



## Missing the trees for the forest? Bottom-up policy implementation and adaptive management in the US natural resource bureaucracy

Kelly Heber Dunning

To cite this article: Kelly Heber Dunning (2017) Missing the trees for the forest? Bottom-up policy implementation and adaptive management in the US natural resource bureaucracy, Journal of Environmental Planning and Management, 60:6, 1036-1055, DOI: [10.1080/09640568.2016.1197105](https://doi.org/10.1080/09640568.2016.1197105)

To link to this article: <https://doi.org/10.1080/09640568.2016.1197105>



Published online: 13 Oct 2016.



Submit your article to this journal [↗](#)



Article views: 192



View Crossmark data [↗](#)



Citing articles: 1 View citing articles [↗](#)

## Missing the trees for the forest? Bottom-up policy implementation and adaptive management in the US natural resource bureaucracy

Kelly Heber Dunning\*

*Environmental Policy and Planning, Massachusetts Institute of Technology, Cambridge, MA, USA*

*(Received 18 March 2015; final version received 20 May 2016)*

For decades, natural resource agencies in the United States have attempted to restore ecosystems using adaptive management, a process that emphasizes experimental learning to reduce uncertainty. Most studies show that it rarely occurs in practice and explain implementation failures as organizational issues. This study draws on policy implementation theory to suggest that behaviors and attitudes of individuals may better explain implementation gaps. This comparative case study finds differences between experts implementing adaptive management in the Fish and Wildlife Service and the United States Geological Survey. These include differences in attitudes, perceptions, and behaviors aimed at promoting individual autonomy, performance standards, and defending individual interests on the job. Policy implications are twofold: first, that individual behaviors impact adaptive management implementation and intrinsic motivation to perform such functions. Second, regardless of agency, experts view their work as a social good. This suggests that a devolved planning process may remedy implementation obstacles.

**Keywords:** adaptive management; ecological restorations; policy implementation; bureaucracy

### 1. Introduction

For the past three decades, natural resource agencies in the United States have sought to restore large-scale ecosystems with a policy known as adaptive management.<sup>1</sup> Designed in the 1970s by ecologists Buzz Holling and Carl Walters, who drew upon operations research and systems science, adaptive management is a structured decision-making framework that helps natural resource managers use purposeful learning<sup>2</sup> to make decisions (Holling 1978; Walters and Hilborn 1978; Walters 1986). The main function of adaptive management is to overcome what its creators regarded as the largest obstacle for decision-makers: science-intensive policy-making under uncertainty over a resource's response to management interventions (Gunderson 2001). In theory, managers who translate the policy of adaptive management into practice undergo the following processes: (1) identify problems in an ecosystem and decide that it needs to undergo restoration, (2) model the ecosystem with several competing simulation models, (3) decide on treatments, (4) administer treatments, (5) collect and analyze monitoring data, (6) based on monitoring data, determine which models correctly simulate an ecosystem, and (7) refine original treatments so that, "management actions evolve as uncertainty is reduced through time" (Williams 2011a, 1371).

---

\*Email: [k\\_heber1@mit.edu](mailto:k_heber1@mit.edu)

Many adaptive ecological restorations tend to involve large-scale, complex, and threatened ecosystems that span many jurisdictions, such as the Columbia and Colorado River systems and the Florida Everglades. Both resource management practitioners and scholars of adaptive management describe it as a simple, compelling, logical, and intuitive policy for managing a natural resource (Stankey *et al.* 2003; Allan and Allan 2005; Kingsford, Biggs, and Pollard 2011). Given the wide appeal of adaptive management, it is noteworthy that many of the original designers of the process are also its sharpest critics (Walters and Holling 1990; Lee 1994; Walters 1997; Gunderson 1999). Specifically, they argue that after 30 years of implementation, few if any successful examples exist (Walters 1997; Allen *et al.* 2011).

This paper presents a comparative case study where the unit of analysis is the individual practitioner at two natural resource agencies in the United States (US), the United States Geological Survey (USGS) and the United States Fish and Wildlife Service (FWS), which implement adaptive management.<sup>3</sup> Its contribution to the large, pre-existing body of work on adaptive management is twofold. Most existing studies of adaptive management tacitly assume that policy implementation is a top-down process, where the policy goal (adaptive management of natural resources) is set at the top-most hierarchical level and is implemented through this hierarchy of authority. Thus, much of the scholarship focuses on agencies and groups of organizations implementing policy. This study instead assumes implementation to be a bottom-up process and its analysis is, therefore, focused on the perceptions of individuals doing the day-to-day interventions in natural systems. Thus, while most of the scholarships take an organization, state agency, or groups of such organizations as the main unit of analysis, this study focuses on agency personnel. Second, this study presents a novel comparative case study analyzing differences between individuals implementing adaptive management within differing agency contexts. Comparative case studies allow theory to illuminate the details of a case and systematic differences to be drawn out within their separate contexts.

This study has three main objectives: first, it explores where numerous case studies on adaptive management place blame for the obstacles to implementation. This section draws on interdisciplinary bodies of theory, including that of public management, bureaucracy, and organizations to show that most of the published works on adaptive management suggest that failures result from specific attributes of agencies. Second, this paper suggests implementation theory of public policy as an alternative explanation, specifically focusing on implementation as a bottom-up process consisting of actions, behaviors, and beliefs of individuals who implement policy on a day-to-day basis. Third, by drawing on this model of implementation, this study presents a comparative case study of the individual experts tasked with adaptive management implementation in two major US natural resource agencies.

## 2. Contemporary debates in the literature on adaptive management

Problems with adaptive management implementation have been discussed extensively in scholarship that spans disciplines. Lance H. Gunderson, a major figure in developing the plan to implement adaptive management in the Florida Everglades Restoration, argues that practitioners implement adaptive management in name only, and that it has never met expectations (Allen and Gunderson 2011). Kai N. Lee, a scholar of science-intensive public policy, compiled a volume of cases of adaptive management only to conclude that there are very few studies that show adaptive management holding up in practice (1994). Carl Walters, an ecologist who pioneered the ideas behind mathematical modeling in

adaptive management, asserts that after decades of taking part in over 25 adaptive management planning projects, only two were actually adaptive in practice. Walters argues that few of these restorations proceeded beyond the model-making phase (1986, 1997).

A contemporary counterpoint to the criticism can be found in the work of experts on adaptive management in the USGS, whose work seeks to improve adaptive management in the Department of the Interior (DOI) arguing that adaptive management is a “real opportunity to improve the management of many natural resources, and that in many cases there may be few alternatives to the use of management for learning [...]” (Williams 2011b, 1378). Similar studies highlight the intuitive structure of the adaptive management framework and assert that it channels human nature when it facilitates managers to decide objectives after evaluating the consequences of previous decisions.

Policy documents that describe adaptive management in the US natural resource management agency context can be found in a comprehensive technical guide, *The Adaptive Management Technical Guide*<sup>4</sup> (Williams, Szaro, and Shapiro 2007). Despite the single set of guidelines, the USGS and the United States FWS have very different implementation outcomes for adaptive management that has led to training programs sponsored by the USGS (Moore *et al.* 2011). Reasons for these differences may include (1) semantic confusion over the definitions of concepts within the adaptive management process outlined in *The Adaptive Management Technical Guide*, (2) practitioners not understanding the usefulness of the component parts of adaptive management, and (3) a lack of real life examples for practitioners to follow (Runge 2011, 220). This implies a tension between top-down policy directives and day-to-day implementation by experts on the ground. For this reason, comparative analysis between individual experts actually implementing adaptive management can generate insights into obstacles beyond those that have been extensively addressed in the literature. First, an interdisciplinary survey of the literature is needed in order to see where implementation breakdowns are said to occur with discussions of theory grounded in the published casework of adaptive management.

