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# Improving our legacy: Incorporation of adaptive management into state wildlife action plans

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## ARTICLE INFO

## ABSTRACT

The loss of biodiversity is a mounting concern, but despite numerous attempts there are few large scale conservation efforts that have proven successful in reversing current declines. Given the challenge of biodiversity conservation, there is a need to develop strategic conservation plans that address species declines even with the inherent uncertainty in managing multiple species in complex environments. In 2002, the State Wildlife Grant program was initiated to fulfill this need, and while not explicitly outlined by Congress follows the fundamental premise of adaptive management, 'Learning by doing'. When action is necessary, but basic biological information and an understanding of appropriate management strategies are lacking, adaptive management enables managers to be proactive in spite of uncertainty. However, regardless of the strengths of adaptive management, the development of an effective adaptive management framework is challenging. In a review of 53 State Wildlife Action Plans, I found a keen awareness by planners that adaptive management was an effective method for addressing biodiversity conservation, but the development and incorporation of explicit adaptive management approaches within each plan remained elusive. Only ~25% of the plans included a framework for how adaptive management would be implemented at the project level within their state. There was, however, considerable support across plans for further development and implementation of adaptive management. By furthering the incorporation of adaptive management principles in conservation plans and explicitly outlining the decision making process, states will be poised to meet the pending challenges to biodiversity conservation.

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## 1. Introduction

The loss of biodiversity is repeatedly identified as the primary threat to long-term ecosystem resilience, with the potential to undermine natural ecosystem function, and threaten human socio, political, and economic stability (Rockström et al., 2009). Concerns about biodiversity have increasingly led to efforts to reduce the rate of species loss, but despite the good intentions of numerous public and private organizations, the number of species at risk continues to rise. In the United States alone there are currently >1900 species listed as threatened or endangered, with potentially thousands more at risk (USFWS, 2010a). Unfortunately, species at risk of future endangerment too often fail to receive significant management consideration because traditional resource allocation in wildlife management focuses primarily on game and endangered species. Moreover, while conservation backstops such as the Endangered Species Act have proven successful at preventing species extinction,

the costs of maintaining populations of critically endangered species is often politically and economically prohibitive, and the bio-functionality of such small populations is questionable (Traill et al., 2010). With limited resources and multiple threats there is a great need to develop strategic conservation efforts that proactively address the continuing threats to biodiversity, and although there is considerable discussion about large scale conservation implementation (e.g., Margules and Pressey, 2000; Groves, 2003), there are surprisingly few successful examples (Halpern et al., 2006).

In 2002, Congress created the State Wildlife Grant program to provide funding to state fish and wildlife management agencies with the goal of maintaining biodiversity, and avoiding the costly and controversial regulations that accompany listing under the Endangered Species Act (AFWA, 2010; USFWS, 2010b). To receive federal funding to support non-game wildlife management, each state was charged with developing a comprehensive wildlife conservation strategy or State Wildlife Action Plan (SWAP). Using the best available science, each plan was meant to articulate a broad vision and conceptual framework for the long-term conservation of biodiversity with an emphasis on proactively conserving declining species and habitats. In 2005, each state submitted an inaugural

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SWAP to the U.S. Fish and Wildlife Service. With consideration of 500 + species per plan (Fig. 1) the SWAPs represent the first national strategic conservation effort for non-game wildlife, and offer a clear opportunity to succeed where other approaches have thus far failed.

To ensure success, and force state agencies to move beyond traditional management approaches, Congress deemed that each plan must incorporate eight central elements (Table 1) including not only management considerations, but also monitoring and programmatic review. While not explicitly outlined by Congress, these elements form the foundation of adaptive management, a management paradigm that aims to continually assess management practices as a means to address uncertainty both in knowledge and outcome (Figs. 2 and 3). The use of adaptive management for managing declining species may be particularly appropriate as adaptive management explicitly acknowledges and attempts to address the uncertainty inherent in managing species where basic biological information and an understanding of appropriate management strategies is often lacking. However, the development of an effective adaptive management framework is challenging. Here I review SWAPs to assess the degree to which each plan developed an integrated and iterative adaptive management framework and discuss the challenges to meeting this goal.

