

Adaptive Management and the Missouri River Recovery Program: Attributes of Effective Governance for AM

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Summary and key findings

This discussion paper presents a summary of first principles and key attributes related to effective governance in the context of Adaptive Management (AM). It draws upon lessons learned from other AM programs, primarily in North America. The intent is to organize this experience to provide insight and stimulate discussion for those working on the collaborative development of an effective system of governance for AM in the Missouri River Recover Program (MRRP). This document is not meant to be prescriptive about what type of governance should be established.

Although several definitions of governance are available, a broadly held view is that it includes a consideration of authority, decision-making, and accountability. The concept of “adaptive governance” has recently emerged in the context of AM which adds a consideration of the need for organizational and institutional flexibility to cope with uncertainty and change.

While AM has been applied for several decades, implementation has not been easy. Obstacles include concerns that implementing and rigorously evaluating management actions different from the status quo may be too costly, too risky, and/or contrary to values of some stakeholders, as well as perceptions that a shift to AM threatens existing management, research and monitoring programs. Effective governance can help to address some of these obstacles by openly addressing differences in value preferences and beliefs about causation, which tend to be at the root of disagreements that inhibit progress on AM.

Effective governance and organizational networks provide a common set of functions. These functions include: (1) trust-building, (2) knowledge generation, (3) collaborative learning, (4) preference formation, and (5) conflict resolution. A typology of systems of adaptive governance identifies four types based on their ability to explore (e.g., variation, risk taking, experimentation, flexibility, innovation) and exploit (e.g., refinement, choice, production, efficiency, selection, implementation, execution). Governance systems that execute well, yet have a limited ability to learn are considered rigid, while systems that are highly exploratory and weaker on execution are labelled flexible. A governance system that does not execute well and lacks innovation is considered fragile. A robust governance system, which is able to both execute well and innovate, and is the preferred domain for AM programs. Formal networks (transparent network of actors participating openly in a defined governance process) can have positive influences on the roles, functions, effectiveness and outcomes of a governance system. Informal networks (shadow network of actors working outside the established process) may have positive effects, but can also undermine the progress made in formal networks.

There is no “one-size fits all” approach to effective governance since success is dependent on the specific context in which it is being applied. Various researchers have sought to identify the factors that enable or inhibit successful AM with the intent of knowing better how to create the ideal conditions for effective governance. These factors can be grouped into three categories, which include:

Attitude/philosophy

- Problem context
- Trust and commitment
- Mindset (around uncertainty, risk, and AM)

Process

- Problem definition
- Executive direction/support
- Leadership and vision
- Integration of AM into management
- Planning
- Communication & organizational structure
- Community involvement
- Facilitation, bridging, and team building
- Knowledge generation and flow (science and local)
- Knowledge interpretation and sense-making

Resources

- Funding/management resources
- Training
- Capacity
- Legislation

It's informative to contrast the nature of these factors within organizations that fail to learn and adapt, versus organizations that are able to learn and adapt (Table 3). Examining this table can help to diagnose the strengths and weaknesses of an existing governance system (i.e., what to keep, what to improve).

These enabling factors can also be divided into three sequential and mutually supportive subsets. Sequencing is important because one factor may be a necessary precursor for enabling the success of others. For instance, understanding the problem context and establishing trust has been identified as essential for setting the foundation for what a governance system must address. This means that a governance system will require mechanisms of conflict resolution and trust building as important precursors. Attributes related to leadership, executive direction, problem definition, communication, and organizational structure have been identified as the next most critical elements to establish. If done well, many of the remaining attributes will follow.

A key component of governance is establishing a successful organizational structure. A review of the executive authority, organizational structure, and activities of four large scale AM programs provides useful insights, in particular:

- Each program has a clear executive authority for AM with a statutory decision maker holding responsibility for this executive authority and that person is informed by other levels of governance;
- Governance structures are organized to deal with policy, management, and technical levels of interaction and decision making and each program has a unique structure at these levels though more senior levels of governance tend to be smaller in size;
- Processes to generate technical information are separated from processes to explore preferences and make decisions; and
- The synthesis of scientific information to inform decision making tends to be completed independently by technical organizations/agencies, though a coordinating group can facilitate synthesis of science; all programs involve some form of independent review;

This paper closes with a summary of some of the challenges to the MRRP in developing the above attributes of effective governance for AM, and examples of strategies which could be applied to overcoming these challenges (see pages 13-15, Table 5). The intent of this summary of challenges and opportunities is to stimulate conversations, ideas, and solutions in a way that supports the collaborative development of an effective system of governance for AM in the Missouri River.

Adaptive Management and the Missouri River Recovery Program: Attributes of Effective Governance for AM

The purpose of this discussion paper is to present a summary of first principles and key attributes related to effective governance in the context of Adaptive Management (AM). This summary draws upon the experience from others applying AM elsewhere around the world. The intent is to organize this experience into a form that provides insight for those participating in the collaborative development of an effective system of governance for Adaptive Management of the Missouri River Recover Program (MRRP). The intent is not to be prescriptive about what type of governance should be in place for the MRRP, but rather to provide an empirical foundation for evaluating the effectiveness of different systems of governance that may be proposed and considered. As an input to the ongoing discussion on governance, this paper would not logically be a part of the MRRP AM Plan, but could be referenced by the chapter of the AM Plan which describes the proposed system of governance (*currently Chapter 2*).

Defining governance¹

The concept of governance as applied to the management of common pool resources largely emerged in the 1990s (Ostrom 1990). Although several definitions describe governance as the structure and processes of decision making and sharing power (Jessop 1998), there is a slightly broader view that involves three dimensions: authority, decision-making, and accountability – “*who has power, who makes decisions, how other players make their voice heard and how account is rendered*”². More recently the term “*adaptive governance*” has emerged in the context of AM, which has added a consideration of the need for organizational and institutional flexibility to cope with uncertainty and change (Folke et al. 2005). Some authors have claimed that AM requires adaptive governance to be successful (Gunderson and Light 2006).

