective benefits of co-management (those measured in dollars and cents, scientific data, and ecosystem outcomes), co-management also holds promise for several types of normative benefits. Co-management regimes are considered to be more ethical than command-and-control management (Hernes, Jentoft, and Mikalsen 2005; Davis 2008; Pinkerton 1989); hold promise for increasing equity and fairness (Beierle and Cayford 2002; Borrini-Feyerabend et al. 2004; Coffey 2005; McCay 1996; Plummer and FitzGibbons 2004); may lead to gains in social capital, increased

conflict resolution, and more harmonious relationships; and may contribute to the empowerment and development of marginalized communities (Birner and Wittmer 2003; Hara and Nielsen 2003; Jentoft 2003; Pinkerton 1989; Pomeroy and Viswanathan 2003).

Taken together, the potential objective and normative benefits make a strong argument in favor of co-management. However, as Jentoft (2003) points out, it is also "possible to support [co-management] for some or just one of these reasons (p. 3)," and that may account for co-management's increasing popularity and prevalence.[1]

1.3. Problem Statement of Thesis

1.3.1 The Study of Co-Management

The primary purpose of this thesis is to develop a definition of co-management that is specific enough to be analytically rigorous and useful, while still maintaining the flexibility necessary to accommodate the diversity of co-management arrangements. This will serve a valuable purpose in portraying the current definitions of co-management used by different scholars, allowing for valuable synthesis and collaborative work that can strengthen the concept as a whole.

Co-management research draws from diverse sources of scholarship. Many of the writings on co-management come out of work done on common-property regimes, community-based management, collaborative planning, alternative environmental dispute resolution, and public participation. Specialists in many different fields have contributed to the growing body of research and practice; Agrawal (2002) lists anthropologists, resource economists, environmentalists, historians, political scientists, and rural sociologists as among those who have "contributed to the flood of writings on the subject (p. 43)." Because of the diverse backgrounds of those involved in the study and implementation of co-management, the definitions of co-management used are equally diverse.

[1] More critical views of co-management do exist. For example, see: Beem (2007), Castrejon and Charles (2013), de Vos and van Tatenhove (2011), and Yandle (2008).

Differing definitions of co-management make it difficult for scholars to exchange ideas and data (Poteete, Janssen, and Ostrom 2010); one person's co-management may be another's collaborative planning, or vice versa. Moreover, many of the definitions used in research on co-management are not specific enough to be analytically useful. Co-management comes in many forms, and a vague, one-sentence definition (as is supplied in many texts on co-management) is not sufficient to develop rigorous case studies with well-defined examples of co-management. Carlsson and Berkes (2005) offer a summation of the many different ways co-management in defined, and Table 1 includes definitions from several of the most well-known articles on co-management.

Author(s)	Definition
ICLARM (1998)	"Co-management is defined as the sharing of responsibility and/or authority between the government and local resource users to manage a specified resource, e.g. fishery, coral reef."
Jentoft (1989)	"…fisheries co-management means that government and agencies, though their cooperative organizations, are sharing responsibility for management functions" and "the responsibility for initiating regulations is shared."
Jentoft, McCay and Wilson (1998)	"[co-management is] defined as the collaborative and participatory process of regulatory decision-making among representatives of user-groups, government agencies and research institutions."
Pomeroy and Berkes (1997)	"Fisheries co-management is defined as the sharing of responsibility and authority between the government and the community of loca fisheres to manage a fishery. Co-management covers various partnership arrangements and degrees of power-sharing and integration of local and centralized management systems."
Sen and Nielsen (1996)	"…fisheries co-management is defined as an arrangement where responsibility for resource management is shared between the government and user groups."

Table 1: Definitions of co-management

In addition, without a comprehensive, clear, and widely applicable typology of local involvement, it is difficult to pursue research that can unify existing work on co-management and take advantage of possible synergies (Agrawal 2002; Beierle and Cayford 2002; Feeny 1992; Gunton and Day 2003; Pinkerton 2003). The study of co-management is weakened because it relies largely on single and

small-N case studies[2]; confusion about definitions makes it difficult to compare these many individual case studies in order to reach more robust conclusions through meta-analysis, prospective large-N studies, and accumulation of data (Poteete, Janssen, and Ostrom 2010).

By providing a common language, hopefully the matrix developed in the following sections will allow different scholars to produce theories and conclusions based on mutually intelligible and consistent underlying definitions. A common definition of co-management, flexible enough to be widely applied but specific enough to provide analytic rigor, will strengthen the field of scholarship by allowing for comparison and synthesis, both within and among research methodology types. A common definition of co-management will make cross-discipline research easier, will set the field up for success in synthesizing existing and future research, and will lead to more robust, analytically rigorous theories and hypotheses.

[2] The body of literature on co-management is a small and more recent subset of commons research, and for the most part takes the form of single case studies or qualitative comparisons between small numbers of cases studies. For examples of single case studies, see: Beesley and Fiori Summer 2008; Davis 2008 and 2011; Ebbin 2002; Kitts, da Silva and Rountree 2007; Pomeroy and Beck 1999; and Sandstrom 2009. For examples of comparative case studies, see: Cronin and Ostergren 2007 (3 case studies); daSilva and Kitts 2006 (8 case studies); Ebbin 2011 (2 case studies); Olsson, Folke and Berkes 2004 (2 case studies); and Pinkerton 1994 (6 case studies).

A few edited compilations have allowed for the close juxtaposition of case studies (i.e. Pinkerton 1989; Meyer et al. 1996; and Wilson, Nielsen and Degnbol 2003). However, these compilations generally rely on informal analyses and narratives, without a clear framework or identification of commons variables.

Few published papers use a meta-analysis method to develop a model for comparing cases to isolate particular relationships or factors (i.e. Gutierrez et al. 2011; Sen and Nielsen 1996; Pomeroy and Berkes 1997), and even fewer attempt prospective case studies (as defined by Feeny 1992) or prospective comparative research (i.e., Borrini-Feyerabend et al. 2004 and Chuenpagdee and Jentoft 2007 who use surveys and interviews to collect new data on multiple cases). In their analysis of 130 fisheries in 44 countries, Gutierrez et al. (2011) assert that their statistical analysis is the "first comprehensive global assessment of social, economic and ecological attributes contributing to fisheries co-management success (p. 386)." It definitely is the first study in the field of co-management to use such a large sample size for its analysis. In contrast, the other comparative analyses I have identified above use much smaller collections of data, ranging from 9 to 24 case studies.

1.3.2 Building Best Practices

A clear, comprehensive definition will be useful to practitioners of co-management, as well as scholars. Practitioners also suffer from the confusion about the definition of co-management, and the isolation of different disciplines addressing the topic. Best practice develops from the study of what other people, communities, and organizations are doing and their outcomes. Knowledge of other efforts and organizations is often an important factor in developing successful community based regimes (Barcott 2011; Ostrom 1990; SDWA 2008; Wondolleck and Yaffee 2000), but definitional confusion impedes the ability of practitioners to identify similar cases and the lessons learned from them.

Development and dissemination of a common definition of co-management will benefit practitioners by allowing for more opportunities for productive communication among those involved in co-management efforts. Having the research and writing on co-management use a common definition will allow practitioners to identify cases most similar to their own, or institutions that use particular mechanisms they are interested in studying and implementing in their own resource area. This will allow resource managers, community leaders, and resource users to initiate contact, share information and resources, strengthen best practices, and contribute to building issue and resource networks.

Chapter 2. Review of Co-Management Literature

Although definitions of co-management are vague and sometimes contradictory, reviewing the body of literature on co-management does reveal some commonalties among the various definitions. This section reviews the general definition of co-management that has developed in the literature. It then explores the different ways that authors contextualize co-management, adding complexity to the understanding of what co-management is. Finally, once co-management is placed within the broader fields of policy and management, I explore the typologies of co-management that have been developed in order to understand differences and complexities within co-management itself. This sets the stage for the development of a definition of co-management that can be widely used and analytically useful, and that is situated within appropriate contexts. This also allows for the development of a typology of co-management that synthesizes existing work and can be used to further understand what co-management is and how it functions.

2.1 The General Definition of Co-Management

Co-management is an evolving concept. Scholars of co-management agree that the most critical aspect is genuine sharing of responsibility and authority for the management of a resource between resource users and a government (i.e., Pomeroy and Berkes 1997; Sen and Nielsen 1996). However, from that general outline, the definitions of co-management begin to diverge.

All of the seminal authors on co-management acknowledge that "co-management covers various partnership arrangements and degrees of power-sharing and integration of local and centralized management systems (Pomeroy and Berkes 1997, p. 466)." Co-management is always placed somewhere in the middle of the spectrum that stretches from hierarchical state management to complete community control, but that is a large gap. From the very beginning of co-management as an

independent concept, it has been used as a wide net that can catch almost anything that is not pure state control or pure community control.[3]

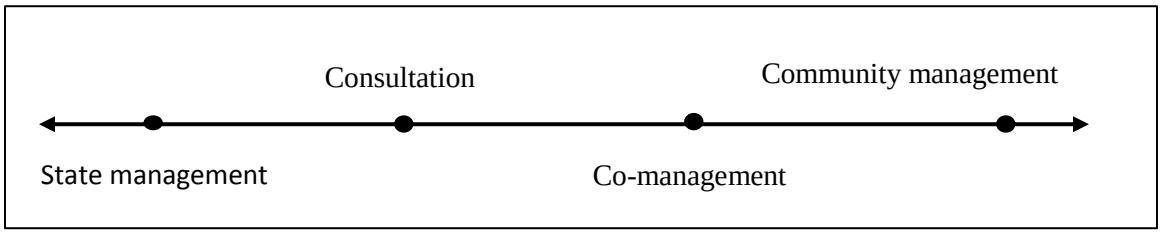

Figure 1: Management spectrum

In the exploration of what co-management is (and is not), I begin by placing co-management within the contexts various authors and practitioners use to understand and help define it. Putting co-management in context allows an understanding of how the study of co-management has developed and the different lenses through which scholars view co-management.

2.2 Putting Co-Management in Context

A general consensus on aspects of a definition of co-management becomes evident through a review of the different ways co-management has been contextualized. Section 2.2.1 sets the foundation with an explanation of common-pool resources, while Section 2.2.2 places co-management within a four-part typology of management. Further insight into co-management is gained through analyzing its place within the literature on public participation in Section 2.2.3, and examining stakeholder theory in Section 2.2.4 further specifies the parties involved in co-management. Section 2.2.5 examines the extent to which co-management is present throughout the stages of management, and Section 2.2.6 reveals the difficulty in trying to align co-management within the framework of decentralization, offering insight into the geographic scope and governmental level that co-management can cover. Section 2.2.7 summarizes the lessons learned about co-management so far.

[3] See Plummer and Fitzgibbons (2004) for a fairly comprehensive overview of the different ways that co-management has been defined and conflated with various management types and governance concepts.

2.2.1 Common-Pool Resources

Classifying types of resources along the axes of excludability and subtractability, they break down into four general categories: public goods, toll goods, common-pool resources, and private goods (Ostrom, Gardner, and Walker 1994).

		Subtractability	
		Low	High
Excludability	Difficult	Public goods	Common-Pool Resources
	Easy	Toll Goods	Private Goods

Table 2: Resource types (Ostrom, Gardner, and Walker 1994, p. 7)

Many natural resources fall under the category of common-pool resources. By definition it is difficult to exclude people from using common-pool resources, and one person's use takes away from another person's use. Fisheries, groundwater, forests, and pastures are some of the most commonly identified natural common-pool resources.

Common-pool resources can be broken down further based on the mobility, storability, and renewability of the particular resource (Ostrom, Gardner, and Walker 1994). Each type of common-pool resource presents particular problems for management, and some types may be more suited, or conducive, to particular management strategies (for example, see: Agrawal 2002; Basurto 2008; Bromley 1992; McCay and Acheson 1987; and Ostrom, Gardner, and Walker 1994). However, the definition of co-management will not change when switching resource types.[4]

[4] For example, Berkes and Farvar (1989); Borrini-Feyerabend et al. (2004); and Ostrom (1990) use multiple types of common pool resources to explore governance issues. The lessons learned from studying co-management in fisheries will be most easily transferred to similar types of common-pool resources, those characterized by mobility

2.2.2 A Four-Part Typology of Management Systems

Management of natural resource systems is widely categorized into a four-part typology: open-access (*res nullius*), state management (*res publica*), community management (*res communes*), and private management (Berkes and Farvar 1989).[5] These management types should be familiar to any scholar or practitioner of natural resource management. For more information, see Berkes and Farvar (1989); Farrell and Morgan (2003); Gray (2005); Ostrom (1990); Ostrom et al. (2002); and Yandle and Dewees (2003).

All four of these management types are recognized as idealized types. In praxis these types are often mixed and the boundaries between them blurred (Berkes and Farvar 1989). Within this typology, co-management is placed on a spectrum between state management and community management (Pomeroy and Berkes 1997), as shown in Figure 1. In terms of values, co-management is "a meeting point between overall government concerns for efficient resource utilization and protection, and local concerns for equal opportunities, self-determination and self-control (Jentoft 1989, p. 144)." More objectively, Pinkerton places co-management at a hypothetical point 8 on a ten-point continuum from state management (at point 1) to self-management (at point 10) (Pinkerton 1994).

It is crucial to understand the difference between community-based management and co-management. There is a clear distinction between co-management and community-based management (CBM) (Alpizar 2006; Pinkerton 2003; Sen and Nielsen 1996): "the main distinction between the two

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and renewability. Further research needs to be done to establish exactly how applicable the developed definition of fisheries co-management is to other types of common-pool resources.

[5] Management types and property rights systems are often conflated. However, in this analysis I deliberately separate management from property rights. The intersections between property rights and management are worthy of study, but an analytical distinction is crucial (Jentoft, McCay, and Wilson 1998). For the purpose of this analysis, property rights are part of the larger system in which a management system is located. Jentoft (2005) makes this distinction, as does McCay (1996). This distinction is also supported by the existence of the public trust doctrine in the United States: the state will, to a certain degree, always have ownership and control of fisheries resources (Baur, Eichenberg, and Sutton 2008; McCay 1989; Wondolleck and Yaffee 2000, p. 232).

terms is that in CBM, the government may play only a small role or no role at all in resource management, while co-management … stresses the achievement of *partnership* arrangements between the government and the communities (Alpizar 2006, p. 643, italics in original)."

It is necessary to make an equally clear distinction between state management and co-management. Co-management is distinct from other arrangements that may merely be "consultative," where the government still maintains control over the creation and implementation of regulations despite input from fishers' organizations or their representatives (Jentoft 1989). Compare this to the fundamental definition of co-management as a genuine sharing of power and authority. A co-management regime must include a real decision-making role for social actors and resource users, and some measure of delegation or devolution of power from the government.