### **2.1. Implementation obstacles in organizations**

This section draws on several bodies of theory in order to explain where case studies on adaptive management tend to place blame for implementation failures. Most case studies blame *organizational attributes* for impeding adaptive ecological restorations, and different bodies of theory reviewed here shed light on several distinct organizational attributes. First theories of organizations and bureaucracies cite two specific organizational attributes: agency *culture* and *constraints* as culprits for lagging policy implementation (Wilson 1989). Agency culture (also called organizational culture) is a product that is learned through the experience of a group (Dodgson 1993). It is as a patterned way that practitioners think about tasks such as implementing adaptive management. Culture “is to the agency what a personality is to a human being” (Wilson 1989, 91). Agency culture changes slowly, if at all, and is passed down from one generation to the next (Selznick 1948; Adler and Jelinek 1986; Schein 1993, 1996).

An example of agency culture and constraints in the case study work on adaptive management can be found in Moore *et al.* (2011)’s work on the National Wildlife Refuge System (NWRS) within the FWS. He analyzes the application of adaptive management on the NWRS and identifies several system-wide barriers to implementation that FWS and USGS are collaborating to improve. These obstacles include: large areas to manage

with limited funds; multiple competing responsibilities for managers; competition between refuges over funding; widespread misunderstanding of the definition of adaptive management; and a lack of know-how within the NWRS to build ecosystem models and perform data analysis. Moore *et al.* (2011) examines collaboration programs between USGS and the FWS as remedies. Insights into the distinct organizational cultures of USGS and FWS emerge in this study, which can be traced to a variety of factors beginning with their statutory mandates. The USGS is composed of scientists who “conduct research in geology, mapping, hydrology, and related sciences [in order to] contribute to the wise management of the Nation’s natural resources” (USGS Manual). FWS on the other hand is less focused on scientific research with a mission is to actively “manage wildlife and the nation’s wildlife refuges, to control predators, enforce wildlife laws, and conserve dwindling populations” (US FWS).

There is evidence that agency culture results in different working definitions for adaptive management between the USGS and FWS. Take for instance the strict way that USGS scientists define adaptive management in their studies as an experimentally rigorous, scientific process that uses primarily quantitative results to improve resource management (see Williams 2011a, 2011b; Williams, Eaton, and Breininger 2011). Beyond this, USGS scientists tend to support a pre-defined and structured decision-making process for resource management, with decision problems clearly stated, alternative actions posed, and selection criteria chosen to select outcomes (Johnson *et al.* 2015). FWS culture, on the other hand, focuses less on structured decision-making and more on active, day-to-day management of the land on the NWRS that spans seven regions across the USA (Danter *et al.* 2000). Furthermore, in the early 1990s, the FWS research division was transferred to the USGS in a bureaucratic reform process, hindering its ability to produce published scholarship on, among other topics, its approach to adaptive management (2000). Moore *et al.* (2011) call for a biological team to be formed in the NWRS in order to address the obstacles to implementation, namely involving its lack of agency capacity to generate ecosystem models and statistically rigorous experimental treatments.

Published studies on adaptive management regularly blame agency-level constraints for implementation issues with adaptive management. Agency constraints are the day-to-day realities that restrict how personnel implement adaptive management (Bardach 1977; Hogwood and Gunn 1984; Wilson 1989). Case studies of adaptive management restorations have described constraints along several lines. Practical logistical barriers such as the high costs, financial losses to certain stakeholders, long timespans, and the bitter political infighting between stakeholders are known to characterize adaptive management restoration programs (McLain and Lee 1996; Walters 2007; Allen and Gunderson 2011). For example, experimental adjustments to seasonal flows along adaptively managed river systems in the Colorado and Columbia resulted in annual losses in the range of several million dollars from lost power production (Walters 1997).

The most frequently mentioned constraint in adaptive management case studies is the prohibitive cost of monitoring experimental treatments, and using this learning to inform decisions (Lee 1994; McLain and Lee 1996; Walters and Green 1997; Walters 2007). Walters (1997) points out that adaptive management monitoring is more expensive than traditional management, which tends to focus on single species. Many high-profile cases of adaptive management involve expansive, complex systems that take long timespans to respond to treatments (Allen and Gunderson 2011). Referring back to the *Adaptive Management Technical Guide*, it must be emphasized that adaptive management is “not an end in itself,” and as such, it requires that practitioners revise management based on

monitoring, yet, given the high costs and complexity of operations, this may not be realistic (Williams, Szaro, and Shapiro 2007).

A second body of theory drawn from sociology can also explain implementation problems by combining agency culture and constraints into one concept: *routine*. An agency-level routine develops when implementing public policy and is a function of resources and constraints (Spaargaren 2011). For example, low budgets, a lack of personnel, and a low level of political clout historically characterized FWS adaptive management projects on the NWRS. Several case studies argue that this prevents FWS from conducting the long-term, expensive adaptive management experiments recommended in the DOI *Technical Guide* (Clarke and McCool 1996; Moore *et al.* 2011). Despite these challenges, there is some evidence that FWS and USGS can collaborate successfully in adaptive management planning, namely in their harvest regulation program for migrating waterfowl. In this program, management decisions are informed using data from populations over millions of square kilometers of wetland habitat from the previous year (Nichols, Johnson, and Williams 1995; Nichols and Williams 2006; Lyons *et al.* 2008).

Studies of adaptive management that characterize the process as agency routine focus on two competing paradigms: *active* and *passive* adaptive management. Active adaptive management is the technical, positivistic approach that is truer to the initial theory, with experimentally designed treatments, mathematical models that compete for accuracy, and quantified data from which managers learn. On the other hand, passive adaptive management is a less technical process with fewer pre-defined steps, where managers give treatments to a resource, watch the resource's response, and then adjust future treatments based on the response (Walters 1986; Hilborn and Walters 1992; Holling and Meffe 1996; Walters 2007; Moore *et al.* 2011). In most published case studies where there is not a clear description of a process for passive adaptive management, it is simply presented as a less desired foil (see Holling and Meffe 1996; Gregory, Failing, and Higgins 2006, 435; Allen *et al.* 2011). Thus, it is often characterized as a failure in agency routine.

Public management theory would pinpoint three organizational attributes as reasons for implementation failures: (1) agency-wide incentive structures that do not encourage adaptive management, (2) agency-wide aversions to learning, and (3) a lack of clearly assigned responsibilities in adaptive restorations (Heinrich and Marschke 2010). Walters and Green argue that they cannot, after working for decades on adaptive management, find any rational incentives for those working in federal agencies to implement it (1997). Cases studies often link points 1 and 2 by describing a general lack of incentives to engage in learning, especially when results of adaptive management experiments may not be popular, or when they cost large sums of money. Admitting these types of mistakes would negatively affect budget allocations in the future, especially if their mistakes are politicized as being costly to the taxpayer (Stankey *et al.* 2003; Walters 2007).