## 2. Literature review

To assess the incorporation of adaptive management in SWAPs I reviewed 53 plans including all 50 states, the District of Columbia, and two territories (Puerto Rico, Northern Marias Island). The majority of plans were available online (AFWA, 2010), but when necessary I contacted state program managers to obtain plans. All SWAPs reviewed here are the inaugural versions presented by the states to the Fish and Wildlife Service in 2005. The purpose of the review was to evaluate plans based on the extent to which states incorporated adaptive management philosophies and developed an integrated adaptive management framework within their plan. Central to this process was identifying the intent of states to implement an adaptive management program upon completion of the plan. A recent resurgence of interest in adaptive management from policymakers, managers, and scientist alike
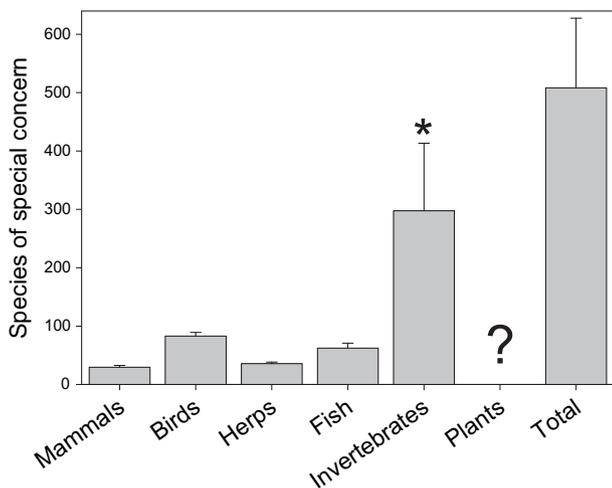
**Table 1**
The eight elements of the State Wildlife Grant program. As part of the founding legislation of the program, Congress mandated states address eight key elements.

| | |
|---|---|
| 1. Species | Information on the distribution and abundance of species indicative of the diversity and health of wildlife |
| 2. Habitat | Descriptions of locations and conditions of habitats essential to species conservation |
| 3. Threats | Problems affecting species/habitats and efforts to restore and improve conservation |
| 4. Actions | Actions proposed to conserve species/habitats and priorities for implementation |
| 5. Monitoring | Plans for monitoring species/habitats and the effectiveness of conservation actions |
| 6. Review | Descriptions of procedures to review SWAP |
| 7. Coordination | Plans to coordinate development, implementation, review, and revision of SWAP with stakeholders |
| 8. Public participation | Broad public participation is essential for developing and implementing SWAP |

(e.g., Williams et al., 2009) has created an environment that favors acknowledgement of adaptive management, but has not necessarily fostered the conditions for implementation.

## 3. Methodology

To begin the evaluation process I searched each SWAP for references to "adaptive management" or other such terms (e.g., adaptive resource management, adaptive ecosystem management, adaptive harvest management). I searched for explicit references because although a plan may inadvertently adhere to the overarching principles of adaptive management, by focusing on specific terminology I hoped to separate accident from action. Moreover,
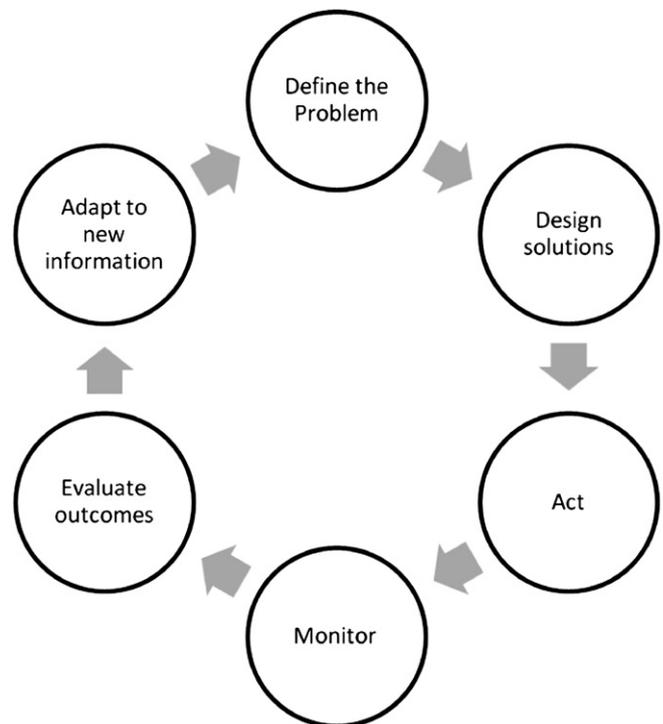