In real situations, these distinctions can often be difficult to make, especially as a management regime does not always take the form of a single institutional structure. A more complex view of what a resource management regime looks like includes the possibility of constellations of "several discrete institutions or organizations," of which some may be government bodies and some may be community-run bodies, responsible in combination for managing a resource (Oakerson 1992). However, a deeper exploration of the management regime should reveal collective-level decision-making that results in management decisions and actions, made or taken jointly by social actors and various levels of the state.

I have now established that co-management falls between state management and community management. It necessarily includes both the state and the community. Next, I situate co-management within the literature on public participation and participatory management. Co-management is a form of participatory management, but it may include "many different possible types of partnership and degrees of power sharing between the community and the central government (Alpizar 2006, p. 643)." How does it compare to other types of public participation in governance and management? Is there a spectrum of participation on which to situate co-management?

2.2.3 Public Participation and Participatory Management

The term 'public participation' is "an ill-defined concept, meaning different things to different people (Coffey 2005, pg. 28)." Here I attempt to clarify both what public participation is, and where co-management can be placed on the spectrum of public participation.[6]

Co-management literature is strongly informed by the study of public participation. Co-management is often set within a spectrum of public participation. Of the extant typologies of public participation, Arnstein's (1969) 'Ladder of Public Participation' is the most influential, and offers a way to understand the intensity of public participation in planning and management.

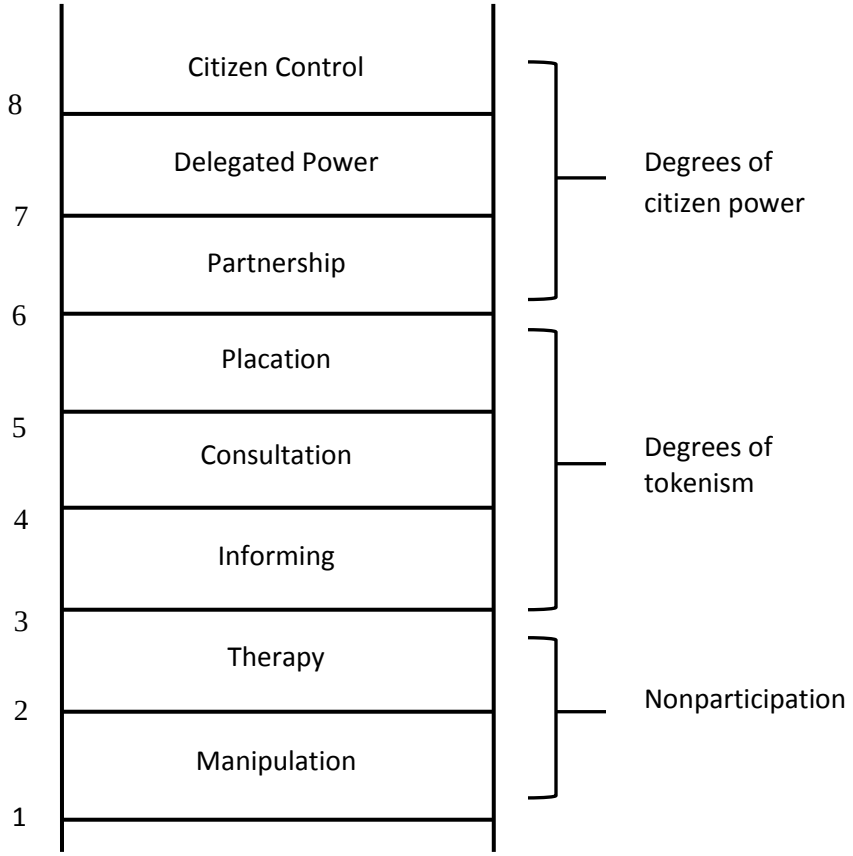

Figure 2: Arnstein's 'Ladder of Participation' (Arnstein 1969, p. 217)

[6] For brief history of public participation in natural resource management in the United States, see Wondolleck and Yaffee (2000, 2003).

The distinctions among the steps of the ladder hinge on power, defined as the ability of citizens to "determin[e] the plan and/or program" or "affect the outcome of the process (p. 216)." Power is crucial to genuine citizen participation, given that "participation without redistribution of power is an empty and frustrating process for the powerless (p. 216)." In fact, citizen participation is a synonym for citizen power. There are eight different levels of public participation, seen in Figure 2, and these eight levels are broken into two categories: (1) thru (5) are labeled as "nonparticipation," and (6) thru (8) are labeled as "degrees of citizen power."

With the aim of defining co-management, the categories of informing, consultation, partnership, delegated power, and citizen control are the most relevant. The other categories focus on manipulative or tokenistic efforts to deliberately obscure the locus of power and power differentials. While this may be the case in some arrangements labeled as 'co-management', for example in the Regional Fisheries Management Council system in the United States which is the target of frustration at times (e.g., McCay 1996), and may be the focus of critical theory, the definition of co-management being developed here is focused on actual differences in involvement and participation, not the false manipulation of participation.

Informing consists of a one-way flow of information, from the government to citizens and social actors. At the informing level of public participation, there is "no channel provided for feedback and no power for negotiation…. people have little opportunity to influence the program (Arnstein 1969, p. 219)." Consultation differs from informing in that it involves a two-way flow of information. Decision-makers ask for citizens' opinions; in natural resource management, this often takes the form of public comment on draft regulations and proposals, and hearings on proposed management actions, as part of the "decide-announce-defend" model of decision-making. However, like informing, consultation does not include any provisions for true citizen influence on decision-making: there is "no assurance that citizen concerns and ideas will be taken into account (*ibid*)."

Partnership is the level of participation where social actors begin to have real power to influence decision-making, and is in fact the first level classified as true participation. 'Partnership' is fundamentally defined as social actors having the ability to "negotiate and engage in trade-offs with traditional powerholders (*ibid.*, p. 217)" and this can take place during one-shot negotiations or through standing institutions where social actors and the government "agree to share planning and decision-making responsibilities through such structures as joint policy boards, planning committees and mechanisms for resolving impasses (*ibid.*, p. 221)." In addition, once the ground rules for decision-making "have been established through some form of give-and-take, they are not subject to unilateral change (*ibid*., p. 221)." At the partnership level, social actors have gained power within the arena of collective-choice decision-making.

The penultimate level is delegated power, where social actors have the "dominant decision-making authority over a particular plan or program (Arnstein 1969, p. 222)," and can assure accountability of the program to their needs. However, social actors are still operating within the structures and institutions set up by government bodies. The final level on the ladder of public participation is citizen control, in which citizens "govern a program of an institution, [are] in full charge of policy and managerial aspects, and [are] able to negotiate the conditions under which "outsiders" may change them (*ibid*., p. 223)." Although Arnstein (1969) is not explicit about it, this level of participation is analogous to community-based management or common property management where resource users design and manage their own governing bodies and structures.

Placing Co-Management Within the Spectrum of Public Participation

Co-management fits best as 'partnership' in Arnstein's model of public participation: social actors have real power to influence public policy, but they are not the sole decision-makers – government still has a large role in co-management. Although I do not have a complete definition of co-

management yet, it is evident that co-management is very high on the scale of possible types of public participation.

2.2.4 Stakeholder Theories

Stakeholder theories are a crucial part of understanding public participation and co-management: who are the interested parties, and who should be included in decision-making and management? [7]

Understanding Different Types of Social Actors

Originally developed in business management, stakeholder theory is now widely applied in public policy and governance (Mikalsen and Jentoft 2001). Essentially, stakeholder theory attempts to identify which social actors need to be involved in management for it to be effective. Additionally, it now often addresses which parties have legitimate claims and *should* be involved in management, even if they do not have the power to impede decision-making or operations. Several different schemes have been developed to categorize types of social actors. For more information on the stakeholder literature, see Mikalsen and Jentoft (2001) and Hatchard (2005).

For the purpose of this thesis, I highlight Mitchell et al.'s (2001) model that breaks down social actors based on their scores on three variables: legitimacy, power, and urgency. These variables can be combined in different ways to affect stakeholders' involvement in management: "one either has to have a legitimate or perhaps urgent claim on the firm or be able to wield power over the firm's decisions (p. 283)." The scores of these three variables combine to determine whether a stakeholder is definitive, expectant, or latent.

[7] Following Borrini-Feyerabend et al. (2004), for the most part I will use different vocabulary than 'stakeholder.' The term 'stakeholder' has a specific historical context, referring to those who dispossessed Native Americans from their land. Instead, I will largely use 'social actor' as an equivalent term. For a discussion on terms, please see Borrini-Feyerabend et al. (2004), pg. 39).

Important to this model is its dynamism: scores on attributes are not fixed, and over time social actors can move from one category to another. For example, a previously latent group "may become more salient to the firm as a result of political mobilization and successful alliance building, or as a consequence of social and economic change (Mikalsen and Jentoft 2001, pg. 284)."

Within fisheries management, social actors are sometimes categorized depending on variables internal to the group, rather than variables that address the relationship between the social actor and the government. These categorizations can be based on the characteristics of the type of community that actors belong to, including functional or territorial communities, and memberships can be multiple and overlapping (Wondolleck and Yaffee 2000). Membership in functional communities can depend on gear type, target species and fishing grounds, owner/skipper/crew distinctions, or employment in different shoreside industries (Jentoft, McCay and Wilson 1998). Additional types of social actors are categorized based on value orientation (Gunton and Day 2003); this is especially relevant when considering that natural resource management now often involves environmental conservation or protection groups who may not have territorial or functional connections.

Identification of different types of social actors is more than an academic exercise. Fisheries are a public trust resource; how can management reflect the interest of the public, and how do you determine what that interest is? By understanding who can affect management, managers can better address issues of efficiency; by understanding who has an interest in the resource, managers can better address concerns for equity and justice.

Social Actors Involved in Co-Management

Initial scholarship on co-management placed it firmly on the side of narrow representation, defining fishery co-management as a management relationship between fishers, fishers' organizations, and government (Jentoft 1989; Pinkerton 1989; Sen and Nielsen 1996). However, as the study of co-

management has developed, it has widened to include a much broader identification of relevant and involved social actors. Fourteen years later, Jentoft acknowledges: “If the democratic principle that those affected by a decision should have a say in the decision-making process applies to fisheries co-management, then more than just fishermen must be involved (Jentoft 2003, pg. 8).”

Contemporary analysts of co-management now largely define it as involving a broad swathe of the public, including most of the social actors who have an interest in the resource or are affected by management activities (e.g., Davis 2011; Gray 2005). Plummer and Fitzgibbons (2004) are representative of the “inclusive approach (pg. 69)” that most advocates of co-management now take, stating that “genuine” co-management is based on broad representation.

2.2.5 From Planning to Implementation: The Stages of Management

Literature on co-management is influenced by the public participation and collaborative planning literatures, both of which place an emphasis on the planning stage of management (e.g., Beierle and Cayford 2002). Scholars of common-pool resources do a more complete analysis of governance at all the stages of management. Ostrom (1990) provides a nested analysis that incorporates all levels of management, from constitutional to operational levels.

Co -management extends to all stages of management, from planning to implementation, to evaluation and adaptation, and is an ongoing process through time. The adaptive management literature offers a complete model of management phases.

Stages of Management

A basic model of management contains six stages: assessment of the problem, design of the management plan, implementation, monitoring, evaluation, and adjustment (Williams et al. 2009).

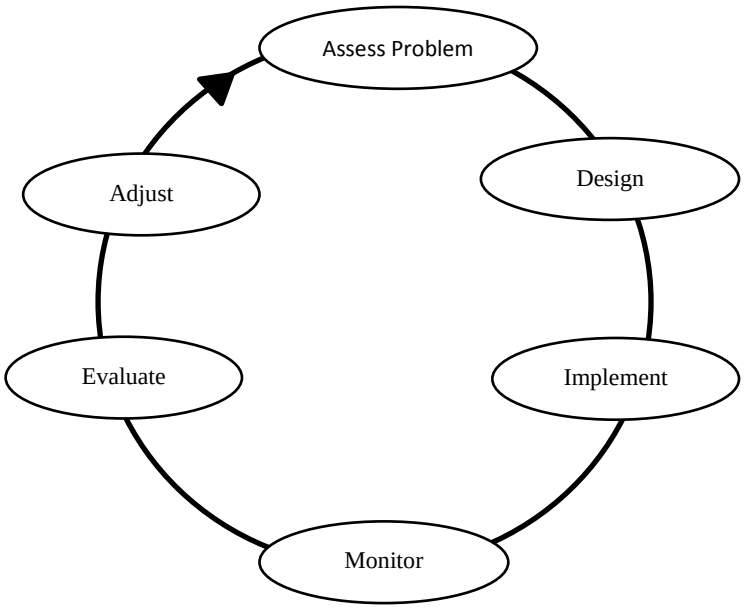

Figure 3: Stages of management (Williams et al. 2009, p. 5)

Management can also be modeled as a two-phase, iterative process, where "technical learning involves an iterative sequence of decision making, monitoring, and assessment [and] process and institutional learning involves periodic reconsideration of the adaptive management setup elements (Williams 2011, p. 1348)."

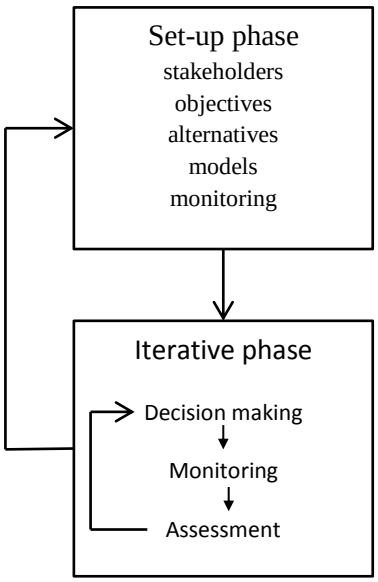

Figure 4: Iterative management process (Williams 2011, p. 1348)

Co-Management Throughout the Management Process

While some analysts of public participation stop the role of involvement at the planning and decision-making stages of management (e.g., Beierle and Cayford 2002), public participation can extend into all realms of public policy and management, occurring at "any or all stages and level of decision-making, including decisions relating to the initial identification of a policy need, to subsequent policy formulation, execution, monitoring, enforcement and review (Coffey 2005, p. 28)." This synchronizes with the idea of co-management, which includes resource users and social actors far beyond just developing the management plan, extending them real authority to have a role in implementation, monitoring, enforcement, and adaptation:

> "the ideal system of co-management is one where almost all management functions are the shared responsibility (p. 69)" of co-managers, and where "fishers have oversight and monitoring powers (McCay 1996, p. 69)."

Finally, co-management is often studied as a manifestation of decentralization. Co-management does not fit well within the decentralization spectrum, yet its place within the framework of decentralization still must be understood as it is not infrequently addressed in the co-management literature (e.g., Pomeroy and Berkes 1997).

2.2.6 Intersections of Co-management with Theories of Decentralization

The understanding of co-management is often confused further when it is used in conjunction with words like 'delegation' or 'devolution' (e.g. Hoel, Jentoft, and Mikalsen 1996, Jentoft 2003, Jentoft and McCay 2003, and R. Pomeroy 2003). In order to determine if there is an intersection between co-management and decentralization, I first lay out a clear definition of the terms.