The need for effective governance

Although AM has been applied for several decades, implementation has not been easy. Obstacles to successful implementation exist in technical, scientific, institutional, and governance domains (Walters 1997; 2007; Gunderson 2015). Of relevance here are obstacles that can be related to systems of governance. Examples include concerns by some stakeholders that implementing and evaluating management actions different from the status quo may be too costly, too risky or contrary to their values, while other stakeholders may see alternative actions and associated effectiveness evaluations as a threat to existing management, research and monitoring programs (Walters 1997). These obstacles are not surprising given the nature of complex ecological policy problems, which generally involve tradeoffs among values, between short and long term consequences, and across spatial scales (local vs. regional vs. national) (Lackey 2006). Addressing differences in value preferences and beliefs about causation are two different dimensions of problem solving, as illustrated in Table 1. Structured decision making and conflict resolution can help to find a ‘fair’ way forward despite differences in values among stakeholders, while AM helps to reduce critical uncertainties in determining the most effective way to achieve agreed upon objectives. Effective governance can help to increase the chances of successful collective action, which is a major challenge across many sectors of society (Ostrom 1998).

The role of governance in AM

It is generally acknowledged that there is no “one-size fits all” approach to effective governance. The design of a governance system depends on its intended purpose and having a clear purpose, scope, and/or expectations around outcomes can enable effective governance (Rijke et al. 2012). Analyses of the role of effective governance/organizational networks to support AM have noted that successful examples tend to serve the following roles/functions: (1) trust-building, (2) knowledge generation, (3) collaborative learning, (4) preference

¹ We note that Version 3 of the MRRP Adaptive Management Plan defines governance as: “*the process of negotiation, coordination and collaboration between agencies, private actors, non-governmental organizations (NGOs), etc. to achieve the joint realization and implementation of a plan addressing an environmental problem (Jessop 1998)....the term governance is used to describe both the organizational structure (e.g., team roles and responsibilities, decision making structure, and communication with MRRIC and its sub-groups) and the process by which the agencies (i.e., Corps and USFWS) will coordinate and collaborate with MRRIC, ISAP, and ISETR when implementing the AM Plan.*”

² Institute on Governance. Defining governance: <http://iog.ca/defining-governance/>

formation, and (5) conflict resolution (Green et al. 2015). All of these roles/functions are relevant to governance of the Missouri River Recovery Program and are important to consider since the design and stated purpose of the organizational structure and processes within a governance system will have a direct bearing on its effectiveness in serving these individual needs.

Table 1. Decision making under varying conditions of agreement, and two strategies of intervention (modified from Lee 1993, who in turn modified this from Thompson and Tuden 1959). Lee (1993) describes how one reduces disputes about causation (i.e. moving from box 4 to box 3, or from box 2 to box 1) through settling, and that one reduces disputes over preferences (i.e. moving from box 4 to box 2, or from box 3 to box 1) through consensus building.

		Preferences about outcomes	
		Agree	Disagree
Beliefs about causation	Agree	1. Computation in bureaucratic structure	3. Bargaining in representative structure
	Disagree	2. Judgment in collegial structure <i>(the AM zone)</i>	4. Conflict

Duit and Galaz (2008) provide a useful typology for describing four types of governance for complex adaptive systems based on their dominant roles/functions (see Figure 1); specifically their ability to engage in activities related to exploration (e.g., variation, risk taking, experimentation, flexibility, innovation) and exploitation (e.g., refinement, choice, production, efficiency, selection, implementation, execution). Both sets of activities are necessary for AM, yet governance systems tend to have varying degrees to which they are able to act in each of these domains. Governance systems that are able to execute well, yet have a limited ability to learn are considered *rigid* (upper left quadrant of Figure 1), while systems that are highly exploratory and weaker on execution are labelled *flexible* (lower right quadrant). A governance system that does not execute well and lacks innovation is designated as *fragile* (lower left corner). A *robust* governance system (upper right corner), is able to both execute well and innovate, and is the preferred domain for AM programs. Authors reviewing governance systems refer to both formal networks (transparent network of actors participating openly in a defined governance process) and informal networks (shadow network of actors working outside the established process). Formal and informal networks can have both positive and negative influences on the roles, functions, effectiveness and outcomes of a governance system (Oh et al. 2004; Tsai 2006).

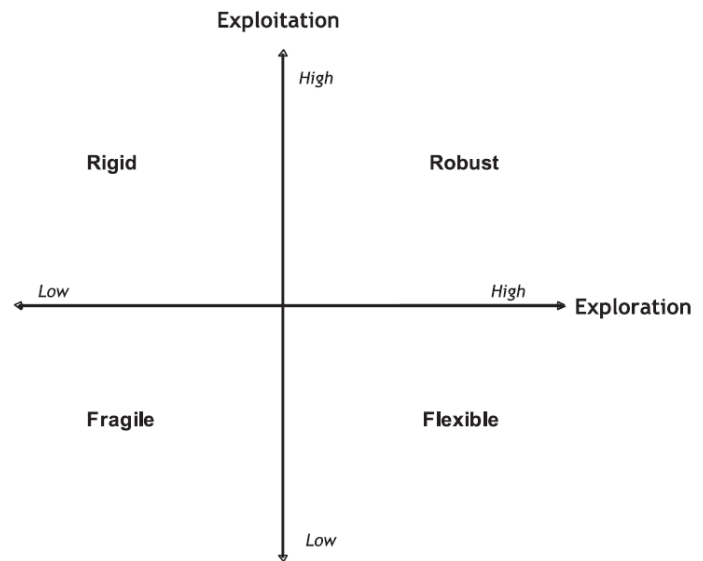


Figure 1. Four types of governance based on the level of engagement around activities of exploitation and exploration (from Duit and Galaz 2008).

One risk of informal networks is that some actors may engage outside of the formal governance network to influence the decision making process or power structure in hidden ways which can undermine trust-building, knowledge generation, and/or collaborative learning of the formal network.