**Fig. 1.** The State Wildlife Grant program protects a variety of non-game wildlife. States listed an average of >500 species of special concern, but these lists represent a conservative estimate of the threats to biodiversity as most states limited discussion of invertebrates to mussels and a few groups of arthropods and only two states explicitly identified plant species.



**Fig. 2.** Adaptive management, often characterized as 'learning by doing', is most simply represented by an iterative decision circle. More precisely, however, adaptive management is a formal iterative process of resource management that acknowledges decision uncertainty and achieves management objectives by increasing system knowledge through a structured feedback process of predictive modeling, management actions, and detailed monitoring (modified from Williams et al., 2009).
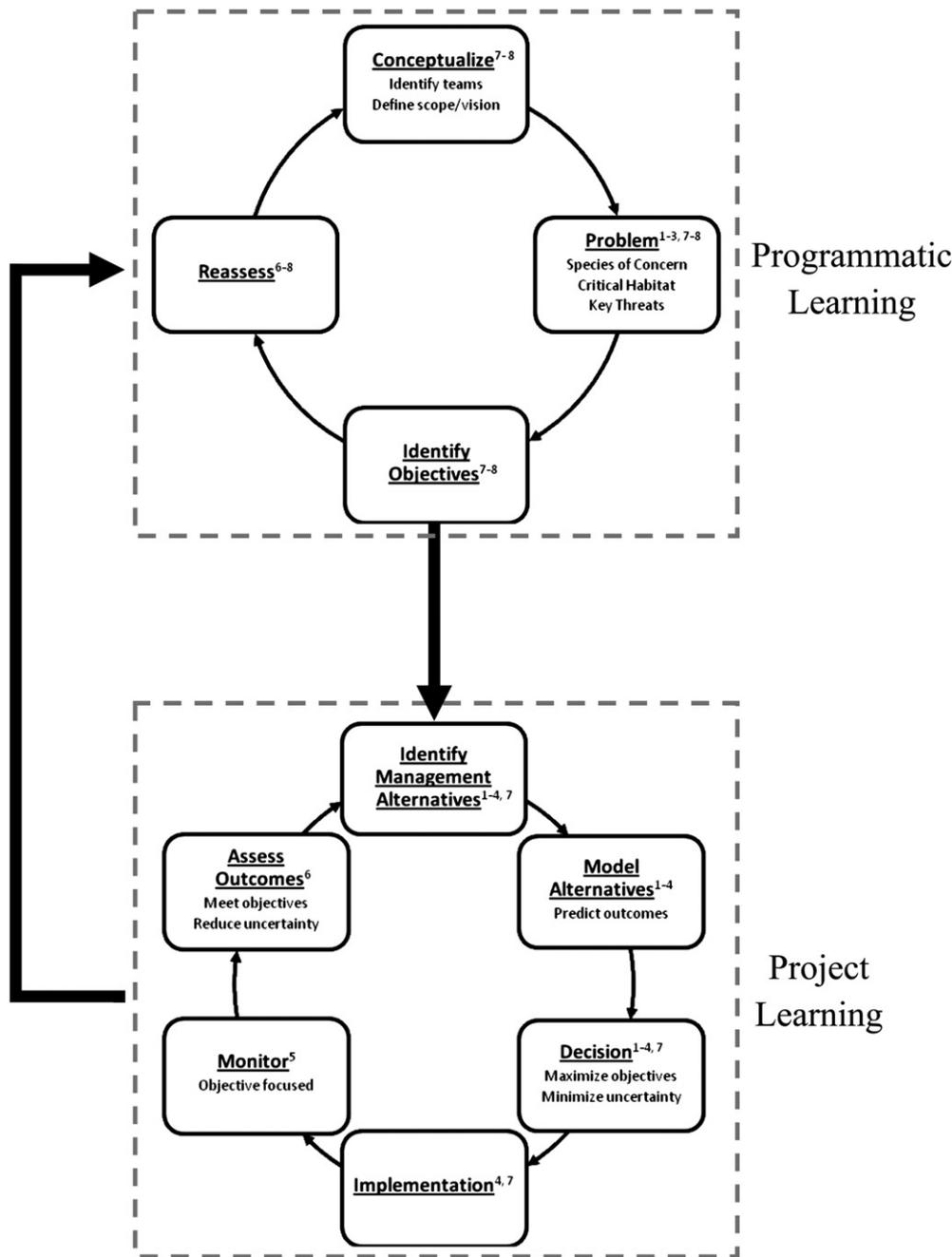
**Fig. 3.** The required elements of the State Wildlife Grant program are inclusive in a double-loop learning cycle of adaptive management. Double-loop learning (Argyris, 1999) is a model of understanding where actions are modified to obtain desired outcomes while simultaneously questioning the values, assumptions and policies that led to the actions in the first place. This concept is elementary to adaptive management (Williams et al., 2009), and modified here to show how the eight key elements outlined by Congress are inclusive in the adaptive management cycle. Here, programmatic learning represents natural resource ethics and values and the process of learning is primarily driven by policymakers, stakeholder groups and the public. In contrast, project learning represents the science and management of natural resources and thus the process of learning is primarily driven by scientists and resource managers. Both states of learning feed into one-another and both are constantly evolving as neither ecological nor social-economic systems are static even when decisions are not being made. Superscripts refer to element numbers from Table 1 that allude to particular stages of the adaptive management cycle.