Within the field of development studies, there is an extensive literature on decentralization (UNDP 1999), and "it is important in our thinking about fisheries co-management that we not reinvent the wheel (Wilson 2003, p. 28)." Within this literature, there are well-defined and distinct meanings

attached to delegation, devolution, and deconcentration; they do not mean the same thing and should not be conflated or confused with each other.

Decentralization is the umbrella term for initiatives and government structures that "seek to redistribute authority, responsibility and financial resources for providing public services among different levels of government (World Bank Decentralization Thematic Team n.d.)." Within that umbrella are three levels of decentralization: deconcentration, delegation, and devolution.

Deconcentration is the weakest form of decentralization: it involves the central or federal government shifting responsibility for tasks to the regional offices or branches of central government agencies, while control is still maintained by the central government (Smith 2001, UNDP 1999). Central government staff in peripheral locations are given more operational control, but still lack control over collective and constitutional choice decisions. Delegation is a higher form of decentralization: more authority is given to more autonomous organizations, most often local governments. The key is that the organization receiving the delegated authority is semi-autonomous from the central government, although ultimate accountability for the services provided still rests with the central government (Smith 2001, UNDP 1999).

Devolution is the highest form of decentralization (excluding privatization, in which government sheds all responsibility for provision of a service). Under devolution, local governments or other designated organizations "acquire the power of **autonomous initiative** and decision making with respect to setting their own rules, goals and objectives (Smith 2001, emphasis in original)." An organization with devolved authority has control over all aspects of service provision: decision-making, finance, and management.

Smith (2001) offers a useful graphic for understanding the different forms of decentralization.

Accountability	Autonomy	
	Low	**High**
Central	Deconcentration	Delegation
Local	Inadequate devolution	Effective devolution

Table 3: Types of decentralization (Smith 2001, p. 17)

The Intersection of Decentralization and Co-Management

There is no clear conclusion on where co-management fits on the spectrum of decentralization. In fact, co-management may occur at any level of government, local, regional, or national (Jentoft 2003), which makes it particularly difficult to align the two frameworks. In addition, some assert that some of the functions of natural resource management should never be outside the authority of the federal government given its responsibility under the public trust doctrine (McCay 1989, Wondolleck and Yaffee 2000). However, there can still be some lessons learned from the exercise of comparing co-management and deconcentration.

The fundamental definition of co-management involves some real degree of power-sharing between the government and social actors: co-managers "should not be acting as mere agents of decisions that are made by higher authorities (Jentoft 2003, p. 5)." Thus, co-management is clearly further along the spectrum of decentralization than the point represented by deconcentration (Noble 2000).

Arguments can also be found that point to co-management existing even further along the spectrum of decentralization, evidencing some of the traits of devolution. Co-management organizations must "have the authority to make and implement regulatory decisions on their own (Jentoft 1989, p. 144)," which resonates with the definition of devolution, and Pomeroy (2003) argues that for co-management to truly exist, governments must "devolve some of their powers (p. 248)." However, it is also necessary to keep in mind that co-management is not the same as community-based

management – it does not necessitate the complete absence of the federal government in management (Jentoft and McCay 2003).

Although decentralization and co-management can look and sound very similar, there are key differences between the two, and co-management does not neatly fit within the framework of decentralization. Co-management can occur at multiple geographic scales and levels of governance, at the level of the local fishery, the regional fisheries management office, or in the development of state or national policy (e.g., C. Pomeroy 2003). In addition, while more intense decentralization loses the involvement of central government, even the most complete versions of co-management will include government as an active managing partner. Thus, while there are similarities between decentralization and co-management, they are not compatible frameworks and should not be used interchangeably.

2.2.7 Conclusion

Examining the different ways that co-management is contextualized and understood informs the understanding of the definition of co-management. Reviewing the analysis in Sections 2.2.1 through 2.2.6 reveals several conclusions about aspects of co-management: complete co-management includes a broad representation of social actors; exists at the 'partnership' level of public participation; and must extend through all stages of the management process. In addition, comparing co-management with the decentralization literature reveals discontinuities between the two, highlighting the fact that co-management can occur at any level of government and at any geographic scale. Thus, a partial definition of co-management has emerged. The next section examines the different ways that authors attempt to categorize different types of co-management and analyzes the completeness of co-management arrangements.

2.3 Typologies of Co-Management

Several authors have attempted to develop schema for understanding different types of co-management arrangements, and to place co-management arrangements along a spectrum from less-complete to more-complete. I argue that none of these typologies or scales is satisfactory, offering both an analytically useful definition of co-management and a convincing argument for different types of co-management that vary based on completeness of the arrangement. However, it is important to understand the existing frameworks while developing a new one, as well as to build upon the bones of previous scholarship. In this section I review six typologies proposed by leading scholars in the field of co-management. Examination of these typologies is a start to identifying variables that can be used later to build a matrix that describes co-management arrangements in detail.

In Section 2.3.1 I examine the typology proposed by Sen and Nielsen (1996) – although it does not advance far beyond Arnstein's (1969) work, the authors do include a useful list of variables that can be incorporated in the co-management matrix I develop in following sections. Similarly, Sections 2.3.2 and 2.3.3 examine the typologies of Pomeroy and Berkes (1997) and McCay (1996), respectively; both typologies share the weaknesses of Sen and Nielsen's model, but contribute to constructing the co-management matrix. Finally, Sections 2.3.4 and 2.3.5 analyze the strengths and weaknesses of the typologies of da Silva and Kitts (2006) and Pinkerton (1989, 2003), and extract useful information from the authors' work.

2.3.1 Sen and Nielsen (1996)

Sen and Nielsen (1996) offer one of the very first typologies of co-management, and indeed is a defining work in the study of co-management as a distinct body of research and literature. The authors specify five distinct types of co-management arrangements (instructive, consultative, cooperative, advisory, and informative), on a spectrum from 'government management' to user group management.'

Figure 5 below shows the placement of each type of co-management on the spectrum.

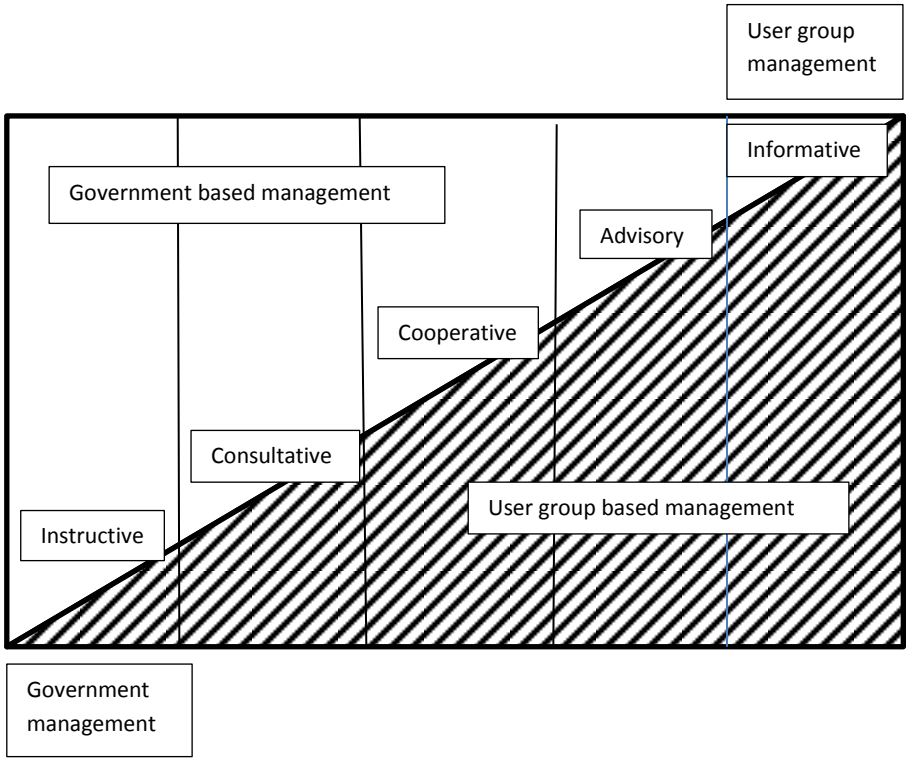

Figure 5: Co-management spectrum (Sen and Nielsen 1996, p. 407)

Instructive management is characterized by "only minimal exchange of information between government and users (p. 406)," with one-way flows of information from the government to resource users, whereas consultative management, the next step on the spectrum, allows for two-way flows of information. There is a significant step up to the third type of management: cooperative management is defined as management where "government and users cooperate together as equal partners in decision-making (p. 406)," and the authors acknowledge that for many scholars this is the definition of co-management. The fourth and fifth types of management are role reversals from instructive and consultative: under an advisory management arrangement resource users make the decisions and government merely ratifies or endorses the decisions, and under informative management resource users have full authority for decision-making as the government has devolved responsibility for management to the resource users.

This framework should be familiar from the previous sections addressing participatory management and public participation, as it does not differ much from Arnstein's 'ladder of participation.' This typology does not offer additional or unique analysis on co-management institutions or arrangements. Indeed, only the third type, cooperative management, fits within the definition of co-management supplied by Sen and Nielsen (1996).

However, Sen and Nielsen do break down co-management in a more useful way. They acknowledge that the five-part typology is a vast simplification, and recognize that co-management "covers a broad spectrum of possible collaborative decision-making (p. 407)," and that it can be further broken down into the "roles of government and user groups in decision-making; the types of management tasks that can and want to be co-managed by user groups and government; and the stage in the management process when co-management is introduced (planning, implementation, evaluation)." Their ideal model of complete co-management is one where "both government and user groups cooperate as equal partners for all management tasks and at all stages in the management process (p. 407)." This analysis informs the development of the following section, highlighting areas of the process that must be addressed in the list of variables describing co-management arrangements.

2.3.2 Pomeroy and Berkes (1997)

Pomeroy and Berkes (1997) present a graphic illustrating a 'hierarchy of co-management arrangements.' Although the authors do not explain their categorization scheme, the scale is self-explanatory to anyone with a passing familiarity with Arnstein's (1969) ladder of public participation and the broader literature on public participation and co-management.

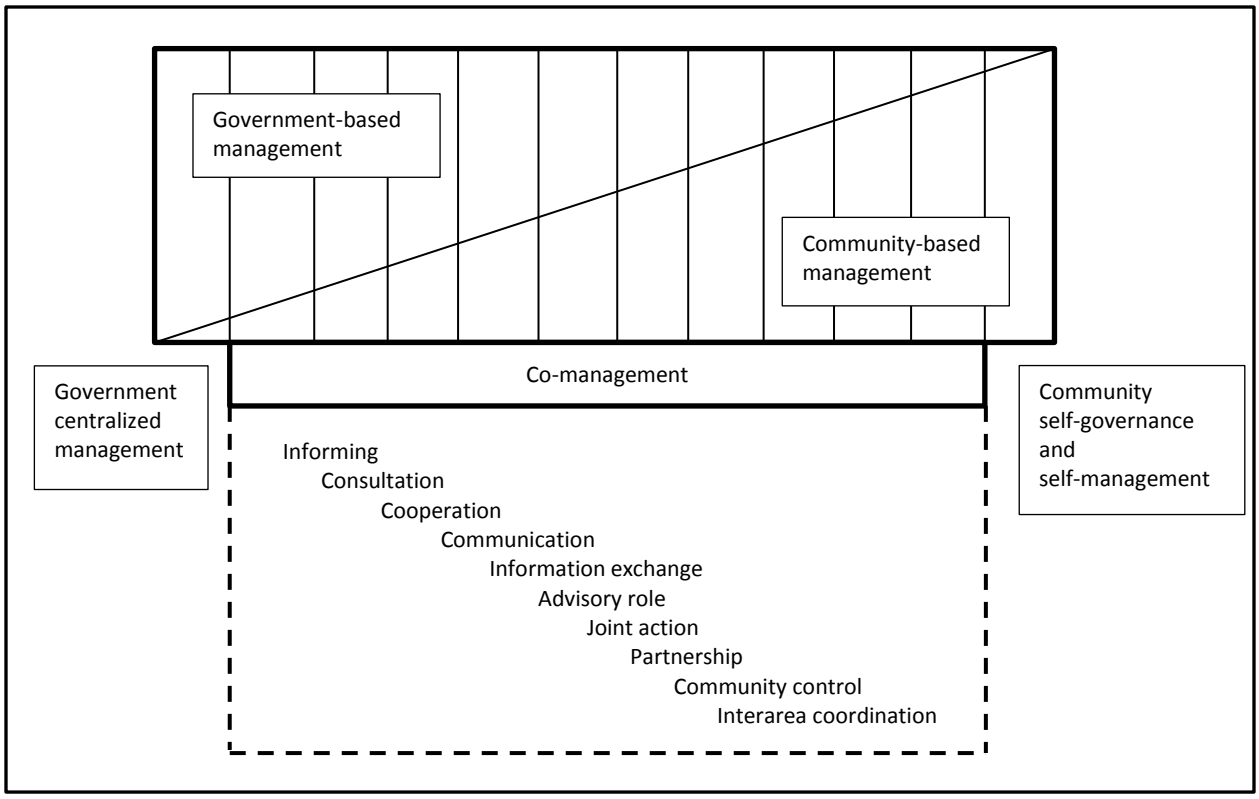

Figure 6: Co-management spectrum (Pomeroy and Berkes 1997, p. 466)

The bulk of the analysis, though, is an attempt to fit co-management within the framework of decentralization, using decentralization as a proxy for analyzing an assortment of co-management case studies.

However, it is clear that these continuums do not neatly match up. The duties of the government in a successful co-management arrangement include "overseeing local arrangements and dealing with abuses of local authority, conflict management, appeal mechanism, backstopping local monitoring and enforcement mechanisms, and applying regulatory standards (p. 478)." This list does not clearly fit within delegation nor devolution: the federal government maintains ultimate responsibility for the state of the resource and the functioning of the management system, meaning it is not devolution, but co-management organizations also have a great deal of responsibility and the ability to make collective level decisions, which is stronger than delegation.

Pomeroy and Berkes (1997) do not clearly align the continuums of decentralization and co-management, and in using decentralization as a proxy for understanding different types of co-management their typology falls short. However, the list of government duties does inform the matrix variables, and the focus on power and authority is valuable to note. As a result, it is clear the co-management matrix must incorporate variables that account for the power and authority belonging to each partner in the management process.

2.3.3 McCay (1996)

McCay's typology of co-management is a simplification of the 'Ladder of Participation' (Arnstein 1969), using only six 'rungs': Government Power, Inform, Consult 1, Consult 2, Co-Management, and Fisher Power, determined by "the level and degree of fisher, or fishery community, power in the process (p. 65)." The 'ladder of fisher participation' thus fits within the themes of public participation, and is not a true examination of different types of co-management: co-management is but one rung on the ladder of public participation in fisheries management.