Attributes of effective governance for AM

Although the attributes of effective governance will vary depending on the specific context of a situation, there has been a common desire among researchers to identify the factors that enable or inhibit successful AM with the intent of knowing better how to create the ideal conditions for effective governance (Alverts et al. 2001; Olsson et al. 2004; 2006; Stankey et al. 2005; Walters 1997; 2007; Greig et al. 2013; Childs et al. 2013; Loftkin

2014; Burns et al. 2015). Due to the variation in situations and approaches for evaluating success, comparisons across case studies are difficult. However, as noted by Greig et al. (2013), these types of studies can reveal a range of cross-cutting and unique factors, which can be grouped into three fundamental categories: attitude/philosophy, process, and resources. Table 2 summarizes factors identified by the above-cited authors as influencing the effectiveness of governance and/or success of AM programs. A summary of these factors (building on Greig et al. 2013) is as follows:

Factors related to attitude/philosophy

- Problem context: Context can cause AM to develop in very different ways. Its proper consideration will help ensure that AM is applied in the appropriate historic and local context including factors and institutional drivers motivating the need and relationships among individuals/organizations involved.
- Trust and commitment: Trust and commitment relate to the strength of the relationships among individuals/organizations, and affects their ability to participate, interact, and engage in the AM process.
- Mindset (around uncertainty, risk, and AM): There can be aversions to acknowledging or dealing with uncertainties in decision making which relate to the risk tolerance of stakeholders and willingness of decision makers to invest in management actions that may be seen as surprises. Embracing uncertainty and learning from mistakes can enable success.

Factors related to process

- Problem definition: Ensures there is agreement among parties and focus on the correct problem, which includes how the problem is expressed. Problem definition needs to be durable and capture the larger context otherwise the focus can be lost or lead to crisis management.
- Executive direction/support: A clear and strong commitment from executives is required, backed up by regulatory authority to do AM, to ensure success.
- Leadership and vision: Leadership is essential, but not sufficient for success. This attribute involves effective communication to gain broad support regardless of the level at which leadership is rooted; though local level leadership may be important in some cases where top down leadership will not work.
- Planning: AM actions are inevitably implemented within existing planning processes. The dominant planning paradigm can affect inhibit success, if they are too restrictive, or enable it if they are sufficiently flexible.
- Communication and organizational structure: Effective, broad-based and two way communication is necessary within and outside the organizational structure governing AM. This attribute includes a consideration of the choice of language, world view being represented, and venues for communication. There is also a need to maintain flexibility in organizational structure to respond to unexpected events.
- Community involvement: The need for community involvement depends on context, which affect the decision about whether to involve the community, who to involve, and how to do it. For public/shared resources, a participatory approach that involves varied stakeholders in knowledge generation, deliberation, and decision making can enable success. The most effective AM programs have a small number of stakeholders who trust each other and can make decisions in an agile manner.
- Facilitation, bridging, and team building: To enable trust and learning, it is important that those individuals involved are supported through neutral facilitation, team building, and a bridging organization that seeks to bring disparate interests together to explore preferences, interpret information, and make decisions.
- Knowledge generation and flow (science and local): Decision making and participation should be based on a strong foundation of rigorous science in the formulation and evaluation of management actions, that can also include local and/or traditional knowledge. Knowledge should flow through the governance network in a transparent way which can be important for building mutual trust.
- Knowledge interpretation and sense-making: It is important to have a transparent and inclusive process for interpreting the information generated through AM, translating the science into a form that facilitates decision making.
- Integration of AM: It is important that the administrative/logistical aspects of AM are embedded into existing management structures and processes rather than in their own isolated institutional structure. People working within institutions should be rewarded for activities that advance AM.

Table 2. An overview of studies and summary of factors that influence effective governance and Adaptive Management.

Enabling/inhibiting factors	Source						
	Alverts et al. 2001 ¹	Olsson et al. 2004; 2006 ²	Walters 1997; 2007 ³	Greig et al. 2013 ⁴	Childs et al. 2013 ⁵	Loftkin 2014 ⁶	Burns et al. 2015 ⁷
Attitude/philosophy							
Problem context	X			X		X	
Trust and commitment		X			X		X
Mindset (around uncertainty, risk, and AM)			X			X	
Process							
Problem definition	X			X		X	
Executive direction/support				X			
Leadership and vision	X	X	X	X	X		
Planning	X			X			
Communication and organizational structure	X			X			X
Community involvement	X	X		X			
Facilitation, bridging, and team building					X		
Knowledge generation and flow (science and local)	X	X	X	X			
Knowledge interpretation and sense-making		X					
Integration of AM						X	X
Resources							
Funding/management resources	X	X	X	X		X	
Training	X			X			
Capacity		X					
Legislation		X					

Notes on the empirical basis for the above studies:

- 1 – Survey of >80 workshop participants involved in AM and salmon restoration across the Pacific Northwest.
- 2 – Comparison of governance systems and outcomes from 6 case studies in US, Canada, Sweden, Thailand, and Australia.
- 3 – Examination of >100 case studies attempting to apply AM related to various fisheries management problems.
- 4 – Nonrandom survey of 21 public and private AM projects in the forest sector across the US.
- 5 – Analysis of qualitative data related to governance from participants involved in a single case study in Arizona.
- 6 – Author’s views based on experience in applying AM to large-scale water resources and ecosystem restoration programs over 25 years in US.
- 7 – Lessons learned from interviews of people involved in 9 AM programs across US.

Factors related to resources

- Funding/management resources: AM requires sufficient funding and management resources to be successful. Level of funding can be an indicator of the presence, or lack, of executive support.
- Training: In some cases there may be a need for staff/those involved to receive AM training to learn new skills that facilitate successful implementation. Key areas include training around basic concepts of AM, details of the AM program, and the knowledge gained to inform future actions/decisions.
- Capacity: Implementation of AM requires sufficient capacity across all entities involved. Governance structures should be realistic in reflecting the available and projected capacity of participating entities.
- Legislation: A strong legislative driver is an important enabling condition to initiate and sustain AM.

As illustrated in Table 3, the above factors can be either enabling or inhibiting to AM, depending on their attributes within participating organizations. Table 3 can serve as a useful diagnostic tool for evaluating both existing and proposed governance structures in the Missouri AM program. We build on this idea further at the end of this paper where we return to the situation in the Missouri.

Table 3. Characteristics of organizations that do, and do not, learn and adapt. Source: Murray and Marmorek (2001).