effective design and subsequent implementation of an adaptive management program requires acknowledgement of key assumptions and criteria. Inadvertent references to processes inherent in adaptive management fail to acknowledge these assumptions and criteria, decreasing the likelihood of success despite the best intentions of the authors. I also searched for references to "structure decision making", a term often used in conjunction with or as a synonym for adaptive management. In actuality structured decision making is problem solving approach best used to facilitate

the development of objectives by stakeholder groups and evaluate alternative decision pathways to meet those objectives. As such, structured decision making is a model for programmatic learning, but does not necessitate the project level learning necessary in adaptive management; although it may be used to facilitate this process as well. There are however, clear benefits to using structured decision making, and the process has gained considerable favor by the U.S. Fish and Wildlife Service and others (e.g., USFWS, 2010c).

If a plan was found to use either term, I further searched the SWAP for a definition, either implicit or explicit, of adaptive management. Adaptive management has multiple meanings that fall upon a continuum of complexity and *a priori* design, starting from the simple (e.g., "learning by doing") and progressing to the more explicit (e.g., Figs. 2 and 3; Holling, 1978; Wilhere, 2002; Aldridge et al., 2004). The purpose here is not to dispute the definition of adaptive management, but rather to argue that SWAPs should explicitly define adaptive management to ensure effective communication and to elucidate intent. Obviously there is a clear distinction in intent, investment, and ultimately success between a plan that proposes to learn from prior management decisions and one that outlines a concise feedback mechanism dependent upon sound scientific principles on which future management decisions will be made.

Focusing on the use of the term "adaptive management" and the subsequent definition as a starting point, I constructed a comparative index based on a hierarchy starting with whether individual plans: (1) mention adaptive management, (2) suggest an interest in integrating adaptive management philosophies in management implementation, (3) developed an integrated iterative process based on adaptive management principles for programmatic level development, (4) developed an integrated iterative process based on adaptive management principles for project level development, or (5) developed one or more "plug-n-play" adaptive management frameworks for specific taxa, habitats, or threats designed for near-term implementation. The purpose of the index is to further elucidate the true intent of states to develop and implement adaptive management strategies by considering the additional effort beyond the plan that would be necessary to reach implementation.