The difference between Consult 1 and Consult 2 is a matter of intention, the difference between 'on paper' and 'on the ground': under Consult 1 "the government agency asks for limited input but seems to prefer not to listen (p. 67)," whereas under Consult 2 "the agency indicates that it intends to listen and take what it hears into account in developing policy (p. 67)." In the distinction between Consult 1 and Consult 2, McCay deals frankly with issues of tokenism, the structures of decision-making that may seem to reflect consultation or co-management, but are manipulated to maintain government control of management decisions. This is one of the frustrations and weaknesses of attempting to categorize co-management based on broad strokes. Instead, it is crucial to develop a suite of descriptive variables that are specific enough to recognize and distinguish tokenism, and illustrates the differences

in management systems that grant social actors and resource users power at the levels of operational, collective, and constitutional decision-making (Ostrom 1990).

McCay makes a stab at examining the specifics of the situation, providing a short list of some examples of co-management: "situations in which meetings are called jointly by fisher organizations and government officials; where fishers have oversight and monitoring powers in relation to a specific fishery management system; and where fishers are funded to hire technical consultants (p. 69)." The definition of an 'ideal' co-management arrangement is:

> "one where almost all management functions are the shared responsibility of government agencies and fishermen. Fishers should be directly involved in decision-making … and have authority to construct and implement regulations."

In order to accurately pinpoint co-management situations, it is necessary to have an encompassing list of these management functions, and a way of determining, if not all management functions are shared, which are necessary and which are sufficient for co-management to exist. DaSilva and Kitts (2006) facilitate this task by providing a definition of complete co-management based on which management tasks are decided and performed jointly.

2.3.4 Da Silva and Kitts (2006)

DaSilva and Kitts (2006) analyze five case studies based on where they fit on a spectrum from local to council/federal for two different categories (data collection and research), and the regulatory framework (determination of primary access privilege, determination of secondary rules, control over design of internal group relationships, and external and internal enforcement).

In the description of the case studies, often quoting the fishery groups' members, a fairly strong view of what co-management should be is evident. Case studies include ones where "a resource user group has the opportunity to design the institutional and governance framework for resources that they depend on (da Silva and Kitts 2006, p. 838)"; the fisher organization decides on its own input

restrictions; social actors are involved in cooperative research even when they agree that "the determination of the biological boundaries of a fishery is most appropriately set by the government (*ibid*., p. 839)"; fisher groups are involved in monitoring fishing activity; social actors are responsible for designing the organizational structure of their own groups, and are responsible for enforcement of their internal rules; and multiple types of groups and social actors are "eligible for participation in decentralized management opportunities (*ibid*., p. 839)."

Although not complete on its own, the framework provided by DaSilva and Kitts (2006) can usefully be incorporated into a typology of co-management and a list of descriptive variables. In addition, it starts to examine the differences among co-management arrangements where social actors have operational, collective, or constitutional authority (Ostrom 1990). The question of who determines membership, who designs the institutions, and who decides on operational rules (such as input control) are crucial for determining the level of social actors' authority in a co-management arrangement.

Pinkerton (1989, 2003) also engages with co-management through the lens of Ostrom's framework. Pinkerton provides a list of management functions that should be included in 'complete' co-management (1989) and follows up with a case study, analyzing the intersection of operational and collective choice rights that make the co-management arrangement 'complete' (2003).

2.3.5 Pinkerton (1989, 2003)

Co-management arrangements can vary along several dimensions, including: the parties involved, the formality or legality of the arrangement, the scale, the "basis for the organization of the group," the species being managed, and the management functions undertaken by the fishing group (Pinkerton 1989, p. *x*). The list of seven management tasks that fits under 'management functions undertaken' is familiar in the literature on co-management: data gathering and analysis, logistical harvesting decisions, harvest allocation decisions, habitat protection, enforcement, habitat

enhancement and long-term planning, and broad policy-making. Beyond these lists, though, Pinkerton offers no further specification about determining the completeness (or lack thereof) of a co-management arrangement.

The co-management arrangement that developed from the Boldt Decision in Washington State is a frequent case study for Pinkerton, and it is held up as an example of fairly 'complete' co-management (i.e., Pinkerton 1992). Several decades after its initiation, it is "very advanced (Pinkerton 2003, p. 62)"; 'completeness' is analyzed as a function of co-managers possessing both operational and collective choice rights. The ability of co-managers to exert power at both levels of decision-making is key: without collective choice rights, any arrangement is "an inappropriate watering down of the term [co-management] (p. 62)," and without operational rights the ability to make collective choice decisions is compromised.

Given the complexity and diversity of arrangements labeled co-management, Pinkerton proposes using "a matrix of other potential co-management rights/activities of varying levels of importance (p. 63)," and identifying the 'degree and type of power' held by co-managers for each of those variables as a rung on a ladder of participation, or a point along a spectrum. This matrix would include the variables and management activities listed above, encompassing the "key decisions about how, when, where, how much, and by whom fishing will occur (p. 62)." Thus, assessing, or 'scoring', co-management arrangements would be a matter of identifying the scope and distribution of power for each aspect of management.

Although Pinkerton does not follow through, "this type of matrix array opens the way to an analysis of what critical bundle of rights is sufficient to allow a co-management system to be effective (p. 63)." My work in the next section can be seen as a direct follow-up to Pinkerton's statements, though it is also reflective of the gaps in the field of co-management studies as a whole. The next section develops this 'matrix' that can be used to determine whether any particular arrangement does in fact qualify as

co-management, and that can be used in the future to score the completeness of the co-management arrangement.

2.3.6 Conclusion

Several authors have attempted to develop typologies for co-management. However, either the typologies are incomplete, or they are unsuited to distinguishing among different types of co-management (as opposed to distinguishing co-management from other types of participatory management). The typologies that provide useful lists of descriptive variables, or offer ways to sort those variables into categories, fail to compile a complete matrix. In the next section I develop a typology of co-management in the form of a matrix for co-management that builds upon the extant scholarship, but fills a crucial gap in the literature. The matrix consists of co-management variables identified from the literature and evaluated on a spectrum. The variables are also translated to be compatible with the Institutional Analysis and Development (IAD) framework.

Chapter 3. Developing a Co-Management Typology Matrix

Using the information and conclusions from Chapter 2, in this section I develop a matrix for describing co-management and analyzing the level of completeness of a co-management arrangement. The matrix can be used to describe co-management in detail, offering a more specific and flexible way of defining and analyzing co-management, and allowing cross-comparison of co-management in practice. The matrix can be used to categorize the presence and completeness of co-management in a case study. Scores of (weak) on a majority of variables would indicate that co-management is not truly present and that the management arrangement is instead merely consultative. Similarly, scores of (strong) on all variables would indicate the highest level of co-management possible.

Section 3.1 places the matrix within the Institutional Analysis and Development (IAD) framework, situating the matrix within a rich body of theoretical literature, and Section 3.2 addresses some of the background assumptions and limitations of the matrix. Section 3.3 identifies the sixteen variables that are the building blocks of a co-management arrangement, and builds a matrix out of those sixteen variables. Section 3.4 concludes with a test of the matrix on three case studies, serving both as a first-test of the validity of the matrix and as a demonstration of how the matrix can be used in the future to enhance the study of co-management.

3.1 Framing the Situation

In order for this matrix to be functional and useful, it must be clear where it fits within a case study or analysis. What is it describing, how does it change over time, and how does it interact with other parts of a situation or institutional arrangement? Characterizing the type of co-management occurring is only one part of a complete analysis, and it is valuable to both practitioners and scholars to see how the structure of the co-management arrangement interacts with the other elements of a

situation. In addition, the matrix must be compatible with a theoretical framework in order for it to achieve maximum usefulness to researchers and analysts.

I use the Institutional Analysis and Development (IAD) framework (Ostrom, Gardner, and Walker 1994; Ostrom 2010). It is a fairly simple framework that provides a clear and accessible map of where the co-management typology fits in an analysis of a co-management arrangement. This typology is designed to be useful to practitioners; it must clearly limit and situate the topic of analysis, without being too complex. In addition, the IAD framework is "intended to contain the most general set of variables that an institutional analyst may want to use to examine a diversity of institutional settings (Ostrom 2010, p. 646)." It is a "metatheoretical language", and by situating the matrix within the IAD framework it becomes compatible with the rich body of work that has been developed within the framework.

The subject of the co-management typology is the "action situation," and the framework shows the relationships among the various other parts of an analysis that interact with and affect the institutions being studied. For more information on the elements of the IAD framework, see Ostrom (2010) and The Vincent and Elinor Ostrom Workshop in Political Theory and Policy Analysis, Indiana University Bloomington.[8]

[8] http://www.indiana.edu/~workshop/

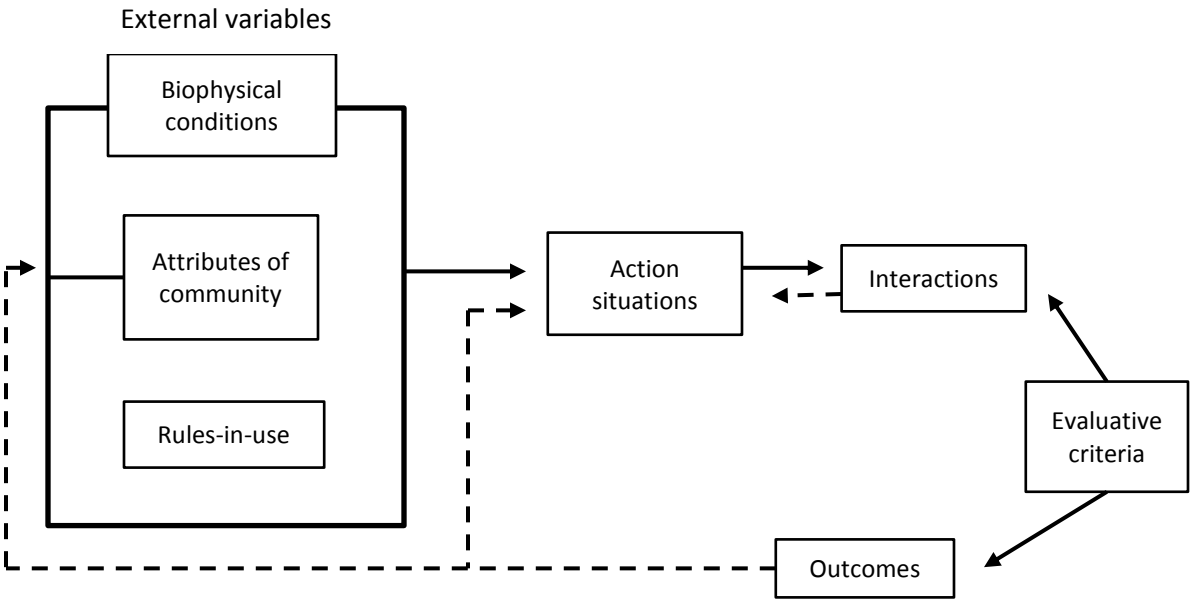

Figure 7: IAD framework (Ostrom 2010, p. 646)

The IAD framework offers additional specificity within the unit of the action situation. Every element of IAD framework is composed of seven types of rules that structure the actions required, prohibited, or permitted by actors in a situation. Table 3 below, developed from Ostrom (2010), defines the seven types of rules. The definitions are fairly straightforward; for more information and explanation, see Ostrom, Gardner, and Walker (1994).

Rule	**Definition**
Boundary	Specifies how actors are chosen to enter or leave positions
Position	Specifies a set of positions and how many actors hold each one
Choice	Specifies which actions are assigned to an actor in a position
Information	Specifies channels of communication among actors and what information must, may, or must not be shared
Scope	Specifies the outcomes that can be affected
Aggregation	Specifies how the decisions of actors at a node are to be mapped to intermediate or final outcomes (i.e., majority or unanimity rules)
Payoff	Specifies how benefits and costs are to be distributed to actors in positions

Table 4: IAD rules (Ostrom 2010)

Figure 8 below shows how the different types of rules relate to the elements of an action situation.

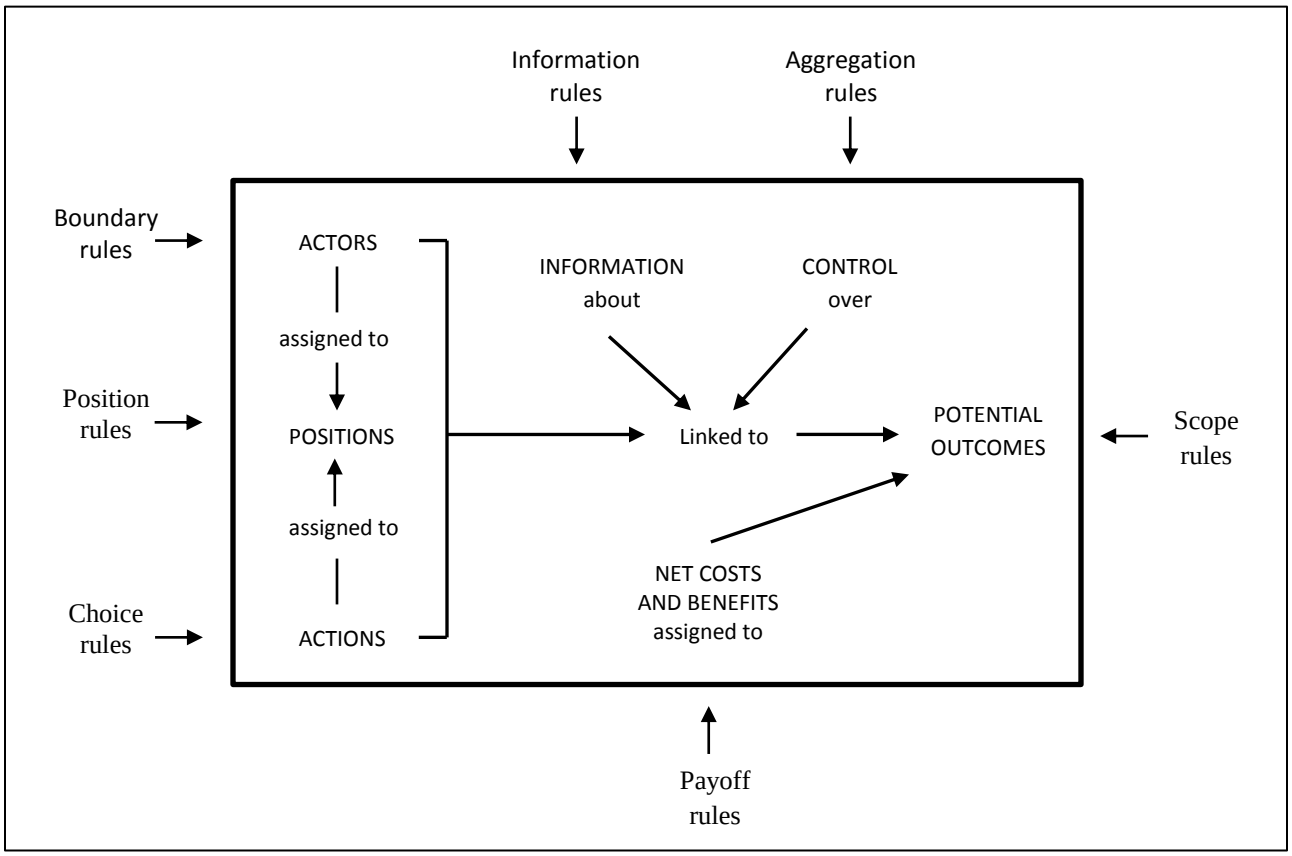

Figure 8: Rules in the action situation (Ostrom 2010, p. 651)

Although I develop the co-management typology, as contained in a matrix with a set of sixteen "variables," those variables can easily be understood as "rules" within the IAD framework. I identify the type of rule to which each variable corresponds. However, I maintain the language of 'variables', and structure the variables within the stages of the management process, in order to retain the matrix's usefulness to practitioners. The model of the management process is easily understood even by those without a grounding in institutional theory; similarly, the terminology of 'variables' is more easily understood than that of 'rules'. Case studies done using the co-management matrix will thus be compatible with the IAD framework, though not explicitly positioned within it if the case study analyst is not familiar with the theory. Future work can be done to formulate the matrix explicitly as an action situation, or to translate case studies into the language of the IAD framework.