Characteristics of organizations that fail to learn and adapt	Characteristics / principles of organizations that successfully learn and adapt
Historical Context	
H1. Management done the same way for a very long period of time, creating inertia	H1. Frequent re-examination of management (actions, products, delivery mechanisms) prevents institutional inertia from being established.
Funding Setting	
F1. Entities providing funding (e.g. legislature) do not want to see \$ spent on experimental management. Funders expect positive results in return for \$ invested, and consider evidence that some management actions didn't work as 'surprises', waste of \$.	F1. Funders recognize uncertainty and are involved in designing intelligent management experiments with 'safe fail' outcomes. Funders buy into learning approach and agree to a contract regarding experimentation so that surprises aren't judged as failures.
F2. Insufficient human resources and funding to carry out AM experiments.	F2. Sufficient human resources and finances provided to carry out AM experiments.
F3. Policy makers want scientists to provide answers without having to do AM experiments that acknowledge ignorance, and may be risky.	F3. High-level political support provided for AM experiments. Uncertainty accepted publicly.
Leadership	
L1. Leaders resist change, discourage risk taking and innovation, and repeat past actions. Create organizational culture in which staff are expected to do the same.	L1. Leaders deliberately challenge themselves to recognize change, innovatively adapt to current challenges and take calculated risks. Create organizational culture in which staff are expected to do the same.
L2. Staff who show existing actions aren't working are criticized, and evidence suppressed.	L2. Staff rewarded for generating information that demonstrates existing actions aren't working. Celebrate surprises and learning.
L3. Leaders cautious and defensive to public;	L3. Leaders are self-confident, willing to explain or defend AM approaches.
L4. Leaders treat unexpected events as aberrant outcomes that don't negate traditional approaches.	L4. Leaders treat unexpected events as catalysts to rethink approaches.
L5. Leadership frequently changing, lack of continuity.	L5. Leadership maintained for longer periods.
L6. Inconsistent political leadership, and wavering support.	L6. Consistent political support.
Definition of Problems and Potential Management Actions	
D1. See problems as linear and break them down into small pieces. Focus on details of the parts over short time horizons and restricted spatial scales.	D1. See both ecosystems and institutions as non-linear systems that respond dynamically to disturbances. Focus on dynamics of the whole system over long time horizons and large spatial scales.
D2. Rely on engineering technology not designed for dynamic ecological systems.	D2. Rely on management actions that emulate natural disturbances, rather than technological fixes.

Characteristics of organizations that fail to learn and adapt	Characteristics / principles of organizations that successfully learn and adapt
Community Involvement Processes	
C1. Institutions isolated from public, or very limited consultation at random intervals. Frequent court cases, advocacy, arbitration.	C1. Collaborative inputs to decision making over sustained period, generating buy-in and trust, allowing stakeholders to move from positions to interests, clarifying areas of agreement and disagreement.
C2. Agency decides what actions should be implemented at local level. Monitoring done by agency if funds available.	C2. Explain goals, and then delegate to local level (e.g. watershed) the task of working out how to achieve them, encouraging experimentation within a framework of consistent monitoring and guidance.
C3. Staff science and data predominant.	C3. Citizen science, traditional knowledge incorporated into decision making.
Planning	
P1. Plan based on past experience, practices, procedures established by senior staff.	P1. Recognize critical uncertainties and plan experiments to test alternative hypotheses / actions.
P2. Collected information stored, but most not analyzed due to lack of incentives and resources to take a critical look at outcomes of actions.	P2. Use information to produce cognitive change in formulation of issues, maintaining critical reflection over policy-relevant time frames (e.g. > 10 years)
Organizational Structure and Communications	
O1. Poor internal communication between departments with different mandates, between disciplinary specialists. Difficult to access required information. ‘File merge’ approach to synthesis.	O1. Collaborative, interdisciplinary working environment with free-flowing communication and easy access to well-synthesized information. Focus on interdisciplinary problem solving, exploration of cumulative effects and dynamics.
O2. Focus on management and emergency response rather than learning.	O2. Use management teams to help create time, resources, opportunities for learning teams, whose main job is learning.
O3. No institutional memory.	O3. Institutional memory is important.
O4. Hidden decision processes.	O4. Clarity of decision processes.
Training of Staff	
T1. Staff not trained to accept change, to deal with surprises or to focus on learning.	T1. Staff trained to embrace change, to focus on learning.
T2. Staff not trained to design and implement AM.	T2. Staff well trained to design and implement AM.
How Science and AM is Conducted	
S1. Advocacy science to support agency’s position (selective evidence). Data kept internal; insist on single, dogmatic agency position regarding data analysis.	S1. Stress on high quality science at appropriate scale, with independent review panels. Data made available; different interpretations of data welcomed, used to postulate alternative hypotheses and design management experiments. Wide publishing of scientific findings.
S2. Agency scientists do work largely independently from public and other institutions.	S2. Agency scientists interact in ‘learning teams’ and/or ‘transboundary issue networks’ with scientists from NGOs, academia and stakeholder groups (incorporating traditional knowledge). Involvement in data collection encouraged to build confidence and trust.
S3. Goals of AM experiments not well defined or linked to decisions; alternative hypotheses not defined for key uncertainties; experimental design at wrong spatial/temporal scale or inadequate to provide required insights; and/or poor documentation.	S3. Clearly defined, measurable goals of AM experiments, linked to decisions; alternative hypotheses defined for key uncertainties; experiments designed at appropriate spatial/temporal scale; thorough documentation; results fed back into revised decisions.
S4. Avoid/ignore cumulative effects due to difficulties of drawing scientifically defensible conclusions.	S4. Consider cumulative outcomes even if scientifically defensible conclusions not possible.

The AM practitioners who contributed to the work by Marmorek et al. 2006 (later summarized by Greig et al. 2013) concluded that enabling factors can be divided into three sequential and mutually supportive subsets (Figure 2). Sequencing is important because one factor may be a necessary precursor of other factors for the overall AM effort to succeed. The yellow box (Problem Context/Trust) sets the foundation for what the AM governance system must address. To enable trust, a governance system will require mechanisms of conflict resolution and trust building as precursors to collaborative decision making and adaptive management. Factors in the green box were seen as the five most critical elements to establish in any governance structure for AM; if done well, the factors in the pink box will follow. Factors related to attitude/ philosophy and process were generally more important precursors than factors related to resources. As well, the 3 factors in blue in Figure 2 (executive direction, community involvement, AM science) best distinguished between AM projects which succeeded (made it around the AM loop) versus those which did not.