This is problematic because adjusting management interventions based on previous learning from mistakes is at the core of the adaptive management process. For instance, Allan and Allan describe the adaptive management watershed planning in the Murray Darling Basin in Australia. They note that agencies "seek to maintain their own comfort" by denying they have ever made mistakes (2005, 421). Agencies may do this by putting deceptive findings in reports so that their management interventions are viewed in a positive light, reporting only favorable outcomes to funding agencies, and putting a positive 'spin' on their results (2005, 421). Another example from adaptive forestry management in the Pacific Northwest shows the United States Forest Service trying to

insulate itself from risk by only permitting foolproof experiments in adaptive management, where the outcomes are already known (Stankey *et al.* 2003; Allan and Allan 2005). Learning was actually avoided when managers would fail to record their findings, actions that reflect a lack of professional incentives to do so (Stankey *et al.* 2003). Gunderson describes how in the Florida Everglades restoration, risk was too high to engage in any actual experimentation and, thus, adaptive management never materialized (1999).

Even if the proper incentives were in place, public management theory raises questions on whether it is possible to know if agency employees are performing their task at all, especially if the task is exceedingly complicated and many individuals are involved (Heinrich and Marschke 2010). This gets to the classic notion of ‘bounded rationality’ where agency managers and lower level personnel cannot direct their attention to all problems at all times. Public management theory would trace the lack of clearly assigned responsibilities to (1) day-to-day tasks that may not be explicitly or objectively defined and (2) high rates of employee turnover acting as a mismatch with the long timeframes required for adaptive restorations (Downs and Rand Corporation 1967; Bardach 1977; Sabatier and Mazmanian 1980).

Case studies on adaptive management support this conjecture, with adaptive ecological restorations often characterized by their inter-agency, often multi-jurisdictional overlap that results in confused responsibilities and redundancy (Stankey *et al.* 2003; Williams, Eaton, and Breininger 2011). Additionally, when several semi-autonomous state and federal natural resource agencies come together as a mega-organization to implement adaptive management on a large scale, each agency has its own protocols that come before its responsibilities to implement adaptive management (McLain and Lee 1996; Gregory, Failing, and Higgins 2006; Allen and Gunderson 2011). Gunderson (1999) describes a 2.5-year development process where dozens of experts worked to create an ecological model for the Everglades restoration process that resulted in enough information to move ahead with management. However, natural resource agencies were “trapped by narrow interpretations of their own mandates” where, for instance, FWS would not allow experimental management interventions if they endangered listed species such as the snail kite (5, 6).

This paper suggests that public policy implementation theory, which probes the intersection between policies laid out in documents versus what happens on the ground may offer a better explanation (Pressman and Wildavsky 1984). Implementation theorists present two options: (1) policy implementation as a top-down phenomenon, where high-level officials write it, and implementation occurs down the agency hierarchy versus (2) policy implementation as a bottom-up activity made up entirely of informal relationships between individuals with day-to-day implementation responsibilities who have a large deal of discretion when implementing (Sabatier and Mazmanian 1980; Sabatier 1986; Lipsky 1993). This study draws on the latter bottom-up theory of policy implementation.

This study suggests that explanatory power over implementation failures of adaptive management can be found by examining the day-to-day activities of individuals and comparing perceptions, behaviors, and beliefs across agency contexts. Bottom-up policy implementation theory examines the way that agency personnel located figuratively at ‘street level’ either work to implement policy or to divert it to their own purposes (Lipsky 1993). Sabatier argues that to study bottom-up implementation, one must identify the actors who deliver a service (in this case, adaptive management of natural resources) and ask them about their goals, strategies, and activities in terms of how programs are financed, planned, and executed (1986).

Table 1. Summary of literature reviewed.

Body of theory: key concept	Papers that use this theory to explain failures of adaptive management	Example from case studies on adaptive management.
Organizations, bureaucratic theory: agency culture and constraints	(Moore <i>et al.</i> 2011; Williams, Eaton, and Breininger 2011; McLain and Lee 1996)	The Colorado and Columbia River restorations saw enormous costs when it came to manipulating their flows as an adaptive management experiment (Walters 1997).
Sociology: agency routine	(Hillborn and Walters 1992; Holling and Meffe 1996; Walters 2007)	Passive adaptive management is often characterized as a breakdown in agency routine (a combination of the above mentioned culture and constraints) (Walters 1986).
Public management theory: organizational attributes including incentive structures, aversions to learning, lack of assigned responsibility	(Stankey <i>et al.</i> 2003; Walters 2007)	In the Murray–Darling Restoration, agencies would rather deny mistakes made instead of engage in an adaptive process (Allan and Allan 2005).
Policy implementation theory: autonomy, behavior drifting towards compliance, actions that are hard to quantify, lack of homogenous tasks	X	X

Bottom-up theorists of policy implementation have several explanations for implementation failures that include: (1) the lack of autonomy of employees, (2) behavior that drifts towards compliance with performance evaluations, (3) the actions of employees are hard to quantify, and (4) the lack of homogenous tasks (Bardach 1977; Lipsky 1993; Heinrich and Marschke 2010). Thus far, individual skills, beliefs, activities, and perceptions of individuals tasked with implementation have been under explored in the adaptive management scholarship, and this study seeks to draw these out. Table 1 summarizes this literature review.

### 3. Design and methods

Comparative studies grounded in interdisciplinary theory are considered best practices when conducting research on public policy (Weiss 1978). Case studies were selected because they allow for detailed examinations of phenomena that allow for in-depth insight (Stake 2013). Mixed methods research with a qualitative component facilitates deep understanding of processes by studying people and their activities embedded in *context* (Denzin and Lincoln 2000). This study's context is the heart of its comparative design, where a 'case' takes individual experts implementing adaptive management as the unit of analysis, with their position within either USGS or FWS as their differentiating context. This is explained by the schematic in Figure 1. Each individual case is made up of data assembled from over 30 structured interviews with practitioners either in the USGS or FWS who implement adaptive management. This study argues that previous work on adaptive management focuses on organizational attributes as causes for implementation

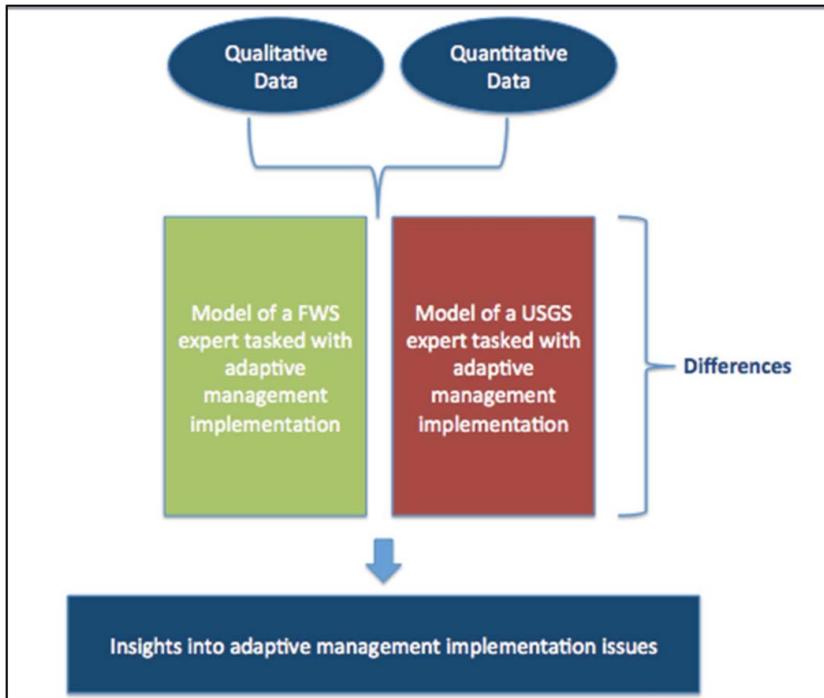


Figure 1. Research design.

failure. This study assesses individuals responsible for implementation in order to gain in-depth understanding of reasons they either implement or avoid implementation altogether.