Now that the subject of the typology is situated in an appropriate context, it is possible to begin the development of the variables of the co-management matrix.

3.2 Background Assumptions

The theoretical work in the following section is based on five background assumptions. First, some normative beliefs are present in the basic assumptions of the co-management typology. More democracy is generally perceived to be better; public participation in management and governance is assumed to be desirable. The more intensive the co-management arrangement is, and the more social actors who are involved in the process, the better decisions will reflect public values.

This does not mean that co-management is always the most effective or efficient way to make decisions. Not all situations call for the same type of management, or the same intensity of public involvement: some cases may differ based on what is cost-effective, efficient, and normatively sufficient. Thus, while there is a degree of normative assumptions in the overall context, the co-management matrix itself and the variables therein are not prescriptive. Complete co-management is not necessary to successful management, or to successful public participation in management.

Second, the typology is also developed and situated within a particular context, and with particular limits and boundaries in mind. First, the focus is on a North American context, particularly within the legal background of the United States of America.[9] Although the literature informing the typology deals with case studies and analyses from around the world, and the matrix ideally can be adapted to any situation, any limits to its universality are the result of its domestic context and focus.

Third, the matrix is developed around the scale of the management of an individual fishery. It is purposely intended to facilitate case study comparisons, not overviews of national or state policy.

[9] The North American context is particular for the role and rights that Native American tribes and nations have; the issue of tribal sovereignty in fisheries management was supported by similar court cases in the United States (Mattz v. Arnett and the Boldt decision) and Canada (R. v. Sparrow), leading to the development of similar management regimes.

National policy and the extant legal structure are largely considered exogenous to the management typology. Again, the typology can be adapted to any level of governance as co-management is not limited by scale and level, but it would require some tweaking of the matrix. Ultimately, the matrix could be used in an analysis of fully nested co-management, but without the time to test the matrix on such an example assurance of its utility is unwarranted.

Fourth, the matrix is developed to analyze formal institutional arrangements; adjustments would have to be made to several variables to accommodate looser, informal arrangements. For example, entry and exit of parties, selection of representatives, and the existence of an ongoing co-management body would all look very different in informal arrangements. However, the question of on-paper versus on-the-ground is difficult, and the matrix for the most part leaves it up to the discretion of the case-study analyst to determine whether formal structures have actual effects on decision-making and behavior. Although the matrix is officially about formal institutional arrangements, written policies, contracts, and organizations, it also recognizes that unofficial arrangements are possibly valid as co-management arrangements, recognizing and respecting that not all institutions are formal and official. However, in the context of the United States, the focus is on formal arrangements.

Finally, the matrix is not a dynamic model. It does recognize the dynamism of real life situations, and some of the descriptive variables provide insight into whether a co-management arrangement will be able to adapt effectively over time and changing conditions. However, there is nothing in the matrix to structure dynamism and change over time; it is a snapshot in time.

3.3 Descriptive Variables for the Co-Management Matrix[10]

For convenience, the descriptive variables are sorted by their place in the stages of the management process. I use a six-step model of the management process: problem conception, design of

[10] For references used in developing the matrix variables, please see Appendix A.

management process, design of management plan, implementation, monitoring and evaluation, and evaluation and adaptation. It is based on the model in Williams et al. (2009) used in Section 2.2.5, but I include a distinction between design of the management plan and design of the management process to include some of the distinction between decision-making at collective and operational levels (Ostrom 1990). However, some variables do overlap or occur during multiple stages. In those cases, the variables are placed in the management stage where they first occur.

All of the variables exist on a spectrum (Figure 9). The starting point of the spectrum represents control by the government agency with responsibility for the fishery in question, while the last point on the spectrum represents joint control by social actors and the government (complete co-management). 'Government' in the context of the matrix refers to the government department with responsibility for the fishery in question. This may by NMFS, through the Department of Commerce, for federal fisheries in the United States; the Department of Fisheries and Oceans for federal fisheries in Canada; or the relevant state or provincial fisheries agency. Co-management necessarily includes the participation of the government agency with statutory responsibility as part of the definition of co-management; the public trust doctrine and Appointments Clause also mandate that government officials with authority from the relevant fisheries agency are involved in the process (Hawkins 2007).

Each variable exists on its own spectrum, described with three levels of management: the first represents consultation; the third represents co-management, and the second is somewhere in the middle. Because any single variable does not determine whether or not co-management is present, and fairly complete co-management arrangements may still have some variables that describe consultation or weak control by co-managers, the points along the spectrum are described as 'weak', 'medium', and 'strong'. The matrix can be used to categorize the presence and completeness of co-management in a case study. Scores of (weak) on a majority of variables would indicate that co-management is not truly

present and that the management arrangement is instead merely consultative. Similarly, scores of (strong) on all variables would indicate the highest level of co-management possible.

The ranking described in Table 4 is an initial effort; additional work needs to be done to specify the relative increase or decrease from one point to the next, and to numerically code the different stages along the spectrum.

The following is a graphic illustration of the spectrum on which the variables exist:

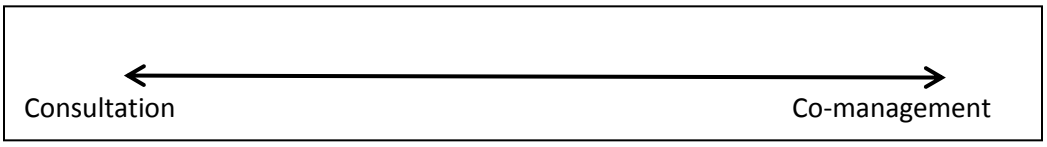

Figure 9: Spectrum of matrix variables

Standard bureaucratic management, announce-and-defend, is off the spectrum to the left; community-based management is off the spectrum to the right (Figure 1). The variables are described solely along the spectrum above, allowing differentiation between consultation and complete co-management, and setting up the ability to differentiate among different levels of completeness of co-management.

3.3.1 Problem Conception

At the initial stage of the management process, several important collective-level issues are addressed under the umbrella of 'problem conception', including who is identified as an affected party, which social actors are involved in the decision-making process, and what is included in the conception of the problem. This is the stage at which fundamental decisions, such as the purpose of organizing co-management and what the co-managers are to manage, are made.

Scope of Representation and Inclusion

The issue of representation and inclusion covers several different aspects of decision-making. The first three variables of the matrix are boundary rules, controlling entry and exclusion, i.e., which actors are allowed to hold the positions of 'participant' in the decision-making and management process. This position may be as generic as being an accepted 'participant' or as specific as being an official member of a decision-making committee or organization.

Variable 1 - Who Chooses Relevant Social Actors (Entry and Exclusion): Control of entry and exclusion is central in determining how power is shared. Does the government decide who to invite to the table, or does the government extend an open invitation to the community at large? The spectrum for this variable ranges from government selection at one end to self-selection at the other. The middle of the spectrum contains several different possible arrangements, including an independent consultant working with government and social actors to identify relevant interests, or an initial selection by government with a process for selected participants to identify and invite other interests.

A secondary aspect of this variable is whether the government provides support in organizing latent and incipient social actors. Under consideration is whether the government identifies missing interests and works to create representatives for them, and whether the government provides support, in resources, time, or money, to help social actors without the capital and capacity to independently organize effective interest groups and represent themselves at the table.

Variable 2 - Scope of Representation: Variable 2 is both a free-standing variable and an if-then corollary of Variable 1. Without considering the selection process, it is possible to characterize the scope of representation of social actors in a co-management arrangement. This extends from just resource users, to all fishery workers, to the extended community of interest. Co-management that only includes fishers is necessarily more limited in breadth and depth than co-management that also includes shore processors, women and the families of fishers, and environmentalists.

Scope of representation may also be used to qualify a weak Variable 1: if selection of participants is controlled by the government, who the government chooses to include can indicate more or less commitment to true co-management versus manipulating the process to maintain control while appeasing social actors.

Additionally, I stipulate that asymmetry of representation and involvement does not invalidate the scoring on this variable. Including a broad swath of the public in management decisions does not mean that all segments of the public must be equally involved. Although management of public resources should have "a basic level of participation [that] involve[s] as many people as possible, or as appropriate given the issue at stake (Coffey 2004, pg. 30)," the differing degrees of intensity of interest in the resource that various social actors have may lead to asymmetrical participation and methods of representative democracy (e.g., Davis 2011; Hatchard 2005; and Mikalsen and Jentoft 2001).

Although it is rarely a good idea to exclude relevant social actors, even those with minor interests, it may not be desirable to include all social actors as equal partners in management. A co-management arrangement may be most efficient when greater responsibility and decision-making power is given to social actors with higher stakes, while less responsibility is given to social actors with lower stakes while still including them in important ways.

Variable 3 - Selection of Representatives: Beyond the decision of which social actors to include, it is necessary to specify who chooses the representatives for each identified interest and thus to whom they are largely accountable. Does the state governor or the head of the fisheries department appoint representatives for each group, or are social actors allowed to select and send their own representatives? The middle point on the selection could be manifested by social actors providing a slate of possible representatives, or a confirmation/approval process for the selected representative(s).

Creating Management Goals and Defining Success

After representation and inclusion is settled – the issue of *who* will be making decisions – it is necessary to determine *what* is to be decided. Before social actors can design a management plan, they have to agree on the goals of management. This is a scope rule: it limits the acceptable outcomes of the management process and limits the scope of impact that the decision-making process and management proceedings can have on the social actors involved in the fishery.

Variable 4 - Selecting, Defining, and Prioritizing Management Goals: This is a crucial aspect of problem conception. Without an agreement on what the goals of management are, it is entirely possible for participants in the management process to be working at cross-purposes; lack of specification of management goals creates unnecessary problems and road blocks in the management process.

Defining and prioritizing goals are crucial to the later selection and analysis of possible management plans and scenarios, and this variable speaks to who actually has power in the situation. Does the government provide pre-selected goals, or do participants select, define, and rank goals once the process is initiated?

3.3.2 Design of the Management Process

After the *who* and *what* of decision-making is decided, the next step of management is to determine *how* decisions will be made, including the design of the decision-making process and the inputs to the decision-making process. The fifth variable is a choice rule, assigning the action of approving, disproving, or requesting modification to the management plan to a particular actor or set of actors.

Decision-Making Authority

Variable 5 - Authority to Ratify and Approve Management Plans and Decisions: Determining who has the final say on approving the management plan and any other decisions taken by the co-management body is crucial in determining what level of co-management is occurring. Under low-level (largely incomplete) co-management, the managing body must submit its decisions to the government for approval or ratification. Alternatively, in mid-level (moderately complete) co-management the government can accept the management plan as a matter of course, but still maintain some degree of authority over the decision-making. At the highest level (complete) co-management, decisions made by the co-management body have the weight and authority of decisions made by the federal or state government, and do not need additional approval from the government. These decisions would of course have to comply with extant laws, and government representatives in the management body might strongly help to shape the management options and decisions.

Financing the Management Body and Management Actions

Variable 6 - Financial Control of the Initial and Continuing Decision-Making Process: Establishing the management and decision-making process includes determining which parties are responsible for financing the decision-making process. Financing the implementation and enforcement of the management plan is a different matter. Instead, this variable specifically deals with the initial financing and/or hosting of developing the decision-making process and constructing the management plan, and the financial arrangements for supporting the ongoing co-management decision-making process and organization.

This variable is a payoff rule, and it is important because it speaks to both formal control and informal influence over the decision-making process. If one party controls the financing of the process, it can threaten to pull financial support if decisions do not go its way, or use money to leverage other

participants in the process. It is unlikely that resource users will be able to fully finance this stage of management. However, some degree of financial participation or joint control and oversight of the money allows a higher degree of power and influence in decision-making.

Developing the Decision-Making Process

Designing the decision-making process incorporates several variables. First, who initially convenes the participants and the process? Second, who controls the initial process design? And, third, do co-managers have the ability to change and adapt the decision-making process?

Variable 7 - Initiator of the Co-Management Process: The social group that provides the initial impetus for the co-management process is not definitive in determining the completeness of co-management, but it does inform an analysis of the power co-managers have in the process. If social actors provide the impetus for the process, initiate the participant selection, and facilitate early meetings, they create and maintain a degree of power in the process that may not be present, or that may be harder to achieve, if government actors are responsible for convening and initially controlling the process. Thus, the spectrum for this variable ranges from government as the initial convenor, to joint convenors, to social actors as the initial convenor.

The seventh variable is another choice rule. Choice rules specify which actions are assigned to an actor in a position, but this 'assignation' occurs at a constitutional-choice level: which social actors are perceived as being able to legitimately initiate a co-management process? This is not a formal designation of a legitimate actor, in which case only the government fisheries department would ever be able to initiate co-management proceedings. Case studies, however, often show co-management initiatives that are promoted and organized by non-government actors. This is in contrast to the fifth variable, also a choice rule, which must be specified formally in legislation or regulation in order to be legitimate.

Variable 8 - Designing the Initial Process Rules and Ability of Participants to Change the Process: The development of initial process rules can have a disproportionate impact on the form later co-management takes and the power co-managers have within the management process. The variable incorporates processes designed by the government, by social actors or independent consultants, and designed jointly.

A follow-up to this variable is the question of whether participants can change the process, regardless of how it is established. The government might provide the initial framework, but is the process responsive to demands for change from within? This is potentially a very complicated variable: do co-managers have to be able to change *certain things*? For example, is the ability to change voting rules more important than the ability to change the management goals or participant criteria? This, however, is a question for future research. The spectrum for this variable remains fairly broad, asking whether participants have the ability to change all aspects of the process, some aspects of the process, or none.