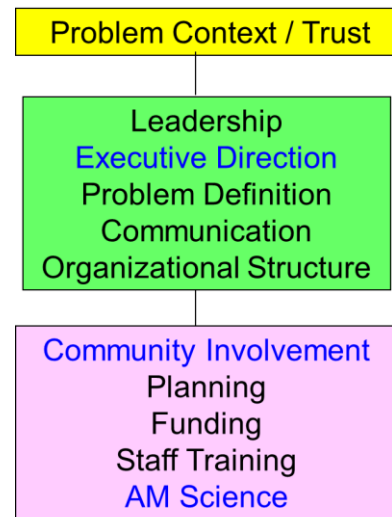


Figure 2. Institutional factors which enable adaptive management (Marmorek et al. 2006; Greig et al. 2013).

Examples of organizational structure for AM

A key component of governance is establishing a successful organizational structure/network for those that will be involved and clear roles/responsibilities within that structure. Table 4 and Figure 3 summarize the executive authority, organizational structure, and activities of four large scale AM programs. Some general observations of these programs include:

- Each program has a clear executive authority for AM; statutory decision making tends to rest with the individual holding responsibility for this executive authority and that person is informed of the decisions of other levels of governance;
- Each program has a unique structure for policy, management, and technical levels of governance;
- Governance at the policy level (involving decisions related to AM program) involves either a more narrow oversight team/committee or a group with more diverse perspectives, generally requiring consensus or a strong majority of support of the group to pass a motion;
- Governance at the management level (involving decisions related to management actions) tends to involve a broad base of stakeholder perspectives;
- Governance at the technical level (involving decisions related to knowledge generation) leads to the generation of technical information across various technical working groups (by subject or domain);
- All programs involve some form of independent science review;
- Stakeholder input is consistently provided at the management level, and in some cases provided at the policy level, though the number of stakeholders involved is much less than the membership of MRRIC;
- Processes to generate technical information are separated from processes to explore preferences and make decisions; and
- The synthesis of scientific information to inform decision making tends to be completed independently by technical organizations/agencies, though a coordinating group can facilitate synthesis of science across diverse entities.

Table 4. An overview of the governance structure of other large scale Adaptive Management programs.

Attribute	U.S. Columbia Basin Fish and Wildlife Program	Trinity River Restoration Program	Glen Canyon Dam Adaptive Management Program	Platte River Recovery Implementation Program
Executive Authority for AM	Fish and Wildlife Program of the Northwest Power and Conservation Council (NPCC)	Record of Decision of the U.S. Department of Interior (DOI; 2000)	EIS for operation of the Glen Canyon Program (1995), Biological Opinion (1996), DOI Record of Decision (1997)	Settlement Agreement and Adaptive Management Program (2007)
Program Structure	No figure available	Figure 3A	Figure 3B	Figure 3C
Program Development	NPCC Fish and Wildlife Program, amended at least every 5 years; needs to be approved by Council. NPCC staff develop fish and wildlife program based on stakeholder input and ISAB input.	Guiding docs are the Flow Evaluation Study (1999), ROD (2000), Integrated Assessment Plan (2009), Annual Investigation Plans. AEAM team (and associated working groups) recommend programs to Trinity Management Council.	GCMRC develops strategic research plan, monitoring and research plan, science plan; passed to technical working groups and science advisors for review; then to AMWG, and on to DOI for final approval	Executive Directors Office (Headwaters, Inc. a 12-person consulting firm) develops draft program together with Technical Advisory Committees (TACs); program then reviewed and approved by Governance Committee
Policy Committee & Decision Process	8 reps on Council, 2 from each of OR, WA, ID, MT; political appointees. Seek consensus but then make decisions by majority vote (5/8), super majority required for changes to fish and wildlife program (6/8, one from each state).	Trinity Management Council (TMC). Seek near consensus (all but one member is sufficient to pass a motion)	Adaptive Management Work Group (AMWG) – follows FACA (Federal Advisory Committee Act), meets at least twice per year	Governance Committee – 12 members (CO, WY, NE, Bureau of Reclamation, Fish and Wildlife Service, S.Platte River water users, N.Platte River water users, NE water users, and environmental groups); 10 votes; by consensus
Stakeholder participation	Sub-basin planning processes (62 sub-basins); other ad hoc processes	Trinity Adaptive Management Working Group (TAMWG) – reviews plans from technical workgroups and makes recommendations to TMC	Adaptive Management Work Group (AMWG) – stakeholder and policy group are the same group	On Governance Committee and on TACs
Technical Advisory Committees	Hydro, Hatchery, Habitat, Harvest interagency technical committees	Working groups on topic areas (geomorphology, riparian vegetation, wildlife, juvenile salmon, adult salmon, rehabilitation site designs)	Technical Work Group reviews GCMRC plans	TACs for land and water do a lot of work in developing the recovery program

Attribute	U.S. Columbia Basin Fish and Wildlife Program	Trinity River Restoration Program	Glen Canyon Dam Adaptive Management Program	Platte River Recovery Implementation Program
Independent scientific review	<p>ISRP (Independent Science Review Panel) reviews all proposals; BPA provides funding</p> <p>ISAB (Independent Science Advisory Board) provides programmatic advice on major issues</p>	<p>Review committees (outside experts) review proposed work.</p> <p>Scientific Advisory Board (SAB) reviews Program products and progress, but sometimes also does technical work for the Program (not truly independent)</p>	<p>Wording of RFPs as well as all proposals are reviewed by independent review panels</p>	<p>ISAC (Independent Science Advisory Committee) reviews State of the Platte report, individual work products, conceptual models, hypotheses, draft papers, etc. Also addresses larger issues (peer review, publishing, structured decision making).</p>
Synthesis of information	<p>No centralized entity to do this. Syntheses provided by ISAB, NOAA Fisheries, USFWS, NPCC, ad hoc Hatchery groups, etc.</p>	<p>Done by separate entities on particular topics. Annual report recently produced Technical Modeling and Analysis Group, but more of a progress report, not a true synthesis.</p>	<p>Peer-reviewed book on the Glen Canyon Program produced a few years ago by the GCMRC– very thorough synthesis. Also produce fact sheets and FAQs; journal articles; website</p>	<p>EDO works with TACs to produce an annual State of the Platte report, including snapshot updates on what’s been learned in the previous year. Summaries for decision makers backed up by technical detail for scientists.</p>
Challenges	<p>Large basin and large numbers of participants in various forums makes it difficult to make agile decisions. Existing uses of the hydrosystem and hatcheries constrain the ability to implement AM actions; AM primarily focused on habitat actions.</p>	<p>Efforts to build trust among participants have at times been challenging.</p> <p>Implementation of many aspects of the program is through Program partners, which ensures continuity, but also has varying levels of peer review and effectiveness</p> <p>SAB not entirely independent; cannot review their own work</p>	<p>Tradeoffs between saving endangered humpback chub and killing non-native trout – very difficult to get consensus</p> <p>Drought has greatly limited experimental flexibility</p>	<p>Some program participants have insisted on having peer reviewed information for decision making, which creates a high overhead for peer review and publishing. This ultimately does produce better quality results, but is less agile.</p>