By mentioning or suggesting adaptive management, the authors of a SWAP may acknowledge the suitability of adaptive management to fulfill the needs of the State Wildlife Grant program, but fail to give managers or policymakers suitable direction on how best to proceed. In contrast, the development of an adaptive management framework at the programmatic or project level (Fig. 3) gives future decision makers a path upon which to make decisions, although the specifics details may need further development. Programmatic and project level frameworks clearly differ in key components and ultimately the effort necessary for development. At the programmatic level adaptive management is meant to guide decision makers through the process of identifying the fundamental objectives and the methods to ensure that those objectives are met and regularly reconsidered given new stakeholder input, new information, and emerging threats. This process is highly value-laden, and benefits from approaches that enable multiple stakeholder input in a transparent environment (e.g., structured decision making). At the project level adaptive management is less focused on fundamental objectives and more focused on the means by which to reach those objectives. At this level, adaptive management is meant to guide managers through the process of identifying alternative management strategies and methodologies for monitoring and assessing management outcomes in light of programmatic objectives. The development of a framework to move through this process can be general (e.g., we will develop alternative management strategies weighted by the best current information) or specific (e.g., we will implement and monitor the outcome of the following four management practices). The later example of a "plug-n-play" framework is highly developed with specific references to alternative management strategies, *a priori* modeling and post implementation monitoring protocols, and methods for assessing the ability of management outcomes to meet program objectives. A "plug-n-play" adaptive management framework is ready for immediate implementation, with sufficient detail to effectively manage specific habitats, species or threats despite the level of uncertainty.

Clearly, the progression from mentioning adaptive management to the development of a "plug-n-play" framework requires considerable increases in both interest in adaptive management and investment toward meeting the goal of an effective adaptive management program. As each step is a progression dependent upon the prior step (Fig. 3), by focusing on how SWAPs progress in the development of adaptive management along the index we can begin to understand the willingness and readiness of states to implement adaptive management for non-game resources.

## 4. Results and discussion

The benefits of incorporating adaptive management approaches into State Wildlife Action Plans were not lost on state planners. Of the 53 plans, all but one explicitly mention adaptive management, and most (83%) suggest that adaptive management is an appropriate approach for non-game wildlife management that should be incorporated into SWAP implementation (Fig. 4); however, no plans made reference to structured decision making. Failure to acknowledge or incorporate structured decision making into the planning process is particularly surprising, first because structured decision making has prominence in the Fish and Wildlife Service, the agency for whom SWAPs were written. Second, the organization and transparency inherent in the process of structured decision making is ideal for facilitating complex decisions with enormous implications (e.g., species of special concern list). Many SWAPs highlighted the challenge of making these decisions and the need for an effective method for overcoming this challenge. Consideration of structured decision making techniques may help facilitate these decisions and give a basis of support to future amendments or challenges to individual SWAPs. Lastly, the framework of structured decision making is an ideal template for the iterative decision making and learning that defines adaptive management; therefore, it is reasonable that the endorsement of adaptive management in the SWAPs would carry with it at least a recognition, if not an endorsement, of the structured decision making process.
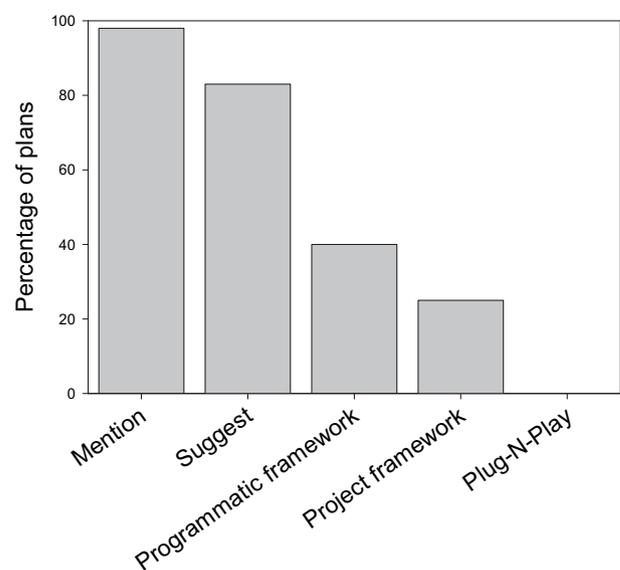


**Fig. 4.** State Wildlife Action Plans showed limited progression toward adaptive management implementation. While most plans mention or suggest adaptive management as a means to non-game wildlife management, the development of a constructive framework at either the programmatic or project level was limited.