Variable eight is a choice rule, as it describes which actors are assigned the action of designing the initial process rules of the decision-making process, and assigns which actors are allowed to change that process. However, this also sets up other boundary, position, choice, and aggregation rules, including: designating committee positions with authority to change the process; determining the eligibility rules for actors to accede to those positions; which actions of changing the process may, may not, or are permitted to be done by those actors; or developing the aggregation rules through which participants may change the process.

Information Generation

An information rule, which specifies how information is created and by whom, and how it is used, can have strong impacts on the relative strengths and influence of social actors and the

government as co-managers. The legitimacy of scientific information often depends on transparency in its creation, and the fact that it comes from a trusted source. Otherwise, 'partisan science' can easily derail a management process and constrain its effectiveness. Collaborative research is often heralded as one of the most important contributing factors in successful co-management, and is often a starting point for developing a co-management arrangement.

Variable 9 - Information Generation and Selection of Sources: In most management arrangements, the government is responsible for providing the scientific information used in the decision-making process. In conflict-ridden situations, this is problematic. Thus, the spectrum for this variable places government-supplied information as the weakest representation of co-management. Information generation at a mid-level of co-management represents arrangements where management participants have agreed on a source of information that is accepted as legitimate, or where all parties are allowed to contribute information that contributes to the co-creation of knowledge. Farthest on the spectrum are arrangements where information is created jointly, through collaborative and participatory research, where social actors participate in the generation of the information used in the management process.

Control of the Agenda

Variable 10 - Control of the Agenda: Small process variables, such as the choice rule of who controls what is and is not allowed on meeting and committee agendas, can sometimes have a disproportionate impact on decision-making and control of the process. This spectrum starts, as many do, with government control of the agenda. This is related to government control of management goals and priorities, and other process-related elements of the decision-making arrangement. Because this is a typology of co-management, it does not extend to community-based management. Thus, at the final

point of the spectrum an arrangement would have joint control of the agenda, not control by social actors.

3.3.3 Design of the Management Plan

Variable 11 - Developing Management Options and Plans: The level of control co-managers have is necessarily limited if they do not have the capacity to contribute to the generation of their own management plans and options, either as individual social actors or as a part of the management body. This is similar to the way the information generation variable works, the power distribution and mechanisms at work. Often co-managers are limited in what they can contribute due to lack of financial, time, and human resources. In the ideal co-management situation, social actors involved in the decision-making process receive support from the government and larger parties to contribute equally in the development of the management options and plans.

Variable eleven, developing management options and plans, is also a choice rule. Similar to variable eight, it also sets up a multiplicity of other rules at lower levels of operation. Indeed, the management plan establishes nearly all of the rules that structure the operational-choice level of management, the nuts and bolts of managing the fisheries. The management plan designates which actors will fill the positions of monitors, enforcement officers, adjudicators, and so forth. It assigns particular actions and responsibilities to those positions, specifies the information rules for management decisions, the scope of management actions allowed, and all the other rules governing the actual day-to-day management of the fishery. Thus, a choice rule at an earlier stage of management and at a collective-choice level action situation has a controlling influence on the rules of an operational-choice level action situation.

3.3.4 Implementation

Complete co-management extends throughout all the stages of the management cycle, with co-managers involved in monitoring, analysis of data, sanctioning decisions, appeals processes and conflict resolution, and other elements of enacting a management plan. Without a hand in implementation, and a voice in a standing body, co-management is incomplete. Involvement in operational-level actions and decisions can be key to meaningful participation at the level of collective-choice (Pinkerton 2003).

There is an extensive list of types of implementation tasks, from day-to-day marketing decisions, to managing quota trading, to handling the collection and disbursement of funds. However, my research does not indicate if any particular tasks are more important to be handled jointly, are more critical to an equal sharing of power. Further research is needed to determine the relative importance of each aspect of implementation.

Variable 12 - Presence and Participation in an Ongoing Co-Management Body: This variable can serve as a proxy for co-managers' participation in implementation tasks, if there is no accounting of which management tasks are performed jointly or the distribution of responsibility for management activities. The presence of a standing organization for managing the resource, and the participation of co-managers in that organization, can speak to the influence of social actors that carries over from the planning to the implementation stages of management. At the beginning of the spectrum, the lack of an ongoing co-management organization indicates a high control by government over management activities. Similarly, the middle point on the scale, a standing body without official positions for co-managers or positions filled by social actors, also speaks to government control over implementation. The final point on the spectrum is an ongoing management body with full participation by co-managers.

Variable twelve is a position rule: does there exist the position of 'member of co-management organization'? However, it also sets up an action situation with its own set of rules; if there *is* a co-

management body, the boundary, position, choice, scope, information, aggregation, and payoff rules for its functioning can be analyzed.

Variable 13 - Involvement in Implementation and Management Tasks: Variable thirteen, involvement in implementation and management tasks, is an operational-level choice rule, assigning the various actions of daily implementation and management to specific actors. The question of co-management is whether the actors who must, or are permitted, to perform implementation actions include co-managers, as well as government fisheries officials.

If information on who performs each management task is available, analysts can use this variable to convey a general idea of the scope of public participation in implementation: are co-managers involved in few or no implementation activities, some implementation activities or responsible for some implementation activities, or most or all implementation activities? Alternatively, do co-managers maintain oversight of all implementation activities regardless of direct responsibility for carrying them out?

High Importance Areas of Implementation

The previous variable is fairly broad and general. I propose several implementation tasks that may be relatively important for assessing the extent of power-sharing in a co-management arrangement, including: oversight and hiring of paid staff; management of quota trading, buying, and selling; disbursement and collection of money; assigning fishing locations or managing the rotation; and controlling fishing effort and deciding emergency measures. However, this proposition is tentative and the least backed by the extant literature; more research must be done to determine which implementation tasks are the most useful in informing an analysis of the extent of co-management.

3.3.5 Monitoring and Enforcement

Variable 14 - Involvement in Monitoring and Enforcement Tasks: The variable for assessing co-management during the management stage of monitoring and enforcement is similar to that of implementation, and is also an operational-level choice level. Both stages encompass mostly operational-level decisions, which may be important to establishing the ability for co-managers to contribute at the collective-choice level, and which can test the extent to which co-management is truly a power sharing arrangement in reality on the ground, but the answer for each individual aspect of monitoring and enforcement may not be significant. Thus, the first, broad variable under monitoring and enforcement reflects Variable 13 from the implementation stage of management, addressing how many monitoring and enforcement tasks co-managers are involved in or have oversight over.

Beyond this broad proxy, I highlight three monitoring and enforcement issues that may be of particular importance in determining power-sharing. First, who are the enforcement officers? Additionally, how are enforcement officers hired and paid, and who oversees their performance? Second, are there graduated and flexible sanctions, and who administers punishment? Third, involvement of co-managers in documentation and collection of monitoring data can have a disproportionate effect on the legitimacy and functioning of the co-management system.

3.3.6 Evaluation and Adaptation: Iterative Decision-Making

The final stage of the management process involves evaluation of both the resource state and the management plan, and making necessary adaptations to the management plan, the decision-making process, or the institutional arrangements. This stage is mostly represented by the variables in the initial decision-making stages, when participants are determining how they will make decisions. However, the dispute resolution process is highlighted at this stage.

Variable 15 - Internal Dispute Resolution Process: Having an internal dispute resolution process is important for legitimacy, creating buy-in, and involving co-managers in resolving contentious issues. Reducing the ability of objectors to circumvent the decision-making system is an important variable for good process. What is of concern for determining level of completeness of co-management, however, is the fact that dispute resolution processes can be used to make important decisions, and co-managers must be involved in the dispute resolution process to maintain power and voice in important decision-making. The spectrum for this variable reflects previous variables: (weak) government is in charge of dispute resolution, whether through external or internal appeals; (medium) co-managers are involved somewhat is dispute resolution, or have a degree of oversight; (strong) dispute resolution occurs under the aegis of the co-management body or institution, with full participation and decision-making by co-managers.

Variable fifteen incorporates the position rule establishing the roles of appellant, defendant, and adjudicator, the boundary rule of whether co-managers are allowed to hold the position of adjudicator, and the choice rule that limits the actions allowed to the role of adjudicator. Although presented as a single element of the co-management matrix, variable fifteen incorporates an entire lower-level action situation of dispute resolution.

The final variable in the matrix does not fit neatly within the stages of the management process, but can be crucial for the impact, effectiveness, and legitimacy of the co-management arrangement.

Variable 16 - Involvement in External Negotiations: This variable includes both involvement in external negotiations over straddling stocks and ocean interception, as is often seen in salmon co-management arrangements (e.g., Pinkerton 1994), and involvement in external issues such as habitat protection agreements and negotiations over development, resource extraction, dams and irrigation, and related water issues (e.g., Ebbin 2002, Pinkerton 1992). Without a say in the external issues that

affect the resource being managed, co-managers are hampered in their ability to effectively protect and manage the resource.

This is a choice rule, questioning whether the action of representing the co-managers' interests in external negotiations is assigned to co-managers, officials from the fisheries department, or other government representatives. As a component of the co-management matrix, it can remain a single choice rule. However, each external negotiation could easily be characterized as an individual action situation, with a corresponding breakdown into its constituent rules.

3.3.7 Summary Table

This table provides a summary of the variables identified above. It also highlights which variables may be crucial to the dynamism of the arrangement and its ability to adapt over time. Variables impacting the dynamism of the arrangement are marked with (**).

Variable	Rule Type	Spectrum		
		Weak - (W)	Medium – (M)	Strong – (S)
1: Entry and exclusion (**)	Boundary	Government selection	Hybrid selection process; independent consultant	Self-selection by social actors; new entry and exit controlled by co-managers
1a: Support for latent interests	Boundary	NO	n/a	YES
2: Scope of representation	Boundary	Only resource users	Includes fishery workers and community members	Includes all affected and/or interested parties, including environmental groups
3: Who chooses representatives	Boundary	Government-appointed representatives	Hybrid selection process	Representatives selected internally by participant groups
4: Defining management goals	Scope	Government defines management goals; no agreement on definitions	Government selects initial goals, open to some modification; some agreement on goals	Goals defined as part of co-management process; joint process of merging and agreeing upon definitions
5: Authority to approve management plans	Choice	Government approval needed	Rubber stamp government approval; limited government ability to change plans or request modifications	No additional approval needed for decisions by co-management body
6: Financial Control of Initial Process	Payoff	Government provides and control money	Government provides money, joint control	All parties contribute, joint control
7: Initiator of the process	Choice	Government initiates	Joint initiators; independent initiator	Social actors initiate
8: Initial process rules	Choice	Government establishes process rules	Some modification allowed; independent consultant structures process rules	Joint development of process rules
8a: Ability to change the process (**)	Choice	Government controls process	Some modification of process allowed	Co-managers allowed to change process
9: Information generation	Information	Government generates all information	Independent source of information; data sharing	Jointly generated information

Variable	Rule Type	Spectrum Weak - (W)	Medium – (M)	Strong – (S)
10: Control of the agenda (**)	Choice	Government control of agenda, accepted topics/issues	Some modification of agenda allowed	Co-managers create and control agenda
11: Developing management plan options	Choice	Government develops all options	Participants create independent management plan options with limited modifications/combinations; co-managers oversee plan development by government staff	Co-managers create management plans jointly, shared oversight and management of staff
12: Ongoing co-management body (**)	Position	No standing organization for co-management	Co-managers participate in non-co-management organization; limited positions for co-managers in organization; intermittent/episodic co-management	Ongoing co-management body; full, prescribed participation by co-managers
13: Involvement in implementation tasks	Choice	Co-managers responsible for no/few implementation activities	Co-managers involved in/responsible for some implementation activities	Co-managers involved in most/all implementation activities, maintain oversight of all implementation activities
14: Involvement in M&E tasks	Choice	Co-managers responsible for no/few M&E activities	Co-managers involved in/responsible for some M&E activities	Co-managers involved in most/all M&E activities, maintain oversight of all M&E activities
15: Internal dispute resolution process (**)	Choice	Government in charge of internal or external dispute resolution process	Co-managers involved in dispute resolution, have some oversight of decisions	Dispute resolution occurs within co-management body, full participation of co-managers
16: Involvement in external negotiations	Choice	The government represents the interests of the co-managers during negotiations	Co-managers are consulted during negotiations or may have a seat on the external management body	Co-managers fully participate in external negotiations; co-management body represents the interests of the co-managers

Table 5: Summary table

Key:

Problem conception	Design of management plan	Monitoring and evaluation
Design of management process	Implementation	Evaluation and adaptation

3.3.8 Operational, Collective, and Constitutional Choice

A review of the categorization of the sixteen variables above reveals a wide diversity of rules that operate at all three levels of choice: operational, collective, and constitutional. To simplify future analysis based on the IAD framework, Table 5 below sorts each variable into the choice-level at which it functions.

Operational Variables	Collective-Choice Variables	Constitutional Variables
1a: Support for latent interests 6: Financial control 9: Information generation 13: Involvement in implementation 14: Involvement in monitoring and evaluation	2: Scope of representation 10: Control of the agenda 11: Development of management options 12: Ongoing co-management body 15: Dispute resolution (for operational issues)	1: Entry and exclusion 3: Selection of representatives 4: Defining management goals/success 5: Authority to approve 7: Initiator of the process 8: Initial design of process rules 8a: Ability to change the process 15: Dispute resolution (for collective choice issues) 16: Involvement in external negotiations

Table 6: Operational, collective, and constitutional choice levels

Additionally, this table of variables provides the foundation for classifying the strength of co-management arrangements. A cursory hypothesis would suggest that the strength of the co-management arrangement increases with the number of variables at higher choice levels that are scored as (strong).

There are some obvious, basic thresholds for categorizing the presence and completeness of co-management in a case study. For example, scores of (weak) on a majority of variables would indicate that co-management is not truly present and that the management arrangement is instead merely consultative. Similarly, scores of (strong) on all variables would indicate the highest level of co-management possible. Additionally, analyzing a case study based on the co-management matrix allows for a clearer comparison among case studies and between the case study and the straw man of complete co-management.

However, real life is too complicated to simply assign numerical values and average the scores of each category and obtain an analytically useful comparison and labeling. It is the work of another Master's Thesis to code and score case studies and determine the relative weights of variables. A logical follow-up to this thesis is to do a quantitative analysis based on the matrix, testing the relative importance of variables with statistical significance, and determine numerical thresholds for sorting co-management into categories based on completeness.

As the case studies below show, some of the variables may be more or less important to determining strength, even within the choice-level categories. And some variables may be more or less important depending on whether the arrangement is more or less formal. Because of this, it is not yet possible to develop statistically significant thresholds for categorizing the completeness of co-management arrangements.

Developing a qualitative categorization scheme would merely repeat the weaknesses and problems with existing categorization schemes that rely on qualitative analysis and subjective ranking.