Selection criteria for respondents were theory-based, drawing on the adaptive management literature in order to select what constituted ‘experts’ who implement adaptive management. Two processes were used to identify a list of informants. First, a snowball process was used to identify informants, beginning with senior practitioners in either the USGS or FWS who had worked on adaptive restorations, and then these informants were asked for additional informants. Second, websites across various adaptive restoration contexts, the NWRS and the USGS, were used, as well as published studies emanating from both agencies and policy documents to further identify a list of respondents. Respondents have a wide range of titles, spanning wildlife biologists, to hydrologists, to land managers, to senior level people who have spent years working on restorations. These respondents were either called or emailed to gain consent to participate in the study, and were guaranteed anonymity.

Semi-structured interview methods were chosen for the rich descriptive detail they offer in building a comparative case (Yin 2009; King and Horrocks 2010). Data were compiled from 65 in-depth interviews over a two-year period (from September 2012 to September 2014) that ranged from 30 minutes to over an hour, with 33 respondents from the USGS and 32 from FWS. Each interview took place over the phone and was transcribed and coded. A complete list of interview questions, as well as descriptive statistics on responses, can be found in Section 4. Qualitative analysis was undertaken using thematic coding; where sets of shared terms and concepts were identified across respondents in order to identify common themes that recur across interviews (Braun and Clarke 2006; Langdridge 2008; King and Horrocks 2010).

Quantitative analysis of participant responses was the first step in narrowing down qualitative themes after thematic coding. Quantitative analysis tested the significant differences between proportions of responses to yes/no questions compared between agencies using a two-tailed *t*-test. Simple random sampling is a prerequisite for this type of statistical test, and though this sampling strategy was not a random sample of a population and it is not exhaustive, it is assumed to be representative of the population of USGS/FWS practitioners working on adaptive management. Once significant differences in responses were calculated (Table 2), then themes could be explored in depth.

#### 4. Results

Bottom-up policy implementation theory explains that implementation failures result from skills, behaviors, actions, and attitudes among agency personnel (Lipsky 1978; Sabatier 1986). The table below summarizes the key differences that emerged between respondents in the agencies. This study found that both USGS and FWS practitioners receive criticism for their preferred mode of adaptive management (utilizing either too formal or too informal of an approach to adaptive management, respectively). Respondents across the agencies had differing views on whether training in adaptive management was a positive development in the field of conservation, with fewer FWS sharing this view compared to the USGS where this was the majority opinion. Very few FWS practitioners felt that coursework enabled them to change the way they implemented adaptive management, compared to USGS practitioners who saw courses and training as major sources of change in implementation strategies. The ability to change implementation strategies is critical according to the definition described in the *Technical Guide to Adaptive Management* discussed in the opening section of this study. Likewise, remarkably few FWS practitioners felt that they would use the material from courses in their day-to-day work, compared to USGS respondents who felt that the classes had a transformative impact on the restorations they were assisting with.

This study found evidence for three types of behavior and attitudes present in implementing personnel in the US natural resources bureaucracy and explained them by drawing on dominant themes elicited from qualitative interview data. Behavior, in environmental social science, is defined as an action that has an impact (Stern 2000). Respondents in this study could engage in a wide range of activities to implement adaptive management. For that reason, the questions were posed to respondents in a way that broadly defined what actions could be, leaving respondents to describe them in greater detail. The behaviors they described included: (1) behavior that promotes individual autonomy and discretion, (2) behavior that complies with, or refuses to comply with, performance evaluations, and (3) defensive behaviors. Significant differences were present in responses between USGS personnel and FWS personnel along these three sets of behavior and attitudes explained in the following subsections.

##### 4.1. Behaviors that preserve individual autonomy and discretion

Bottom-up policy implementation theory suggests that autonomy and discretion are of critical importance for ground-level personnel tasked with implementation of adaptive management (Sabatier 1986; Lipsky 1993). This study found strong evidence for the presence of these types of attitudes and behaviors among agency personnel, where FWS individuals were concerned about their ability to work on day-to-day projects with a high degree of discretion that they felt they had earned through years of experience and hard

Table 2. Significant differences between respondents: FWS and USGS Personnel Implementing Adaptive Management.

Interview questions	FWS, <i>n</i> = 32	USGS, <i>n</i> = 33	Test statistic and significance level of difference in two-tailed test
Does the way you implement adaptive management get criticized because it is too formal an approach?	Yes 13%	Yes 79%	-5.33***
Does the way you implement adaptive management get criticized because it is too informal an approach?	Yes 91%	Yes 12%	6.37***
Does the way you implement adaptive management get criticized because its approach is too positivistic?	Yes 19%	Yes 45%	-2.24*
Does the way you implement adaptive management get criticized because its approach is too flexibly defined?	Yes 88%	Yes 6%	2.57***
Should there be performance standards for those implementing adaptive management?	Yes 30%	Yes 47%	-0.83
Is training or coursework on adaptive management a positive development in your field?	Yes 44%	Yes 85%	-3.46***
Should there be a single guide or plan for implementing adaptive management?	Yes 13%	Yes 79%	-5.33***
Is training or coursework on adaptive management making changes in the way you do your work? OR If you lead classes, does this change the way you do implementation (i.e. when consulting on FWS restorations)?	Yes 16%	Yes 85%	-5.63***
Will you use any of the material you learned in these classes? OR If you lead classes, does this change the way you do implementation (i.e. when consulting on FWS restorations)?	Yes 16%	Yes 85%	-5.63***
Do experts implementing adaptive management guard their own resources (like their salaries, promotions, and so on) in a way that may prevent them from fully implementing the policy?	Yes 25%	Yes 30%	-0.45

\*\*\*Significant at  $\alpha = 0.01$ .

\*\*Significant at  $\alpha = 0.05$ .

\*Significant at  $\alpha = 0.1$ .

work. USGS officials contested these beliefs, instead suggesting that this is the very reason that adaptive management fails so often, and that in order for it to work, there are strict implementation steps. When these steps are not followed, adaptive restorations face the many pitfalls outlined earlier.

The most commonly cited need for discretion involved how they diagnose ecological problems and invent solutions in adaptive ecological restorations. In the FWS, managers are actively managing the NWRS, with many respondents responsible for day-to-day controlled burns, bulldozer operations, and other interventions in land management. These individuals repeatedly commented on how they do not define adaptive management as a form of positivistic 'strict science' or in the words of one NWRS land

manager “science that is more appropriate for an academic setting, with experimental designs and good *t* and *r* values.” Instead, they valued discretion aimed at physically managing the land, implementing treatments (including controlled burns, plantings, and drainage), and changing their future actions based on the response they observe – what some respondents called a *practice-oriented* definition of adaptive management. FWS respondents continually drew on notions of improvisation when discussing their implementation process. They emphasized the value, efficiency, and practicality behind what they called a *learn as you go* approach.

USGS practitioners uniformly contested the need for individual discretion, instead of promoting the importance of a strict series of steps in adaptive restorations. These include experimental design of treatments that test a pre-defined hypothesis of how a resource will respond – a *research-focused* definition of adaptive management. These endeavors often end in published science, and always require serious efforts to intelligently manage data. USGS personnel lamented how the adaptive management process breaks down in the absence of pre-defined steps, creating situations where, for instance, the data gets “abandoned in a filing cabinet somewhere.” In the USGS, discretion was not the most important aim when compared to the need for a strict process where personnel quantified data from deliberately planned treatments, so that treatments are ‘measurable’ and measurements can be replicated and analyzed over time. Several USGS officials who had been working on adaptive management for decades cited a ‘front-loaded process’ where logically sequenced, quantifiable treatments were planned and applied up front; these would then be tested and re-designed if they were not completing the original objectives. Practitioners repeatedly spoke of a precise view of the tasks embedded in adaptive management:

The byproducts of adaptive management are formatted in a quantitative attempt at measured learning where that quantity is taken into account for the next decision step, and that learning is taken into account for future decisions. My [USGS] colleagues and other “technical folks” tend to have this expectation, lots of people look at adaptive management as learning by doing, but in reality there’s a lot of devils in the details and it’s important to clarify what those details are.