Although all but one plan referenced adaptive management and many had specific sections dedicated to the topic (66%), there remained significant hurdles toward implementation. The first challenge stemmed from an inability to define adaptive management, with nearly half the plans (47%) failing to attempt a definition. Plans with explicit definitions varied significantly and most plans had only vague references to the 'process', 'principles', 'spirit', or 'context' of adaptive management with no clear understanding of the meaning of these terms to the authors or subsequently to stakeholders, policymakers or managers. Definitions were further confused because most plans discussed adaptive management in conjunction with monitoring, in many cases insinuating that monitoring is somehow adaptive management. While monitoring is an important component of an adaptive management program, monitoring in isolation is clearly not adaptive management. The failure and confusion in defining adaptive management and the discrepancy between states may simply reflect an argument of semantics (Aldridge et al., 2004), but the lack of a coherent and unified approach to adaptive management may predict larger systematic problems.

Given the vast scale and number of participants involved in the successful implementation of a SWAP, failure to clearly define adaptive management may hamper management implementation at multiple levels within a given state. Confusion among stakeholders or between various levels of managers or policymakers may result in nonconformity in application and ultimately failure. For example, if a manager reading a SWAP is left to their own interpretations, they may interpret the meaning of a reference to adaptive management as simply "learn-as-you-go" (Hilborn, 1992; Halbert, 1993). The result of this interpretation is the reasonable, but inappropriate, assumption that changing management actions when they fail is adaptive management (i.e., trial and error learning); however, the intent of the authors of the SWAP may include a more rigorous *a priori* design focused on reducing uncertainty. In this example, the failure to elucidate the meaning of adaptive management from the perspective of the authors may ultimately lead to programmatic failure.

The challenge of inconsistent and even lacking definitions is further compounded when considered beyond the boundaries of individual states. Although the State Wildlife Grant program is based on state management of wildlife resources, the intent and the overall purview of the program inherently extends regionally, nationally or even internationally. Inconsistent or contradictory approaches to adaptive management among plans will certainly lead to confusion among state agencies, but more importantly this confusion may limit the ability of the U.S. Fish and Wildlife Service to develop a more comprehensive non-game adaptive management program analogous to the North American Waterfowl Management Plan (USFWS, 2010d). Often cited as the pinnacle of adaptive management, the North American Waterfowl Management Plan has successfully overcome the challenge of working across borders and among agencies by forming a foundation of clear objectives set in a common vernacular. If the State Wildlife Grant program is to achieve the status of the North American Waterfowl Management Plan and ensure the integrity of biodiversity for future generations, there must be replicable and consistent approaches to adaptive management among states founded upon a common definition.

The challenge for the authors and indeed, everyone interested in the successful implementation of an adaptive management plan is how best to define adaptive management. Graphical representations (e.g., Fig. 3) are helpful, but an explicit definition that references the intent as well as the processes of adaptive management is likely still necessary (e.g., Fig. 2). In addition, case studies of successful and unsuccessful adaptive management programs are widely documented in the literature (e.g., Allan and Stankey, 2009; Mysiak et al., 2010), and references to closely related examples not only have the benefit of insight into the meaning of adaptive management, but the process as well. Indeed, eleven SWAPs (21%) referenced a current or historical adaptive management program from which to model SWAP implementation. Another approach commonly evoked to help define adaptive management is to outline key or fundamental components of the process. In the literature references to the fundamentals of adaptive management (e.g., Lee, 1993; Wilhere, 2002; Williams et al., 2009; Argent, 2010) often differ, but include discussion of the importance of 1) clear objectives, 2) the iterative decision process and the decision maker, 3) partners and participants, 4) uncertainty and the opportunity to learn, 5) action despite uncertainty, 6) predictive models, 7) management and monitoring to reduce uncertainty, and 8) a commitment to the process. By focusing on the key components of adaptive management, SWAP authors can articulate the context dependent meaning of adaptive management as it relates to the specific goals of non-game wildlife management. Ultimately, successfully defining a seemingly nebulous term such as adaptive management to a diverse audience may require the inclusion of a multitude of approaches.