Instead, the case studies below serve as a demonstration of how the matrix could be used in the future to construct and test a valid categorization scheme.

3.4 Case Studies: Testing the Matrix

Case study analysis follows from an extensive review of the literature on the management of common-pool resources. A survey of the literature resulted in a list of eighty-six articles or book chapters that describe case studies labeled as cooperative planning, collaborative management, co-management, or a variation thereof. A second review with a focus on institutional arrangements and management processes produced a short list of twenty-two case studies. Nine North American case studies with the most comprehensive information on the management process were selected for a preliminary analysis based on the co-management matrix[11]. Following that review, I selected three case studies that highlight particular elements of the matrix and future work that needs to be done, and that represent cases of weak, medium, and strong co-management.

Using the summary table of co-management variables, I re-interpreted the three case study analyses in the professional literature; some case studies consisted of a single professional paper, while for others I used complementary articles by the same author. A complete and thorough analysis of case studies using the co-management matrix would of course require a more extensive use of secondary and primary sources. Complete information on all the variables was not present in any of the case studies, which highlights both the possible usefulness of the matrix for developing coherent prospective case study research and the challenges of pursuing a quantitative analysis based on the matrix.

[11] The nine case studies analyzed were: Southern Southeast Regional Aquaculture Association, southeast Alaska (Amend 1989); Commercial Groundfish Initiative, British Columbia (Davis 2008); District 4A Working Group, southwest Nova Scotia (Kearney 1989); Montauk Tilefish Association, northeast United States (Kitts, da Silva, and Rountree 2007); New Jersey Spawner Sanctuary Program (McCay 1989); Timber/Fish/Wildlife Agreement, Washington State (Pinkerton 1992); Nuu-chah-nulth Regional Aquatic Management Society, Vancouver Island (Pinkerton 1999); Big Creek Ecological Reserve, California (Pomeroy and Beck 1999); and Tassassen RHC, Sweden (Sandstrom 2009). In some cases, additional articles were used to supplement the information in the case study (i.e., Da Silva and Kitts 2006; Davis 2011; and Pomeroy 1999).

However, sufficient information was available in the cases selected to provide an adequate initial test of the matrix, to corroborate qualitative judgments of the case studies with structured analysis, and to highlight future work.

One of the focuses of the case studies below is to use the matrix to examine whether the case studies labeled as 'co-management' do indeed fit the developed definition of co-management. All three cases were labeled as co-management by the authors, but using the co-management matrix reveals the extent to which that label is accurately applied. The matrix offers a structured way to test the qualitative judgment of the case study analysts who label their cases as 'co-management'. Using the matrix offers a way of unpacking the term co-management' as it is applied to case studies.

3.4.1 District 4A Working Group

In his study of fisher involvement in management in the southwest Nova Scotia lobster fishery, Kearney (1989) questions whether the participatory management is co-management or co-optation. In doing so, the author reveals a subjective judgment questioning the validity of labeling the management regime as co-management. This reservation is borne out in analyzing the arrangement with the matrix variables.

Nova Scotian lobster fishers were able to influence the management process through informal means and political pressure, through the lobbies of Bear Point-Shag Habour-Woods Harbour Fishermen's Association (BSWFA) and the Maritime Fishermen's Union (MFU). However, they were also directly involved in management through the participation of fishers in the District 4A Working Group. This Working Group is the focus of the co-management analysis. It is occasionally difficult to disentangle the two sources of influence that fishers had on the management process: political pressure forced the creation of the Working Group and the commission of an independent study of the fishery, and the author's focus on the fishers' development of a 'social movement' further skews the matter. Regardless,

enough information on the institutional arrangement is present to attempt a rough test of the Working Group as co-management.

Below is Table 6, the results of scoring of the variables with information present:

Var.	Score	Notes
1	Weak	DFO established elections process, invited other interests to Working Group
2	Weak	Two principal groups in management process: state, inshore fishermen
3	Medium	Representatives elected by fishers, but DFO invited other representatives
4	Medium	DFO focused on minimum lobster size; fishers focused on trap limits. DFO shifted focus to accept trap limits as primary regulation
5	W/M	DFO must approve plans; DFO later agreed to accept fishers' plan if it met criteria
8	Weak	DFO established the Working Group and its structure
8a	Medium	Working Group established nomination procedure for election of representatives, removed voting privileges for non-elected representatives
9	Medium	DFO commissioned independent study of 4A lobster fishery
11	Medium	Fishers in Working Group developed their own management plan

Table 7: District 4A Working Group

Overall, Kearney's (1989) analysis of the fishery's management is one of dysfunction and limited effectiveness. The management of the fishery was rife with social conflict, and often management initiatives fell apart. The Working Group was established by the government as a response to strong protest and violence in the fishery. However, once established, fishers, with the support of the BWSFA and MFU, were able to exert influence over the management process and strengthen their role in management.

Comparing the 4A Working Group to the conclusions established in the Literature Review reveals additional weaknesses in the co-management arrangement: the 4A Working Group does not have broad representation of social actors and does not extend through all stages of management, although it does come close to the 'partnership' level of public participation (Arnstein 1969).

In conclusion, the 4A Working Group is an example of weak co-management. Although it scores (medium) on several constitutional-level issues, co-management is limited to the planning process, and often the concessions from the government on constitutional-level issues came from political pressure and social disruption rather than from the structure of the co-management arrangement. This case

study highlights the need to better accommodate distinctions between formal and informal decision-making processes, and suggests that operational- and collective-choice level variables may be relatively more important than their choice-level sorting suggests.

3.4.2 Big Creek Ecological Reserve

Pomeroy and Beck's (1999) analysis of the management of the Big Creek Ecological Reserve presents again the difficulty of classifying reality on the ground in fisheries management: the official rules of the Reserve represent co-management at a fairly limited level, but the informal mechanisms and usual and accustomed procedures give fishers a much larger voice in the management process.

Cooperative management started as a "handshake agreement" between the manager of the terrestrial Landels-Hill Big Creek Reserve and the fishers who wanted to access the Big Creek groundfish fishery through sites in the terrestrial reserve. The manager, employed by the University of California, and the fishers agreed that access to the fishery would be dependent on the establishment of a no-take zone adjacent to the terrestrial reserve and fishers' participation in collecting environmental and fishery data.

The creation of the official Big Creek Ecological Reserve followed several years later, and formalized the authority of the terrestrial reserve manager. The reserve manager functions as a go-between for the California Department of Fish and Game (CDFG) and the Big Creek fishers, and the manager's approach to decision-making has allowed a large voice for fishers in the management process. The analysis is focused on the management arrangement after the establishment of the Big Creek Ecological Reserve and summarized in Table 7.

Var.	Score	Notes
1	Medium	Terrestrial reserve manager has legal authority over access to Big Creek. In practice, the manager approaches management collaboratively, allows access to Big Creek dependent on voluntary participation in a preseason research meeting
2	Weak	Participants are fishers, the reserve manager, and CDFG personnel

Var.	Score	Notes
5	Medium	The reserve manager has authority over day-to-day decision-making; CDFG provides broad oversight
7	Medium	Reserve manager proposed no-take zone as a compromise for fishers' access, had 'vision' of marine protected area
8	Medium	Reserve manager is in charge, and is an employee of the UC not CDFG; manager has changed management process in response to fishers' input
8a	Medium	Manager worked with CDFG to amend reserve legislation language to accommodate existing arrangement and drafted a Memorandum of Understanding to specify the roles of CDFG and the reserve manager
9	Medium	Reserve manager and fishers designed Big Sur hook-and-line (HLS) survey, an ongoing research effort. CDFG pursues own data collection, does not always trust or incorporate HLS data
10	Medium	Reserve manager guides the management process, but is open to modification from fishers; fishers' concerns and interests have led to changes in management process, entry and exit procedures, and structure of HLS
11	M/S	Fishers have strong input into management plan; the reserve manager makes amendments to plans in response to fishers' input. However, this process is informal and depends on actions and behavior of reserve manager. Reserve manager has official control of the development of the management plan.
13	Medium	Fishers involved in some implementation activities
14	Medium	Fishers have active role in enforcement and monitoring of access to reserve and participation in the fishery
16	Weak	Fishers and reserve manager lack control over other negative impacts on fishery, including other commercial and recreational fishing and habitat degradation

Table 8: Big Creek Ecological Reserve

The reserve manager plays a key role as a mediator and independent manager; the entire co-management arrangement hinges on the reserve manager as an employee of the University of California rather than as an employee of the state government. As such, the official arrangement is one of co-management between the CDFG and the University of California. In practice, the manager established a co-management arrangement with fishers through informal mechanisms: "the arrangement has been flexible, with mechanisms for dialogue between fishers and the reserve manager and for fishers' continued input in the process of institutional change (p. 733)."

This analysis supports the authors' claim that "the full potential of the experiment on comanagement at Big Creek has yet to be realized (p. 734)." The Big Creek management arrangement is characterized by the limited participation of social actors and a dependence on informal mechanisms.

However, fishers are also involved in many operational-level tasks, and informally have a very high degree of control over management decisions and the management process. Cooperation in research served as the primary mechanism for developing the co-management arrangement, and the reserve manager and fishers were able to influence the development of the formal institutional arrangement to fit the existing co-management agreements. Thus, the Big Creek Ecological Reserve is indeed an example of co-management, albeit an incomplete one.

3.4.3 The Commercial Groundfish Initiative

The management arrangement for the groundfish fishery on Canada's Pacific coast is one of the strongest examples of co-management available in the literature, and the institutional information available in Davis (2008, 2011) is excellent. The Commercial Groundfish Initiative was set up by the Department of Fisheries and Oceans (DFO), and contained two separate committees, the Commercial Groundfish Integrated Advisory Committee (CGIAC) and the Commercial Industry Caucus (CIC): the CGIAC incorporated a wide selection of social actors as participants, while the CIC included only commercial participants.

The presence of two different committees allowed for asymmetric representation and involvement of social actors, letting a broad cross-section of social actors have influence over the process, while resource users were intensively involved in developing management of the fishery. Although the DFO has ultimate authority over the process, and is unlikely to relinquish it, the process itself was very responsive to participants and the ongoing co-management body has extensive control over the fishery's management as summarized in Table 8.

Var.	Score	Notes
1	W/M	DFO invited participants to the Initiative committees; CIC later invited DFO and provincial government to participate
1a	Weak	Lack of organization of fishing interests was a problem in some fisheries
2	Strong	CGIAC included government, labor, aboriginal groups, coastal communities, and recreational and commercial fishers; CIC included only fishers, and later government

Var.	Score	Notes
3	Medium	Some groups felt DFO placed inappropriate restrictions on who could represent groups; confusion and lack of consistency in selection process; perception that DFO tried to manipulate representation
4	Medium	DFO identified 5 guiding principles, but the CIC later expanded on those principles. CGIAC was designed to allow input into overarching objectives, but this did not work very well in practice
5	Medium	Initiative was supposed to produce recommendations for DFO to consider; CIC said the plan produced could not be modified at all, and DFO accepted the plan as-is
6	Strong	Cost-sharing agreement to fund facilitation and meeting space for CIC
7	Weak	DFO held informal scoping meetings, then convened the Initiative
8	Medium	Initiative was supposed to have some input into the design of the process, but many groups were invited too late to meaningfully participate. An independent facilitator also contributed to helping CIC participants design their decision-making rules.
8a	Medium	CGIAC was not able to make meaningful change to process, although the structure was designed to allow it. CIC consensually developed process principles, including bounding of possible outcomes. All CIC participants found the process sufficiently flexible.
9	Weak	DFO provided data and information, and it was difficult for the CIC to access it.
10	Medium	CGIAC wanted more control over topics to be considered; DFO assigned tasks to CIC, but CIC included additional topics
11	Strong	CIC developed the management plan
12	M/S	Initiative lasted 3.5 years; CIC continues to meet and refine agreements
13	Medium	Industry-funded associations share management costs and responsibilities
15 (coll)	Medium	Sector A tried to go outside the process with political lobbying; DFO insisted issues be resolved within the CIC

Table 9: Commercial Groundfish Initiative

The Commercial Groundfish Initiative is a strong example of co-management, with a formal agreement and organization, and a strong degree of control by resource users. The CGIAC element of the Initiative was less successful, with many social actors feeling that they did not have the impact that they should have on the process design and development of management goals. In addition, DFO controlled many initial elements of process, only to have the CIC go beyond their mandate and take additional power for decision-making.

3.4.4 Case Study Comparisons

Although cursory, applying the matrix to the three case studies begins to test the validity of the list of variables, as well as to highlight issues of further study. First, using the matrix to score the case

studies supports the qualitative judgments on the completeness of co-management in each case; in each case, the relative number of variables scored as 'weak', 'medium', or 'strong' coincides with the authors' judgments of the cases as examples of weak, medium, or strong co-management.

Second, if information on a variable were lacking in all the cases studies, it would call into question the relevance and validity of that variable. However, all of the variables in the matrix are represented in at least one case study, as shown in Table 9:

Variable	District 4A	Big Creek	CGI
1	Weak	Medium	Weak/Medium
1a			Weak
2	Weak	Weak	Strong
3	Medium		Medium
4	Medium		Medium
5	Weak/Medium	Medium	Medium
6			Strong
7		Medium	Weak
8	Weak	Medium	Medium
8a	Medium	Medium	Medium
9	Medium	Medium	Weak
10		Medium	Medium
11	Medium	Medium/Strong	Strong
12			Medium/Strong
13		Medium	Medium
14		Medium	
15			Medium
16		Weak	

Table 10: Case study comparison

Third, several other items of note become apparent in the comparison table. The stronger the co-management arrangement, the more information is available in the variables table. This raises the question of whether there is a bias in the matrix and the case study selection that favors case studies with more information on the matrix variables over those with less.

Fourth, variables 2 (scope of representation), 5 (authority to approve the management plan), 8 (initial process rules), and 11 (development of the management plan) all increase in ranking as the co-management arrangement as whole increases. Does that suggest that these four variables are of

particular importance in the strength of a co-management arrangement? However, only seven variables have information available in all three cases, and the number of case studies is low; how relevant would this result be across a more extensive analysis?

A fifth issue is raised by the contra-indicated variables in the Commercial Groundfish Initiative: variables 1 (entry and exit), 1a (support for latent interests), 7 (initiator), and 9 (information generation) are all (weak), despite the strength of the co-management arrangement as a whole. The first three of those weak variables play into the issue of representation and involvement in the initial development of the Initiative, and these issues were highlighted by Davis (2011) as the elements that weakened the co-management arrangement. Interestingly, cooperative research is generally highlighted as an important element of co-management, yet the weak and medium case studies scored higher on that variable than did the strongest example of co-management. Would further testing reveal this variable to be less important than previously hypothesized?

