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Invited Article

Learning and Adaptation in Waterfowl Conservation: By Chance or By Design?

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ABSTRACT The most recent revision of the North American Waterfowl Management Plan seeks to increase the adaptive capacity of the management enterprise to cope with accelerating changes in climate, land-use patterns, agency priorities, and the waterfowl and wetlands constituency. Institutional and cultural changes of the magnitude envisioned are necessarily slow, messy processes, involving many actors who at a minimum must agree on the need for change. Waterfowl conservation now finds itself in the transition zone between business as usual and some new mode of operation. There are at least 2 different perspectives of this transition: one focuses on process, accountability, and planning for change; another focuses on solutions generated from an organic process of creativity, information sharing, and risk-taking. Both of these views have something to contribute, but some in the wildlife management enterprise may tend to focus more on the first view. We suggest that ideas from panarchy theory, especially those related to the behaviors of complex adaptive systems, can help waterfowl managers better understand and foster the institutional changes they seek. © 2016 The Wildlife Society.

KEY WORDS adaptation, adaptive management, complex adaptive system, decision-making, panarchy, waterfowl conservation.

The 2012 revision of the North American Waterfowl Management Plan (NAWMP Revision; http://nawmprevision.org/) is part of a growing trend in conservation in which social and ecological systems are seen to be linked, with each affecting the behaviors of the other (Holling 2001). The approach has less to do with managing for a steady stream of ecological goods and services and more to do with expanding the capacity of socio–ecological systems to cope with uncertainty and adapt to change. This "resilience" perspective emphasizes the need for continual learning at multiple scales, with careful attention to cross-scale effects and feedbacks (Folke 2006). Adaptive management can play a critical role in building this culture of learning, in which the focus is on planned, iterative learning for problems that are well-bounded and characterized by conservation objectives and actions that are tightly linked (Johnson and Williams 2015). An increasingly recognized challenge in application of adaptive management, however, is indeterminism in the social context of management (Humburg et al. 2006, Tyre and Michaels 2011). Even in these cases, however, adaptive management can foster social learning about the objectives and actions used to frame and determine management policies, and the forms of resource governance that are conducive to healthy, resilient socio–ecological systems. We discuss these ideas about learning and adaptation in the context of the waterfowl management enterprise.

The NAWMP Revision describes 3 interrelated goals: 1) to create and maintain abundant and resilient waterfowl populations to support hunting and other uses without imperiling habitat; 2) to create and maintain wetlands and related habitats sufficient to sustain waterfowl populations at desired levels, while providing places to recreate and ecological services that benefit society; and 3) to increase numbers of waterfowl hunters, other conservationists, and citizens who enjoy and actively support waterfowl and wetlands conservation. The NAWMP Action Plan (http://nawmprevision.org/sites/default/files/NAWMP%20Action%20Plan%20Dec%202012-final%20w%20memo%20and%20cover.pdf) goes on to provide a number of recommendations for pursuing these goals; here, we focus on 1) increasing adaptive capacity so structured learning expands as part of the culture of waterfowl management and program effectiveness increases; and 2) integrating waterfowl management to ensure programs are complementary, inform resource investments, and allow managers to understand and weigh tradeoffs among potential actions. These recommendations focus on the culture, institutional arrangements, and governance structure of the waterfowl management enterprise. In particular, the NAWMP Action Plan suggests that the 3 federal government agencies having management authority for migratory birds should consider comprehensive, long-term changes in processes and institutions to ensure the

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simultaneous pursuit of all 3 principal goals. Referred to as "coherence" (Runge et al. 2010) and later as "integration," institutional transformation has been a key theme of the NAWMP Revision. However, although there has been notable progress in this regard from a technical perspective (Runge et al. 2010, Mattsson et al. 2012), agreement on the nature and extent of institutional change remains elusive.

Why would this be so? In part, perhaps because scientists are largely being tasked with this mission, and scientists tend to think in a linear manner: identify a research question, select the methods, collect and analyze data, and draw conclusions. It is a tried-and-true approach for understanding and manipulating physical and biological systems. However, we question how well linear thinking works when applied to understanding and designing social systems, where how people "feel" about an idea is at least as important as how sensible, prudent, or rational it is (Gunderson and Holling 2002). Thus, perhaps the waterfowl management community might be better served by expending less time on planning change and more time on understanding and enabling the process of change.

THEORIES OF CHANGE

Nichols (2000) described learning and adaptation in waterfowl management as an evolutionary process, with selective pressures shaping changes in the philosophy and policies of the management enterprise. It is a great metaphor, but biological evolution is an autonomous process without the benefit of human foresight and intentionality. We can learn and adapt by design. We can plan to change. Yet development of waterfowl conservation may have more in common with biological evolution, where adaption is driven by chance rather than design, than is commonly appreciated.