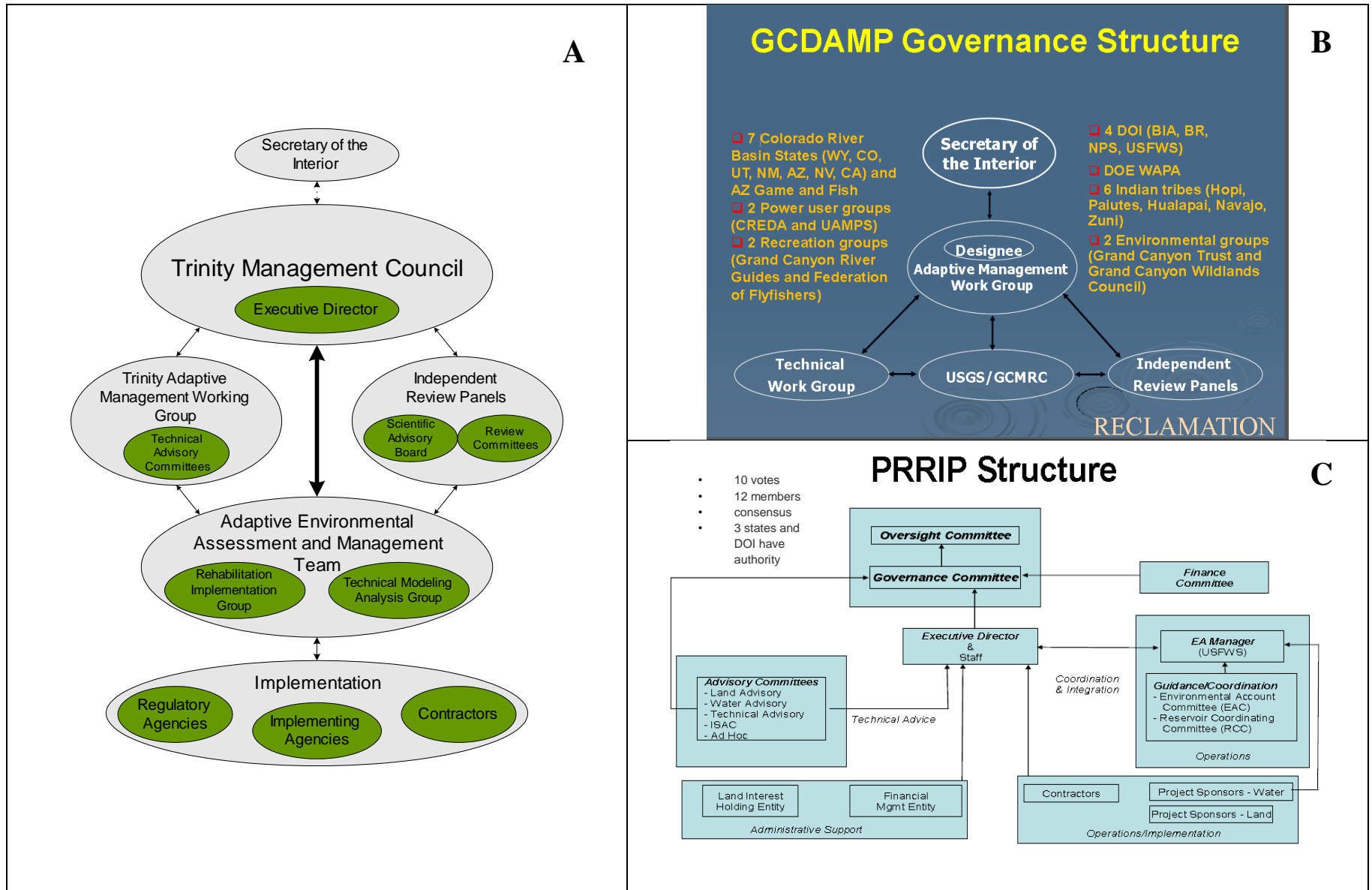


Figure 3. Summary of the structure of other large scale Adaptive Management programs: (A) Trinity River Restoration Program, (B) Glen Canyon Adaptive Management Program, and (C) Platte River Recovery Implementation Program.

Moreover, [Steven Daniels](#) (a professor and community development specialist from Utah State University) commented at a conference on how organizations can prepare themselves for AM (pg. 13 in Alverts et al. 2001):

“*Detail complexity* that focuses on components and *dynamic complexity* that focuses on connections and inter-relationships are both important forms of understanding. For a well-functioning organization three types of teams are necessary: *management teams* that ensure orderly flow of information, resources and tasks; *crisis teams* that provide quick response to emerging conditions and deadlines; and *learning teams* that pursue inquiry and exploration. Organizations don’t learn, teams do! Organizations just take the credit. The problem is that understanding dynamic complexity is essential (i.e., detail complexity is not enough). This requires learning teams, and learning teams are rare in resource agencies.”

As noted in version 3 of the Science and Adaptive Management Plan for MRRP, clarity is also required around the types of decisions and their relationship to the different governance structures (e.g., policy, management, or technical decisions). For example, policy decisions may involve changes to the Missouri River Mainstem System Master Water Control Manual, management decisions may involve changes in the scale of implementation of management actions (e.g., moving from Level 2 to Level 3 actions on pallid sturgeon), and technical decisions may involve choices around data collection, data analysis, evaluating action effectiveness and reporting.

Observations of the strengths and weaknesses of other AM programs are helpful since they can be used to inform development of a governance structure at the executive, policy, management, and technical levels, as well as broader discussions around the appropriate size of the groups, their membership and rules of conduct, information flows (e.g., expected inputs/outputs), and the specific role and/or types of activities at each level (e.g., types of decisions, trust-building, knowledge generation, exploration of preferences, evaluation of management actions). Importantly, choices around these aspects of the governance structure will affect the ability of the attributes of effective governance to enable successful AM.