USGS informants would often characterize the FWS approach as more *off the cuff* or *learn as you go*, while also suggesting that this is not truly a scientific approach. USGS informants repeatedly expressed frustration with flexible definition of implementation tasks and responsibilities in adaptive management and stated, either directly or implicitly, that if something is labeled adaptive management and it does not use their specific set of tasks defined in the DOI *Technical Guide*, it is merely a buzzword. One official’s frustration was clear:

Adaptive management is the new paradigm, or new buzzword depending on how you see it [...] I don’t think most people who think about implementing things in adaptive management have any idea of what that really means or what they’re talking about [...] it’s a buzz word, and it’s often used to say, “We are not going to define what we are going to do, we don’t know how.”

Officials in the FWS disagreed with a strictly pre-defined set of tasks and processes, and repeatedly emphasized their right as experienced practitioners not to use this approach, and to use their own judgment when implementing instead. They argued that the NWRS is too large and variable. To FWS personnel, adaptive management projects

need to be flexible enough to be applied in divergent restorations that could be as small as 5 acres or as large as 1 million acres, with tasks shared across a handful of managers or dozens. This meant awarding the individual manager a large degree of discretion, instead of forcing him to rely on a pre-set list of steps and procedures. FWS managers focused on the merits of individual, intimate knowledge of a resource system that stems from managing land on a daily basis. They argued that experience equips them to make major management decisions and adapt accordingly when prior decisions fail. Thus, it may not be surprising to find hundreds of individualized implementation strategies across the NWRS for adaptive ecological management.

USGS officials contested an individualized implementation approach because the insights they generate lack comparability between ecological restorations. They argued that in order for learning and diminished uncertainty to result, there needs to be a comparability between data sets, across refuges and across cases. This is lost when individuals fail to comply with implementation steps. One respondent gave an example of a periodic drawdown on wetlands on one part of the NWRS that could be used to inform management on another. "When FWS personnel keep this data in their heads, it gets lost." USGS respondents cited a commonly uttered phrase as an agency-wide pet peeve: doing adaptive management without trying. Take, for instance, the representative words of a FWS informant: "To those of us who are on the ground in refuges, a lot of our work is done by simply being on the land, or by being outside, we are kind of functioning adaptively without trying, and there can be a benefit to seeing several degrees in the range of adaptive management." USGS respondents viewed this phrase with caution, with many arguing that it translates to, "anything can be adaptive management." USGS Informants repeatedly cited this as a road to implementation failure. FWS respondents on the other hand saw real value in a 'spectrum' of definitions of adaptive management, better suited to the range of projects that arise on the NWRS. In the words of another respondent from FWS:

It can be really loose and really tight; the looser ones are more of a day-to-day, trial and error, like the guys running the equipment. Trial and error has a negative connotation [...] but the way these guys do it though, they run bulldozers a certain way, but it wasn't right, so they modify it until they get to a result. Those guys are actually working under the purest form of adaptive management.

One suggestion for improved implementation from USGS personnel was that application of adaptive management should be restricted exclusively to situations that are amenable. If a restoration lacks key elements (an ecosystem where adaptive management makes sense, a political environment where it is feasible, mathematical modeling capabilities, data analysis, hypothesis testing, and experimental design), then the restoration simply would not undergo an adaptive restoration. In their view, the more positivistic definition of the adaptive management process has proven successful in the past, most notably with the waterfowl harvest management program. Many even pointed out that this was, in fact, a FWS program, though initiated under a large degree of cooperative effort between agencies. Many USGS respondents noted that much criticism of adaptive management is directed against restorations that never constituted what they perceive as a truly adaptive process, and hinted that there would be less controversy over the policy if only adaptive management processes that met the criteria were counted.

Across agencies, there were some practitioners who were more willing to lend support to the other agency's implementation strategies, or be reflectively critical of their own views. For example, some FWS officials acknowledged that data collection and retention for future reference could use improvement, although intuitive knowledge of a resource

was useful and important. The following response is indicative of many FWS respondents who were self-critical of certain aspects of their approach:

The problem I have with our intuitive approach is that a lot of these guys never write anything down. The “learning” often gets stuck in a file cabinet and nobody knows it’s there. But that’s the only way we know if we are doing something better, to document the results towards achieving your objectives [...] so we are asking our people to keep better notes. You’ve got to hope they have time to fill stuff out though, standardized stuff like spreadsheets. It’s getting harder and harder for people to sit down at a desk and document stuff when they barely have time to get out in the field anymore.

However, many respondents emphasized that implementation gaps between FWS and USGS implementation styles can never be breached:

I have spent my whole life on refuges, I make decisions based on intuition [...] I say, “let’s try this,” and “let’s try that.” I never wrote it down, it never was a “study,” I didn’t collect data in a formal matter, but after looking at nests for 10 years you understand systems on a very intuitive level. And that’s what makes people on the refuges different, the USGS guys drive me nuts, they’re modelers, mathematicians, they put numbers in boxes and they’ve felt like they’ve captured reality, all they’re doing is taking what managers and biologists do, and putting a number in a box and say “now you’re doing science.”

Another respondent suggested that the USGS process for implementation simply cannot work, because ecological restorations are simply too complex.

I have a friend in one of the reserves, she is a numbers person. One of the things we work on is locating [...] nests. I’d say, “I think it’s over there,” (I was keying in on habitat variables in my head) and she’d come out repeatedly and write down everything I’d say, and she’d ask “What do you measure?”[...] but really, I am just thinking like a bird [...] USGS people don’t realize nature doesn’t live in boxes, and we are floundering because of it. At Patuxent, for instance, you have all these different experiments with controls, and there’s just always elements of nature that screw up their stuff.

This excerpt suggests an important piece of information in the comparative differences between USGS and FWS implementation. FWS experts view discretion and autonomy as pathways to lessen uncertainty in restorations, whereas, USGS employees view it as a standardized protocol with a pre-determined series of rigorous steps. The adaptive management scholarship suggests that both attitudes have some truth to them. FWS experts suggest that flexibility is central to adaptive restorations, while USGS officials cite the need for rigorous science and comparable results.

#### ***4.2. Behaviors that drift towards compliance with performance standards***

Bottom-up policy implementation models suggest that individuals will exhibit behaviors and attitudes that drift towards compliance with performance standards instead of behaviors that further the implementation of adaptive management (Lipsky 1993). This is rational behavior that sees individuals spending scarce time and resources fulfilling tasks that will count towards rewards, be they promotions, a raise, or retaining employment. This study’s findings somewhat contradict this model, as many respondents were openly dissatisfied with performance standards presented in DOI training classes, which aimed to move implementation to a more positivist paradigm of adaptive management. Informants from FWS voiced real intentions to not comply with the changes that these

capacity-building courses suggest. FWS personnel argued that class content, aimed to adjust implementation strategies on the NWRS, often diverted attention away from tasks they considered to be *true* adaptive management, and remarked that they would not comply with these learned standards of performance.