Finally, the informal co-management of the Big Creek Ecological Reserve and the formal co-management of the Commercial Groundfish Initiative, and the two government-initiated arrangements, can be compared. I hypothesized that the variables of selection of representation and control of entry and exit would become relatively more important in a formal arrangement than they would in an informal one, yet neither are rated as (strong) in the CGI. And the District 4A Working Group and the CGI are both government-initiated arrangements, yet they had very different results. Variables 8 (initial process rules) and 11 (development of the management plan) jump into focus as crucial differences between the two, but this needs to be tested further.

These six issues are only some of the elements of co-management that further comparison of cases and statistical analysis would shed light on. The co-management matrix is an important first step in developing a stronger analytical and quantitative understanding of co-management, but much work is

yet to be done. Comparing the case studies, and examining the variables that scored particularly high or low, reveals some focus for future study on the relative importance of variables.

Chapter 4. Future Work

With the development of the list of variables and matrix for analyzing co-management, it is possible to conceive of a definition of complete co-management. Not only does complete co-management have broad representation of social actors and extend through all the stages of management, but it contains all the elements of the 'partnership' level of public participation. All of these stipulations are incorporated within the matrix, and scores of (strong) across the board denote the highest level of co-management possible. Conversely, scores of (weak) across the board reveal when an arrangement is weak co-management or consultation.

The matrix allows for a structured understanding of the strengths and weaknesses of any case study, showing what gaps in management exist and allowing for strengthening them. However, the work yet to be done is to specify and understand the many permutations of incomplete co-management that occur, and to determine an analytically valid method for dividing mid-level co-management into different categories of completeness. Which variables are crucial to functioning co-management, and which would be devalued or partially-weighted in a statistical analysis?

Additionally, many of the variables need further specification. For example, are some implementation, monitoring, and enforcement tasks more important than others in determining co-management? Must particular tasks be shared for co-management to be present? And must co-managers be able to change some particular aspects of the process, even if the whole process is not open to adaptation?

Finally, the matrix must be tested both internationally and on informal arrangements. Do all the variables still apply when studying an informal arrangement? Do some gain more importance than they would in a formal setting? And, though I assert it to be theoretically true, is the matrix truly translatable across legal and cultural barriers, and across different types of resources?

The development of the matrix is a crucial step in advancing the analytic rigor of the study of co-management. It is a foundation for future quantitative analysis and statistical testing, and can serve as the guideline for developing prospective research and testing across case studies. Moreover, when used to analyze case studies, its clarity allows resource users, fishery managers, and other social actors to identify similar cases in order to seek inspiration and information, and to help improve best practices. While work is yet to be done, this matrix is an important foundation and useful analytical development in the study of co-management.

Chapter 5: Appendix A

Author's Note: These are references that informed my thinking about the variables. A particular variable may not be explicitly discussed or evaluated; I may have extrapolated from details of the case study or analysis.

Variable	References
1: Entry and exclusion	Acheson and Brewer 2003; Amend 1989; Arnstein 1969; Berkes 1989a; Berkes 1989b; Berkes et al. 2001; Chuenpagdee and Jentoft 2007; Davis 2008; Davis 2011; Eythorsson 2003; Gibbs and Bromley 1989; Hatchard 2005; Heinz III Center 2000; Hernes, Jentoft, and Mikalsen 2005; Jentoft and McCay 1995; Jordan 1989; Kearney 1989; MacInnes and Davis 1996; McCay 1989a; Mikalsen and Jentoft 2001; Oakerson 1992; Ostrom 1992; Pinkerton 1992; Plummer 2006; C. Pomeroy 2003; C. Pomeroy and Beck 1999; Rice 2005; Rogers and Weber 2010; Ruddle 1989; Sandstrom 2009; Schusler et al. 2003; Sidaway 2005
1a: Support for weak and latent interests	Berkes 2002; Berkes et al. 2001; Bingham 1986; Bown et al. 2013; Chuenpagdee and Jentoft 2007; Gunton and Day 2003; Hanna 2003; Hara and Nielsen 2003; Jentoft and McCay 1995; MacInnes and Davis 1996; MacLeod 1989; Mikalsen and Jentoft 2001; Mow et al. 2007; R. Pomeroy 2003; R. Pomeroy and Berkes 1997; R. Pomeroy, Katon, and Harkes n.d.; Shackleton and Campbell 2001; Susskind and Cruikshank 1987; Timko and Satterfield 2008
2: Scope of representation	Alpizar 2006; Amend 1989; Beierle and Cayford 2002; Berkes 1989; Berkes et al. 2001; Bingham 1986; Blumenthal and Jannink 2000; Borrini-Feyerabend et al. 2004; Coffey 2005; Davis 2011; Eythorsson 2003; Gunton and Day 2003; Hatchard 2005; Hawkins 2005; Heinz III Center 2000; Hernes, Jentoft, and Mikalsen 2005; Hoel, Jentoft, and Mikalsen 1996; Innes and Booher 1999; Jentoft 2000; Jentoft 2003; Jentoft and McCay 1995; Jentoft, Mikalsen, and Hernes 2003; MacLeod 1989; McCay 1989a; McCay 1996; Mikalsen and Jentoft 2001; Nelson and Lien 1996, p. 279-280; R. Pomeroy, Katon, and Harkes n.d.; Sandstrom 2009
3: Selection of representatives	Acheson and Brewer 2003; Amend 1989; Arnstein 1969; Berkes et al. 2001; Bingham 1986; Davis 2008; Davis 2011; Doubleday 1989; Eythorsson 2003; Hoel, Jentoft, and Mikalsen 1996; Hatchard 2005; Heinz III Center 2000; Helliwell 2009; Jentoft and McCay 1995; Jentoft, Mikalsen, and Hernes 2003; Kearney 1989; Knapman 2005; McCay 1996; Mikalsen and Jentoft 2001; Ostrom 1990; C. Pomeroy 2003; R. Pomeroy and Berkes 1997; Rice 2005; Ruddle 1989; Schusler et al. 2003; Sidaway 2005; Symes 2005; Verheij, Makoloweka, and Kalombo 2004; Wilson 2003b

Variable	References
4: Defining management goals	Allen et al. 2011; Berkes et al. 2001; Bingham 1986; Borrini-Feyerabend et al. 2004; Chuenpagde and Jentoft 2007; Dale 1989; Davis 2011; Ebbin 2011; Espinosa-Romero et al. 2011; Eythorsson 2003; Garcia 1996; Grafton and Kompas 2005; Hara and Nielsen 2003; Innes and Booher 1999; Mow et al. 2007; Noble 2000; Ostrom 1990; Ostrom 1992; Pinkerton 1989; Pinkerton and Weinstein 1995; Plummer 2006; C. Pomeroy 2003; R. Pomeroy, Katon, and Harkes n.d.; Richardson and Green 1989; Rogers and Weber 2010; Sidaway 2005; Tietenberg 2002; Wilson 2002; Wilson 2003a
5: Authority to approve management plans	Acheson and Brewer 2003; Amend 1989; Arnstein 1969; Beierle and Cayford 2002; Berkes 1989; Berkes 2002; Bingham 1986; Blumenthal and Jannink 2000; Borrini-Feyerabend et al. 2004; Buck 1989; Doubleday 1989; Eythorsson 2003; Freeman 1989; Hall-Arber 2005; Jentoft 1989; Hoel, Jentoft, and Mikalsen 1996; Loucks, Wilson, and Ginter 2003; McCay 1989a; McCay 1996; McKean 1992; Nielsen 1996; Oakerson 1992; Olsson, Folke, and Berkes 2004; Ostrom 1990; Pinkerton 1987; Pinkerton and Weinstein 1995; R. Pomeroy and Berkes 1997; Sandstrom 2009; Sen and Nielsen 1996; Shackleton and Campbell 2001; Wilson et al. 2006
6: Financial Control of Decision-Making Process	Amend 1989; Beesley and Fiori Summer 2008; Bingham 1986; Blomquist, Dinar, and Kemper 2010; Blumenthal and Jannink 2000; Davis 2008; Langdon 1989; McCay 1989a; R. Pomeroy, Katon, and Harkes n.d.; Shackleton and Campbell 2001; Sidaway 2005; Susskind and Cruikshank 1987; Wondolleck and Yaffee 2000
7: Initiator of the process	Beesley June 2010; Beierle and Cayford 2002; Chuenpagdee and Jentoft 2007; Cruz 1989; Freeman 1989; Hara and Nielsen 2003; Kearney 1989; Kitts, da Silva, and Rountree 2007; Langdon 1989; McCay 1989a; Morrell 1989; Mow et al. 2007; Olsson, Folke, and Berkes 2004; Pinkerton 1987; Pinkerton 1999; C. Pomeroy 1999; C. Pomeroy and Beck 1999; Richardson and Green 1989; Rogers and Weber 2010; SDWA 2008; Sidaway 2005; Vodden, Ommer and Schneider 2005; Wondolleck and Yaffee 2000
8: Initial process rules	Acheson and Brewer 2003; Amend 1989; Beesley and Fiori Summer 2008; Beierle and Cayford 2002; Berkes et al. 2001; Davis 2008; Davis 2011; Doubleday 1989; Gelcich et al. 2009; Gunton and Day 2003; Hara and Nielsen 2003; Hoel, Jentoft and Mikalsen 1996; Innes and Booher 1999; Kearney 1989; McCay 1989a; Morrell 1989; Mow et al. 2007; Ostrom 1990; Plummer 2006; C. Pomeroy and Beck 1999; Sidaway 2005; Susskind and Cruikshank 1987; van Ginkel 2005; Wondolleck and Yaffee 2000
8a: Ability to change the process (**)	Amend 1989; Arnstein 1969; Berkes 1989; Blomquist, Dinar, and Kemper 2010; Davis 2008; Davis 2011; Dolsak and Ostrom 2003; Gelcich et al. 2009; Gunton and Day 2003; Innes and Booher 1999; Jordan 1989; Ostrom 1992; Pinkerton and Weinstein 1995; Plummer 2006; C. Pomeroy and Beck 1999; R. Pomeroy, Katon, and Harkes n.d.; Sandstrom 2009; Stern et al. 2002; van Ginkel 2005

Variable	References
9: Information generation	Beesley and Fiori 2008; Basurto and Ostrom 2009; Berkes et al. 2001; Blomquist, Dinar, and Kemper 2010; Buck 1989; Busiahn 1989; Cohen 1989; Cronin and Ostergren 2007; Cronin and Ostergren Winter 2007; da Silva and Kitts 2006; Dale 1989; Degnbol 2003; Ebbin 2002; Ebbin 2009; Farrell and Granger Morgan 2003; Freeman 1989; Gelcich et al. 2009; Hanna 2003; Jentoft 2003; Langdon 1989; McCay 1996; Murray, Bavington, and Neis 2005; Ostrom 1990; Ostrom 1992; Pinkerton 1989; Pinkerton 1999; Pinkerton 2003; C. Pomeroy 1999; R. Pomeroy and Berkes 1997; C. Pomeroy and Beck 1999; Regier et al.. 1989; Rogers and Weber 2010; Schumann 2010; SDWA 2008; Stercho 2006; Tietenberg 2002; Vodden, Ommer, and Schneider 2005; Wilson 2002; Wilson 2003c
10: Control of the agenda (**)	Arnstein 1969; Dolsak and Ostrom 2003; Freeman 1989; Kearney 1989; MacInnes and Davis 1996; McCay 1996; Morrell 1989; Pinkerton 2003; Plummer 2006; Shackleton and Campbell 2001; Sidaway 2005
11: Developing management plan options	Amend 1989; Arnstein 1969; Bardhan and Dayton-Johnson 2002; Busiahn 1989; Cohen 1989; da Silva and Kitts 2006; Dale 1989; Davis 2008; Freeman 1989; Gunton and Day 2003; Hall-Arber 2005; Jentoft 1989; Kearney 1989; Loucks, Wilson, and Ginter 2003; McKean 1992; Mow et al. 2007; Ostrom 1990; Pinkerton 1989; Pinkerton 2003; Ruddle 1989; Sidaway 2005
12: Ongoing co-management body (**)	Alpizar 2006; Amend 1989; Arstein 1969; Beesley June 2010; Begossi and Brown 2003; Berkes 1989; Berkes et al. 2001; Borrini-Feyerabend et al. 2004; Cohen 1989; Dale 1989; Davis 2008; Doubleday 1989; Ebbin 2009; Jentoft 1989; Jordan 1989; Kearney 1989; Ostrom 1990; Pinkerton 1999; R. Pomeroy, Katon, and Harkes n.d.; Rogers and Weber 2010; Ruddle 1989; Vodden, Ommer and Schneider 2005; Wondolleck and Yaffee 2000; Sandstrom 2009; SDWA 2008
13: Involvement in implementation tasks	Alegret 1996; Basurto and Ostrom 2009; Beesley June 2010; Doubleday 1989; Hanna 1996; Jentoft 1989; McCay 1989a; McCay 1996; Ostrom 1990; Pinkerton 1994; Pinkerton 2003; Pinkerton and Weinstein 1995; Rogers and Weber 2010; Sen and Nielsen 1996
14: Involvement in M&E tasks	Agrawal 2002; Alegret 1996; Basurto and Ostrom 2009; Beesley June 2010; Berkes et al. 2001; Blomquist, Dinar, and Kemper 2010; Borrini-Feyerabend et al. 2004; Busiahn 1989; Cox et al. 2010; da Silva and Kitts 2006; Dolsak and Ostrom 2003; Farrell and Granger Morgan 2003; Fernandez-Gimenez et al. 2008; Hanna 1996; Jentoft 1989; Kitts, da Silva, and Rountree 2007; Langdon 1989; McCay 1996; McKean 1992; Olsson, Folke, and Berkes 2004; Ostrom 1990; Ostrom 1992; Pinkerton 1989; Pinkerton 1994; Pinkerton 2003; C. Pomeroy 1999; C. Pomeroy 2003; Rettig, Berkes, and Pinkerton 1989; Rogers and Weber 2010; SDWA 2008; Sidaway 2005; Stern et al. 2002; Verheij, Makoloweka, and Kalombo 2004

Variable	References
15: Internal dispute resolution process (**)	Agrawal 2002; Berkes et al. 2001; Borrini-Feyerabend et al. 2004; Blumenthal and Jannink 2000; Blomquist, Dinar, and Kemper 2010; Cox et al. 2010; Cruz 1989; Dale 1989; Eythorsson 2003; Gibbs and Bromley 1989; Hanna 2003; Jentoft 2003; Loucks, Wilson, and Ginter 2003; Metzner, Harte, and Leadbitter 2003; Oakerson 1992; Ostrom 1990; Ostrom 1992; Pinkerton 1992; R. Pomeroy, Katon, and Harkes n.d.; Ruddle 1989; Sandstrom 2009; Short 1989; Stern et al. 2002
16: Involvement in external negotiations	Berkes 2002; Berkes et al. 2001; Cohen 1989; Dale 1989; Doubleday 1989; Freeman 1989; Pinkerton 1989; Pinkerton 1992; Pinkerton 1994; Pinkerton 2003; Ruddle 1989; Stern et al. 2002; Wigen 1989

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