The second challenge faced by SWAP authors was developing a conceptual framework for adaptive management. Only 21 of the plans (40%) presented a rigorous framework for adaptive management at the programmatic level, even fewer presented project level approaches (25%), and none of the plans had a "plug-n-play" framework meant for immediate implementation. The lack of a "plug-n-play" framework is not unexpected, and may even be appropriate for a document with an obviously broad purview; however, the incomplete development of a programmatic framework was more surprising. The required elements outlined by Congress (Table 1) functionally mimic programmatic learning (Fig. 3), and given that all plans addressed these elements it would seem self-evident that all plans developed a framework for programmatic level adaptive management. At the most basic level this is true. All plans present a problem, identify objectives, and suggest a process of reassessment; however, following from the lack of a clear definition of adaptive management there was confusion over the reassessment process and the rigor of that procedure. In particular, there was confusion between continual reassessment of objectives (i.e. programmatic learning) and assessment of the ability of management actions to meet those objectives (i.e. project learning). This seemingly minor discontinuity can lead to discrepancies in the process of assessment, even within a single SWAP, and clearly creates obstacles to understanding how information learned at the project level is used to inform programmatic decisions. In defense of the SWAP authors, however, the problems and confusion surrounding the assessment process is a predictable outcome of the Congressional mandates (Table 1). While programmatic review is clearly outlined by Congress, management assessment is not, but rather is buried under the heading of monitoring. Although this may appear to be a minor lack of emphasis by Congress, it is important to realize that monitoring is not evaluation, but the means by which to gather data for the purpose of evaluation. It is also important to realize that at the programmatic level the outcome of a management action is not likely to be the primary source of uncertainty. Changing conditions, be they economic, social, or ecological, and the resulting impacts on stakeholder input are likely to play a much larger role in shaping future objectives (Manfredo, 2008). To ensure the long-term success of the State Wildlife Grant program each SWAP must include a clear, concise, and most importantly, transparent timeline and procedure for continual review of programmatic objectives that emphasizes multi-source learning (e.g., social

and political), not only learning from management actions (Berkes and Folke, 1998; Armitage et al., 2010; Allen and Jacobson, 2009).

Whether states effectively developed a framework for programmatic level adaptive management may be subjective, even arguable, but the lack of project level adaptive management is not. With few exceptions, most SWAPs failed to even begin to mention methods for identifying alternative management actions, procedures for a priori predictive modeling, or the process of assessing management outcomes. While there was more discussion of management implementation and monitoring procedures, even these often lacked the clarity necessary for implementation. Ultimately, clear articulation of project level approaches to adaptive management will be necessary to ensure success at the state level or across the State Wildlife Grant program.

## 5. Conclusions

There can be no doubt that the burden placed upon states to manage such an array of species is incredible. The lack of knowledge and the uncertainty of outcome can be overwhelming and lead to management paralysis. Adaptive management is an effective means to manage wildlife resources proactively while acknowledging and mitigating uncertainty, and while states have done well to begin to incorporate adaptive management approaches into their respective SWAPs, there remains room for improvement. To meet this challenge, state planners must begin to develop an explicit framework for adaptive management implementation that considers both programmatic and project learning. Daunting and time intensive the process may seem untenable, but there are opportunities to build on what has been done and learn from others. Consideration of adaptive management success stories (e.g., adaptive harvest management of waterfowl; Williams and Johnson, 1995; Williams, 2006), and examples from other SWAPs will help facilitate this process, as will technical guides and scientific literature aimed at helping conservation practitioners develop adaptive management programs (e.g., Salafsky et al., 2001; Allan and Stankey, 2009; Margoluis et al., 2009; Williams et al., 2009).

Unfortunately an adaptive management framework is only the beginning. The success of the State Wildlife Grant program, and thereby biodiversity conservation in the United States, ultimately rides on the implementation of each SWAP. All state fish and wildlife agencies have a storied legacy of resource management, but to achieve their SWAP goals each state will have to build upon previous successes. Improvement begins by emphasizing strengths and strengthening weaknesses. State agencies, like nearly all wildlife and land management agencies, have historical strengths in involving stakeholders, implementing management actions, and assessing management outcomes. Where challenges arise are in the methods and support for identifying fundamental objectives, implementing monitoring programs, and developing competing and testable models of management outcomes. Overcoming these challenges may require a considerable shift in the current paradigm of wildlife management, but based on the efforts of the SWAP authors, the states seem poised to meet this challenge.

## Acknowledgements

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