Several respondents detailed performance standards discussed in the classes and training sessions offered by the USGS. According to several USGS instructors, classes improve scientific rigor of restorations on the NWRS. They also act as an evaluation tool on current adaptive management implementation on the NWRS, and suggest new standards, for future performance in terms of adaptive management policy implementation. Thus, individuals are not being evaluated by a list of performance standards as a strict definition of the term would suggest, but rather classes aim to set new standards. The FWS respondents were nearly universally skeptical of these courses. One senior official in the FWS compared these classes as speaking different languages, "There is a big difference between us [FWS] and USGS. The folks teaching classes are arrogant towards us, and each side becomes more and more hard to understand."

One individual who had worked for several decades on adaptive restorations in FWS expressed his dissatisfaction:

I sit through the discussions they give, and they are way over my head, and a lot of this is learning theory, and there's a lot of math, and it is just so pie in the sky and theoretical I don't know how useful it is on the ground.

One USGS employee described the classes and how he felt that the tools, language, and logic intimidate many experts in FWS. He then noted that it has potential to be accepted if taught to managers in a way that is sensitive to these perceptions, something that is a central focus of those who offer the classes. This is evident in one USGS course instructor's response: "We have several new agency-specific courses and workshops to describe the process, and improve the standards of implementation, and people seem very interested and see a lot of value in them," but then he went on to point out that these same classes may "scare some people or intimidate people because they think that you need all these complex tools to implement adaptive management." He warned that if individual managers in FWS or on the NWRS start thinking that adaptive management is not the answer to their decision problem, then even less effective management will result. He argued instead that, "there are very simple tools available to implement adaptive management. You don't necessarily need stochastic dynamic programming." Another USGS expert familiar with these courses suggested that in order to increase acceptance of these newer performance standards, FWS employees had to self-select into the classes. In other words, allow people to take them voluntarily, and popularity along with perceptions of value of the course content may spread by word of mouth.

FWS respondents suggested that performance standards were aimed at bringing the FWS methods closer in line with USGS protocol and, thus, were a source of mistrust. Many in FWS described their implementation strategy as the result of decades of managing certain ecosystems. In the words of one FWS respondent with a widely shared sentiment, "A lot of our managers are afraid of the USGS formalized thing, they do a lot of stuff in their head...It's hard for them to recognize what they're doing, then explain it to someone else." The most common themes to arise from interviews with FWS practitioners were that tasks and responsibilities of implementation were (1) repeated so often they became second nature and that (2) it was hard to describe the process as it is too complex and it is the result of large amounts of experience.

When USGS managers were asked to comment on repeated and internalized processes, near universal themes emerged, where managers regarded these tactics as inefficient, subjective, and far from the scientific method. One USGS official asked what would happen if “the only person on the NWRS who knew the critical movements of a key species up and died,” and though the intentions were glib, the thematic focus of this question was a re-emerging theme among USGS practitioners who emphasized the importance of agency-wide memory as one of the main purposes of an adaptive restoration. USGS respondents placed importance on scientific replication, whereby, management actions are well documented in quantitative data and anybody new to the restoration can access this information and know how to move forward. USGS practitioners noted that delay, inertia, and dysfunction result when everything is done in the heads of even the most competent and experienced managers. They viewed these classes and performance standards as the next step in improving implementation.

#### **4.3. Defensive behaviors**

Theorists suggest that implementation may falter when individuals are too heavily focused on their own resources and interests, leading them to actively subvert implementing policy or to divert resources to their own purposes (Downs and Rand Corporation 1967; Lipsky 1993). This study finds no evidence for this, but does find evidence for unique employee attitudes towards their employer, evidenced across DOI employees, that suggest a universal perception that their work does ‘social good.’

FWS experts were concerned about perceptions of legitimacy in their approach to adaptive management but not for the usual reasons that theory would suggest, such as worry over higher salaries, program budgets, and project funding. Instead, respondents across agencies have a very important attribute in common: an intrinsic motivation to work for the FWS or the USGS grounded in personal values and a belief system that the work they do somehow positively impacts society and future generations. When this work was criticized, they felt that their approach had to be defended. In other words, theory predicts FWS defending their approach to adaptive management for programmatic survival, salaries, or promotions, when in reality they defend their approach to adaptive management because they believe that it results in a social good. Likewise, USGS are not trying to impose a more positivistic scientific approach to adaptive management because they are trying to further the aims of their agency, or their professional resources, but instead they believe that their approach is more successful in ecological restorations and also generates a social good.

When asked for suggestions on where the collaboration between FWS and USGS could go next, several FWS respondents echoed this sentiment: “When USGS folks work with us, they build mathematical models based on what we [in the FWS] do in our brains,” emphasizing that there are shared aims between the two agencies but that disagreement over implementation strategies exist. This respondent did acknowledge a desirable scenario in which the USGS would “[work] really closely with NWRS people to show them how to, “put numbers in boxes, finally acknowledging our form of “off the cuff science” and giving it credibility.” In other words, if the FWS would learn to use more systematic forms of data collection and analysis to make decisions, their approach to adaptive management may gain legitimacy with the USGS. Many in the FWS were looking for a middle-of-the-road hybrid between their more intuitive approach and the positivistic approach of USGS, but also simply desired people in the USGS to recognize legitimacy in the FWS approach.

FWS employees, primarily those on the NWRS, emphasized that non-compliance with the more positivistic style of adaptive management was not willful or defensive, but rather the result of day-to-day demands on their time. Many FWS practitioners repeatedly emphasized that the sheer volume of competing responsibilities was what prevented them from implementing adaptive management. These competing tasks include running the refuge administratively, drafting a budget, ensuring visitor safety and security, educational outreach, and maintenance. The NWRS scale acts as an additional constraint that shapes the way managers define adaptive management. According to one FWS informant with 10 years of experience implementing adaptive management, the NWRS has 350 biologists working across 100 million acres. Many respondents argued that given such constraints, a strict formula for an adaptive ecological restoration with measurable steps, data collection and analysis, and mathematical modeling, is not practical for personnel on the NWRS.

Most FWS respondents cited practical day-to-day constraints on their time as having the largest impact on how they implement (or fail to implement) adaptive management:

[USGS] has huge staffs of scientists with lots of resources. Look at what they did with the adaptively managed bigger programs; they're all really intensive, they take a lot of staff, energy, and money. A guy doing a 5 acre tract is working by himself with 4 people to staff that refuge [...] what does he do with this little 5 acre tract of land to be managed adaptively, look at literature? Stay on top of it? Listen to locals? This is the middle ground we need to arbitrate.

One retired FWS official who had worked implementing adaptive management for over 30 years put the sentiment bluntly, "Those [USGS] guys aren't in the real world. Don't tell some biologist out in the middle of nowhere he isn't doing adaptive management. It's far more constructive finding practical ways to improve the type of management that he is doing."

## **5. Conclusions and policy implications**

To characterize the split in implementation entirely across agency lines would be misleading, just as it is somewhat simplistic to view implementation failures as organizational attributes versus individual behaviors of those tasked with implementing. Additionally, this study does not reject the importance of organizational attributes as explaining implementation gaps. Instead, it supplements the large number of published studies that already explore organizational explanations with novel contributions on the importance of individual employees' perceptions and their relationships to implementation gaps.