How can we develop an effective system of governance that supports AM in the Missouri River program?

The scale of the Missouri Basin makes it a challenging place to implement AM, both technically and institutionally. Having a healthy dialogue on these challenges, and what strategies can be used to overcome them, is an important step towards designing an effective system of governance. Table 5 outlines examples of such challenges and strategies. It is not intended to be either comprehensive or prescriptive, but rather is meant to stimulate a conversation amongst interested parties (e.g., lead agencies, AM ad hoc Working Group, ISAP, ISETR) on the most critical challenges and priority strategies for addressing them, as well as to elicit ideas on other challenges and strategies. Those conversations should help to develop a form of governance that supports effective AM in the Missouri River, and is incorporated into the AM Plan.

Table 5. Challenges for implementing AM in the MRRP (with respect to various attributes of governance), and example strategies for overcoming those challenges. Attributes have been lumped together where the challenges and strategies are similar.

Attributes of governance which can enable or inhibit AM	Challenges in establishing a form of these attributes of governance that enables AM	Strategies for overcoming these challenges
<p>Trust and commitment to AM</p> <p>Problem context</p> <p>Mindset (around uncertainty, risk, and AM)</p>	<ul style="list-style-type: none"> - strongly held positions, highly constrained systems of river management and a history of court cases (as well as other factors) have created a low level of trust, risk aversion, and resistance to changes in river management through AM - lead agencies are generally focused on achieving management objectives, and do not have a long tradition of acknowledging uncertainty and doing AM 	<ul style="list-style-type: none"> - open sharing of current knowledge and evidence (e.g., ongoing effects analysis, structured decision making) build trust and shared understanding of uncertainties - ongoing collaboration in the design, implementation and evaluation of the AM program helps to build trust - shared success in well monitored ‘safe fail’ management actions will create greater understanding of (and commitment to) AM, provided that effects on both species and human considerations are tracked
<p>Problem definition</p>	<ul style="list-style-type: none"> - managing the Missouri River is a very complex problem (i.e., protecting multiple human considerations at multiple locations while recovering three species at risk, for which there are moderate to large knowledge gaps, during a time period of constrained resources) 	<ul style="list-style-type: none"> - clarifying which problems do <i>not</i> require AM - ongoing efforts at structured decision making and science / AM plan design recognize this problem complexity and have designed tools to grapple with it - trust will gradually build if annual reporting on the AM program reflects these multiple dimensions, provides evidence on outcomes, and clarifies rationale for decisions
<p>Executive direction</p> <p>Leadership and vision</p> <p>Integration of AM into management structure</p> <p>Legislation</p> <p>AM Training / Capacity</p>	<ul style="list-style-type: none"> - finding a series of actions that will avoid jeopardy for the listed species, protect human considerations and so provide a legislative mandate for AM via the next Biological Opinion - ensuring that lead agencies have a corporate culture that’s designed and trained to implement AM (at all levels) is a big job requiring a paradigm shift - AM is only one of many priorities within the lead entities for the MRRP, and may easily get swamped by other priorities unless all levels of the organization understand its importance 	<ul style="list-style-type: none"> - continuing to work collaboratively toward a set of AM actions that avoid jeopardy and thereby obtain a legislative mandate for AM - provide leadership, mission statements, governance structure, staff priorities and performance metrics, champions and training required to understand, embrace and support AM at all levels within both lead and participating agencies - work hard to ensure continuity of leadership and political support - develop agile ‘learning teams’ and ‘crisis teams’
<p>Planning</p>	<ul style="list-style-type: none"> - existing planning methods (e.g., USACE guidance master manual, USACE Planning Guidance Notebook ER1105-2-100) were written prior to effects analysis and structured decision making work, do not incorporate current scientific understanding, and do not have an AM orientation 	<ul style="list-style-type: none"> - invest time in carefully working through alternatives to existing planning methods with stakeholders, and incrementally designing, implementing and monitoring safe-fail AM actions - use empirical evidence of effectiveness to improve planning methods
<p>Communication and organizational structure</p>	<ul style="list-style-type: none"> - it’s very difficult for people in various roles (MRRIC participants, managers, policy makers, scientists) to absorb all of the 	<ul style="list-style-type: none"> - present information at appropriate level for each audience, with high-level, decision-oriented summaries clearly linked to their technical justification for those who want to

Attributes of governance which can enable or inhibit AM	Challenges in establishing a form of these attributes of governance that enables AM	Strategies for overcoming these challenges
	<p>material that's generated, to understand the <i>key</i> technical details, and to know their implications for decisions</p>	<p>dig into the evidence, as is done in the "State of the Platte" reports</p> <ul style="list-style-type: none"> - clearly define AM roles and responsibilities, and organizational interdependencies, seeking agility, responsiveness and effectiveness - ensure that people receive the information they need (including interactions with others) and are well trained to execute their AM roles effectively
<p>Community involvement and informal networks</p> <p>Facilitation, bridging, and team building</p>	<ul style="list-style-type: none"> - earnest effort has been made to involve all agencies, tribes and communities through MRRIC in a well-facilitated process, but its large size makes it more appropriate for consultation, not designed for agile review and feedback - MRRIC meetings are costly - use of shadow networks remains a risk and can undermine progress 	<ul style="list-style-type: none"> - provide MRRIC with frequent updates through website and other means - continue to interact in person with MRRIC 2 times / year for 2-way communication on learning, state of the system, review of annual plans, etc., explore other avenues for communication (e.g., polling) - rely on smaller MRRIC workgroups (ideally < 15 people) for agile review and feedback to lead agencies between MRRIC meetings - build trust through candid and open communication on all aspects of the program, and genuine responsiveness to feedback, reducing risk that people use shadow networks
<p>Knowledge generation and flow (science and local)</p> <p>Knowledge interpretation and sense-making</p> <p>Science Capacity</p>	<ul style="list-style-type: none"> - Though the state of understanding is sufficient to implement AM actions for birds, there is a much more uncertainty on what actions help pallid sturgeon - Reducing uncertainties related to pallid sturgeon requires an intensive <i>science surge</i> which exceeds the current research capacity and funding - There is a distinct trade-off between systematically reducing uncertainties through Level 1 and 2 research (more fiscally efficient but slower) vs. proceeding sooner with Level 3 in-river actions to help pallid sturgeon before uncertainties are reduced (may provide biological benefits sooner) - There may be challenges in moving to Level 3 actions if uncertainty persists - Much scientific information is not intelligible to stakeholders 	<ul style="list-style-type: none"> - Level 1 and 2 research efforts need to be designed to provide hypothesis tests in as efficient a manner as possible, taking advantage of all possible spatial and temporal contrasts in field conditions - Analyses of the effectiveness of potential Level 3 actions for pallid sturgeon need to candidly acknowledge uncertainties, and implement those actions in a systematic way which appreciably reduces those uncertainties over a biologically meaningful time period - Welcome multiple alternative analyses of available data to address key management questions, and ensure high level of peer review - Advances in scientific understanding need to be clearly translated into implications for decisions, as is done in the "State of the Platte" reports
<p>Funding / management resources</p>	<ul style="list-style-type: none"> - Federal funding for the MRRP is being heavily scrutinized, and increasingly hard to defend 	<ul style="list-style-type: none"> - Develop a broad base of support for the AM and science program as the most cost-effective and ecologically-effective approach to both recovering listed species and protecting human uses of the river - Demonstrate progress and success