For instance, the NWRS is so large that a similar positivistic versus intuitive implementation divide has emerged between FWS experts in recent years. Whether they fall on the active (positivistic adaptive management) to passive (intuitive adaptive management) spectrum depends on the available resources on a given refuge – an organizational attribute. One senior FWS official reflected on this development in the past 15 years and outlined several regions in the system, including Region 5 (New England) and Region 3 (the Great Lakes), that adopted the positivist approach to adaptive management that characterizes the USGS. It is important to note that these regions in the refuge system had the capacity to reach out to the leading technical experts in the USGS to enlist them to design management frameworks with a more technical approach. On the other hand, FWS officials in the Pacific Northwest region of the NWRS went the opposite

route, characterizing their approach as “not so much controlled experiments like in region 5.” On the other side of the debate, many USGS officials broke rank to express how the contextual needs of the FWS make their passive approach necessary: “I would like to see more agency [USGS] support [for the FWS approach],” one respondent remarked, adding, “I’m going to get in trouble for that.” She indicated that when more groups are allowed to apply adaptive management and its decision-making frameworks, this improves restorations.

This research has two implications for policy implementation in the natural resources bureaucracy. First, that individual attitudes and behaviors of those tasked with implementing adaptive management are important when examining the implementation failures of adaptive management, and second that individuals working in the FWS and the USGS show a strong sense of intrinsic motivation to do the work they do and a strong belief that the work they do performs a social good. This contributes to theories of bottom-up policy implementation that overlooks employees in bureaucracies who are genuinely intrinsically motivated to perform the work they do. DOI employees working on adaptive management are distinct from other bureaucrats tasked with policy implementation who are more widely discussed in theory, such as those working in post offices or departments of motor vehicles that tend to be known for their ‘mediocre levels’ of service delivery (Lipsky 1993).

Further research may tease out different typologies of bottom-up policy implementers, categorizing those with intrinsic motivations and those without, and characterizing contrasting outputs. Future research may benefit from insights from this study regarding methods and design. Through the use of mixed methods and cross-agency comparison, detailed and context-rich examinations of the reasons that individuals fail to implement policy were possible. For example, without in-depth interviews, contestation of seemingly straightforward concepts would not be obvious, such as the nuanced definitions across agencies of “what it means to do science.” Points of agreement among individual practitioners, only made obvious through a comparative design, lead to findings that showed where real incentives can be offered to encourage implementation of more robust forms of adaptive management. For instance, regardless of agency, respondents nearly universally agreed that there was a need for improvement to data management practices – practices that are critical to the learning component of adaptive management.

Another possibility is devolving responsibility for planning implementation, over the long and short term, to experts who have to do it, and putting accountability mechanisms in place to ensure that plans are followed. For example, conservation plans for each individual refuge on the NWRS are required through federal legislation; this law could be a starting point for an addendum that also requires planning for the implementation of adaptive management. Those with day-to-day responsibilities on the refuge are responsible for writing the implementation plans, thereby, increasing buy-in and legitimacy. This process would enable the so-called ‘thinly stretched guys’ described by so many in the FWS to plan context-relevant implementation programs that reflect their budgets, resources, and capacity. This way, their expertise and discretion is tapped into, and more realistic plans are formed. These plans could also follow USGS style guidelines for more positivistic science in adaptive ecological restorations. Devolved planning for adaptive management implementation may be the first step to experts across the DOI viewing adaptive management as more of a *continuum*, instead of two opposing paradigms where experts must quarrel for legitimacy. Despite the differences outlined here between implementers in the FWS and the USGS, there was a stated openness to

work cooperatively for mutual gains, a reassuring finding with implications for natural resource management in the US.

### Acknowledgements

Thanks to Larry Susskind, Michael Piore, and Judy Layzer for comments on this paper. Additional thanks to the two anonymous referees who contributed much thought and substance to the final version of this manuscript.

### Disclosure statement

No potential conflict of interest was reported by the author.

### Notes

1. A restoration is a process where natural resource managers administer treatments to an ecosystem with hopes that it will return to a healthy state.
2. Learning is the process of increasing information that we know about a system's response to treatments. Learning can inform decisions on what future treatments a resource requires.
3. Individual practitioners within the US Fish and Wildlife and the United States Geological Survey (USGS) work to implement adaptive management but it is important to note that the USGS is the science agency of the Department of the Interior (DOI) and as such holds no land. Other agencies within the DOI such as US Fish and Wildlife or the Bureau of Land Management can invite the USGS to cooperate on projects where practitioners implement adaptive management on these land holdings.
4. According to *The Adaptive Management Technical Guide*, adaptive management is a, "decision process that promotes flexible decision making that can be adjusted in the face of uncertainties [...] It is not a 'trial and error' process, but rather emphasizes learning by while doing. Adaptive management does not represent an end in itself but rather a means to more effective decisions and enhanced benefits" (Williams, Szaro, and Shapiro 2007, vii).

### References

- Adler, Nancy J., and Mariann Jelinek. 1986. "Is 'Organization Culture' Culture Bound?" *Human Resource Management* 25 (1): 73–90.
- Allan, C., and C. Allan. 2005. "Nipped in the Bud: Why Regional Scale Adaptive Management is Not Blooming." *Environmental Management* 35 (3): 414–425.
- Allen, Craig R., Joseph J. Fontaine, Kevin L. Pope, and Ahjond S. Garmestani. 2011. "Adaptive Management for a Turbulent Future." *Journal of Environmental Management* 92 (5): 1339–1345.
- Allen, Craig R., and Lance H. Gunderson. 2011. "Pathology and Failure in the Design and Implementation of Adaptive Management." *Journal of Environmental Management* 92 (5): 1379–1384.
- Bardach, E. 1977. *The Implementation Game: What Happens After a Bill Becomes a Law*. Vol. 1. Cambridge, MA: MIT Press.
- Braun, Virginia, and Victoria Clarke. 2006. "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology* 3 (2): 77–101.
- Clarke, J.N., and D. McCool. 1996. *Staking Out the Terrain: Power and Performance Among Natural Resource Agencies*. Albany, NY: SUNY Press.
- Danter, K.J., D.L. Griest, G.W. Mullins, and E. Norland. 2000. "Organizational Change as a Component of Ecosystem Management." *Society and Natural Resources* 13 (6): 537–547.
- Denzin, N.K., and Y.S. Lincoln. 2000. "The Discipline and Practice of Qualitative Research." in *Handbook of Qualitative Research 2*, edited by N.K. Denzin and Y.S. Lincoln, 1–28. London: Sage.
- Dodgson, Mark. 1993. "Organizational Learning: A Review of Some Literatures." *Organization Studies* 14 (3): 375–394.

- Downs, A., and Rand Corporation. 1967. *Inside Bureaucracy*. Boston, MA: Little, Brown, 264.
- Gregory, Robin, Lee Failing, and Paul Higgins. 2006. "Adaptive Management and Environmental Decision Making: A Case Study Application to Water Use Planning." *Ecological Economics* 58 (2): 434–447.
- Gunderson, Lance. 1999. "Resilience, Flexibility and Adaptive Management: Antidotes for Spurious Certitude." *Conservation Ecology* 3 (1): 7. [http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/2472/http\\_\\_\\_www.ecologyandsociety.org\\_vol3\\_iss1\\_art7\\_.pdf?sequence=1&isAllowed=y](http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/2472/http___www.ecologyandsociety.org_vol3_iss1_art7_.pdf?sequence=1&isAllowed=y)
- Gunderson, Lance H. 2001. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington DC: Island Press.
- Heinrich, C.J., and G. Marschke. 2010. "Incentives and Their Dynamics in Public Sector Performance Management Systems." *Journal of Policy Analysis and Management* 29 (1): 183–208.
- Hilborn, Raymond, and Carl J. Walters. 1992. "Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty." *Reviews in Fish Biology and Fisheries* 2 (2): 177–178.
- Hogwood, B.W., and L.A. Gunn. 1984. *Policy Analysis for the Real World*. Vol. 69. Oxford: Oxford University Press.
- Holling, Crawford S. 1978. *Adaptive Environmental Assessment and Management*. Caldwell, NJ: Blackburn Press.
- Holling, Crawford S., and Gary Meffe. 1996. "Command and Control and the Pathology of Natural Resource Management." *Conservation Biology* 10 (2): 328–337.
- Johnson, F.A., M.J. Eaton, J.H. Williams, G.H. Jensen, and J. Madsen. 2015. "Training Conservation Practitioners to be Better Decision Makers." *Sustainability* 7 (7): 8354–8373.
- King, Nigel, and Cristina Horrocks. 2010. *Interviews in Qualitative Research*. London: Sage.
- Kingsford, Richard T., Harry C. Biggs, and Sharon R. Pollard. 2011. "Strategic Adaptive Management in Freshwater Protected Areas and Their Rivers." *Biological Conservation* 144 (4): 1194–1203.
- Langdrige, Darren. 2008. "Phenomenology and Critical Social Psychology: Directions and Debates in Theory and Research." *Social and Personality Psychology Compass* 2 (3): 1126–1142.
- Lee, K.N. 1994. *Compass and Gyroscope: Integrating Science and Politics for the Environment*. Washington DC: Island Press.
- Lipsky, M. 1978. "Standing the Study of Public Policy Implementation on its Head." in *American Politics and Public Policy*, edited by Walter Dean Burnham and Martha Weinberg, 391–402. Cambridge, MA: MIT Press.
- Lipsky, M. 1993. "Street-Level Bureaucracy: An Introduction." *The Policy Process: A Reader*, edited by Michael James Hill, 381–385. London: Harvester-Wheatsheaf.
- Lyons, J.E., M.C. Runge, H.P. Laskowski, and W.L. Kendall. 2008. "Monitoring in the Context of Structured Decision-Making and Adaptive Management." *The Journal of Wildlife Management* 72 (8): 1683–1692.
- McLain, Rebecca J., and Robert G. Lee. 1996. "Adaptive Management: Promises and Pitfalls." *Environmental Management* 20 (4): 437–448.
- Moore, Clinton T., Eric V. Lonsdorf, Melinda G. Knutson, Harold P. Laskowski, and Socheata K. Lor. 2011. "Adaptive Management in the US National Wildlife Refuge System: Science-Management Partnerships for Conservation Delivery." *Journal of Environmental Management* 92 (5): 1395–1402.
- Nichols, James D., Fred A. Johnson, and Byron K. Williams. 1995. "Managing North American Waterfowl in the Face of Uncertainty." *Annual Review of Ecology and Systematics* 26: 177–199.
- Nichols, James D., and Byron K. Williams. 2006. "Monitoring for Conservation." *Trends in Ecology and Evolution* 21 (12): 668–673.
- Pressman, J.L., and A.B. Wildavsky. 1984. *Implementation: How Great Expectations in Washington are Dashed in Oakland: Or, Why it's Amazing That Federal Programs Work at All, This Being a Saga of the Economic Development Administration as Told by Two Sympathetic Observers Who Seek to Build Morals on a Foundation of Ruined Hopes*. Berkeley: University of California Press.
- Runge, M.C. 2011. "An Introduction to Adaptive Management for Threatened and Endangered Species." *Journal of Fish and Wildlife Management* 2 (2): 220–233.

- Sabatier, P.A. 1986. "Top-Down and Bottom-up Approaches to Implementation Research: A Critical Analysis and Suggested Synthesis." *Journal of Public Policy* 6 (01): 21–48.
- Sabatier, P., and D. Mazmanian. 1980. "The Implementation of Public Policy: A Framework of Analysis." *Policy Studies Journal* 8 (4): 538–560.
- Schein, Edgar H. 1993. "How Can Organizations Learn Faster? The Challenge of Entering the Green Room." *Sloan Management Review* 34 (2): 85–92.
- Schein, Edgar H. 1996. "Culture: The Missing Concept in Organization Studies." *Administrative Science Quarterly* 41: 229–240.
- Selznick, Philip. 1948. "Foundations of the Theory of Organization." *American Sociological Review* 13 (1): 25–35.
- Spaargaren, G. 2011. "Theories of Practices: Agency, Technology, and Culture: Exploring the Relevance of Practice Theories for the Governance of Sustainable Consumption Practices in the New World-Order." *Global Environmental Change* 21 (3): 813–822.
- Stake, R.E. 2013. *Multiple Case Study Analysis*. New York: Guilford Press.
- Stankey, G.H., B. Bormann, C. Ryan, B. Shindler, V. Sturtevant, R. Clark, and C. Philpot. 2003. "Adaptive Management and the Northwest Forest Plan: Rhetoric and Reality." *Journal of Forestry* 101 (1): 40–46.
- Stern, P.C. 2000. "New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior." *Journal of Social Issues* 56 (3): 407–424.
- Walters, Carl J. 1986. *Adaptive Management of Renewable Resources*. New York: Blackburn Press.
- Walters, Carl. 1997. "Challenges in Adaptive Management of Riparian and Coastal Ecosystems." *Conservation Ecology* 1 (2): 1. [http://legacy.juniata.edu/projects/it110/ms/References/460\\_Coastal%20Zone%20management/Protected%20areas%20and%20management/1\\_Adaptive%20coastal\\_management.pdf](http://legacy.juniata.edu/projects/it110/ms/References/460_Coastal%20Zone%20management/Protected%20areas%20and%20management/1_Adaptive%20coastal_management.pdf)
- Walters, Carl J. 2007. "Is Adaptive Management Helping to Solve Fisheries Problems?" *AMBIO: A Journal of the Human Environment* 36 (4): 304–307.
- Walters, Carl J., and Crawford Stanley Holling. 1990. "Large-Scale Management Experiments and Learning by Doing." *Ecology* 71 (6): 2060–2068.
- Walters, Carl J., and Ray Hilborn. 1978. "Ecological Optimization and Adaptive Management." *Annual Review of Ecology and Systematics* 9: 157–188.
- Walters, Carl J., and Roger Green. 1997. "Valuation of Experimental Management Options for Ecological Systems." *The Journal of Wildlife Management* 61: 987–1006.
- Weiss, C. H. 1978. "Improving the Linkage Between Social Research and Public Policy." in *Knowledge and Policy: The Uncertain Connection*, edited by Laurence E. Lynn Jr, 23–81. Washington, DC: National Academies Press.
- Williams, Byron K. 2011a. "Adaptive Management of Natural Resources—Framework and Issues." *Journal of Environmental Management* 92 (5): 1346–1353.
- Williams, Byron K. 2011b. "Passive and Active Adaptive Approaches." *Journal of Environmental Management* 92 (5): 1371–1378.
- Williams, Byron K., Mitchell J. Eaton, and David R. Breininger. 2011. "Adaptive Resource Management and the Value of Information." *Ecological Modelling* 222 (18): 3429–3436.
- Williams, Byron K., Robert C. Szaro, and Carl D. Shapiro. 2007. *Adaptive Management: The US Department of the Interior Technical Guide*. Washington DC: US Department of the Interior, Adaptive Management Working Group.
- Wilson, James Q. 1989. *Bureaucracy*. New York: Basic Books.
- Yin, Robert K. 2009. *Case Study Research: Design and Methods*. Vol. 5. London: Sage.