Literature Cited

- Alverts, R., Calhoun, J. M., and Lee, R. L., (technical editors). 2001. Organizational Learning: Adaptive Management for Salmon Conservation Conference Proceedings. University of Washington, Olympic Natural Resources Center, Forks, WA USA. Available online: <http://digitalarchives.wa.gov/WA.Media/do/2B578FFD9FBB99CE15EB5B9AC430EB0B.pdf>
- Burns, R., T. St. Clair, M. Anderson, R. Thom, A. Quinn, and C. Fleming. 2015. MRRP Adaptive Management Plan: Incorporating Lessons Learned from Adaptive Management Programs Throughout the United States.
- Childs, C., A. M. York, D. White, M. L. Schoon, and G. S. Bodner. 2013. Navigating a murky adaptive comanagement governance network: Agua Fria Watershed, Arizona, USA. *Ecology and Society* 18(4):11. <http://dx.doi.org/10.5751/ES-05636-180411>
- Dietz, T., E. Ostrom and P.C. Stern. 2003. The Struggle to Govern the Commons. *Science*. 302 (5652): 1907-1912
- Duit, A. and V. Galaz. 2008. Governance and Complexity—Emerging Issues for Governance Theory. *Governance: An International Journal of Policy, Administration, and Institutions*. 21 (3): 311–335.
- Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* 30:441–73.
- Green, O.O., L. Schultz, M. Nekoro, and A.S. Garmestani. 2015. Chapter 7: The Role of Bridging Organizations in Enhancing Ecosystem Services and Facilitating Adaptive Management of Social-Ecological Systems. Pages 107-122 in C.R. Allen and A.S. Garmestani (editors). *Adaptive Management of Social-Ecological Systems*. Springer Publishing.
- Greig, L.A., D.R. Marmorek, C. Murray, and D.C.E. Robinson. 2013. Insight into enabling adaptive management. *Ecology and Society* 18(3): 24. Available online: <http://www.ecologyandsociety.org/vol18/iss3/art24/>
- Gunderson, L. 2015. Chapter 3: Lessons from Adaptive Management: Obstacles and Outcomes. Pages 27-38 in C.R. Allen and A.S. Garmestani (editors). *Adaptive Management of Social-Ecological Systems*. Springer Publishing.
- Gunderson, L. H., and S. S. Light. 2006. Adaptive management and adaptive governance in the everglades ecosystem. *Policy Sciences* 39:323-334. <http://dx.doi.org/10.1007/s11077-006-9027-2>
- Jessop, B. 1998. The rise of governance and the risks of failure: The case of economic development. *International Social Science Journal*. 50 (155): 29–45.
- Lackey, R.T. 2006. Axioms of ecological policy. *Fisheries*. 31(6): 286-290.
- Lee, K.N. 1993. *Compass and Gyroscope: Integrating Science And Politics For The Environment*. Island Press.
- Loftin, M. K. 2014. Truths and governance for adaptive management. *Ecology and Society* 19(2): 21. <http://dx.doi.org/10.5751/ES-06353-190221>
- Marmorek, D.R., D. Robinson, C. Murray and L. Greig. 2006. *Enabling Adaptive Forest Management – Final Report*. Prepared for the National Commission on Science for Sustainable Forestry by ESSA Technologies Ltd., Vancouver, B.C. 94 pp.
- Murray, C. and D. Marmorek. 2001. *Organizational Learning: Adaptive Management for Salmon Conservation*. Draft Synthesis Report from a conference sponsored by the Olympic Natural Resources Center; Bellevue, Washington, December 2-4, 2001. 65 pp.
- Oh, H., Chung, M., Labianca, G., 2004. Group social capital and group effectiveness: The role of informal socializing ties. *The Academy of Management Journal* 47: 860–875.
- Olsson, P. C. Folke, and F. Berkes. 2004. Adaptive co-management for building resilience in social-ecological systems. *Environmental Management*. 34: 75-90.
- Olsson, P., L. H. Gunderson, S. R. Carpenter, P. Ryan, L. Lebel, C. Folke, and C.S. Holling. 2006. Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society* 11(1): 18. Available online: <http://www.ecologyandsociety.org/vol11/iss1/art18/>

- Ostrom, E. 1990. *Governing the commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.
- Ostrom, E. 1998. A Behavioral Approach to the Rational Choice Theory of Collective Action. *American Political Science Review* 92 (1): 1–22.
- Rijke, J., R. Brown, C. Zevenbergen, R. Ashley, M. Farrelly, P. Morison, S. van Herk. 2012. Fit-for-purpose governance: A framework to make adaptive governance operational. *Environmental Science and Policy*. 22: 73-84.
- Stankey, G.H., R.N. Clark, and B.T. Bormann. 2005. Adaptive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 73 p.
- Tsai, K.S. 2006. Adaptive Informal Institutions and Endogenous Institutional Change in China. *World Politics* 59 (1): 116–141.
- Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology*. Available online: <http://www.consecol.org/vol1/iss2/art1/>
- Walters, C.J. 2007. Is Adaptive Management Helping to Solve Fisheries Problems? *Ambio*. 36(4): 304-307.