Life is an example of a complex adaptive system, consisting of a diversity of components, interacting to produce pattern, with natural selection choosing what patterns persist and proliferate (Levin 1999). Social systems (families, communities, governments, institutions) are also complex adaptive systems, with diverse individuals interacting, and with morals, traditions, and governing bodies acting as agents of selection (Norberg and Cumming 2008). All complex adaptive systems have an evolving nature that is characterized by an ongoing cycle of exploitation, conservation, release, and reorganization (Fig. 1; Holling 2001). A large body of theory encompassing these ideas about change in linked social–ecological systems is termed "panarchy" (Gunderson and Holling 2002).

Here, we briefly describe the 4 phases of the adaptive cycle with special reference to human institutions to provide context for what follows. We begin with the exploitation or growth phase, in which the interest is in the design of operating protocols and pursuit of efficiency. Single-loop (i.e., incremental) learning dominates (Pahl-Wostl 2009). Uncertainty declines over time, as decision-makers become more knowledgeable, experienced, and confident. Importantly, conflict is diminished because decision-makers share a common frame of reference. The exploitation phase is followed by the conservation phase, which is characterized by

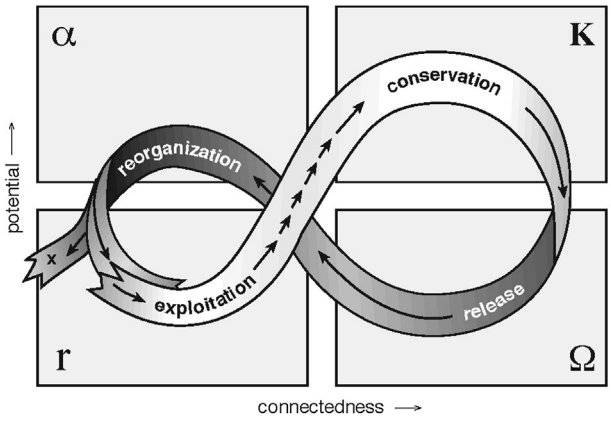

Figure 1. A stylized representation of the 4 phases in the dynamics of complex adaptive systems. From Panarchy by L. Gunderson and C. S. Holling. Copyright © 2002 Island Press. Reproduced by permission of Island Press, Washington, D.C., USA.

increasing predictability in decision-making and economies of scale. Dynamic systems, however, do not always tend toward stationarity. Tension can build, generated by an overreliance on rules and procedures, overspecialization, disregard for dissenting opinions that threaten the status quo, group-think, and a dichotomy of interests. The institution eventually may become brittle, lacking the adaptive capacity to cope with new and unanticipated challenges. This recognition is typically followed by a release phase of relatively rapid change, typically stimulated by crisis and the realization that old ways are not up to new challenges. The history of waterfowl management is replete with examples of institutional change in the face of crises: market hunting and the Migratory Bird Treaty; the Dust Bowl and the "Duck Stamp"; habitat deterioration and the Farm Bill and North American Wetlands Conservation Act; and conflict in the regulatory process and adaptive harvest management (Johnson 2011). Today, the "rising challenges presented by a changing climate, social changes, the effects of global economic pressures on land-use decisions, and fiscal restraint faced by agencies" (http://nawmprevision.org/) has NAWMP framers focused on the reorganization phase, where new modes of operation are considered and where old connections among actors—managers, stakeholders, bureaucrats, scientists, and politicians—are critically examined and new ones explored (Walker et al. 2004). New actors can emerge and novel ideas can be generated. Yet it is also a time when uncertainty is high and predictability is low (Holling 2001). Whatever form the transformative change ultimately takes, it occurs as a result of this reassortment process and the selective pressures—ecological, economic, political, philosophical, and judicial—that eventually produce what may be an uneasy consensus for moving forward (Lee 1993, Holling 2001).

PROPOSITIONS FOR SEEKING CHANGE

Panarchy theory provides a rich set of propositions (Holling 2001, Gunderson and Holling 2002, Folke 2006, Walker et al. 2006) for navigating the change that NAWMP seeks:

1) Large scales constrain. Small scales innovate. In managing natural resources, rules, laws, treaties, and cultural norms encode a memory of past experiences and help guide the search for solutions (Folke 2006). However, they also constrain what is possible in seeking change and often are highly resistant to change. For example, some in the waterfowl community have observed that the long-standing division between institutions for waterfowl habitat and harvest management at the national scale represents considerable resistance to institutional change. It is worth noting that novel solutions in response to crises rarely originate from this level of social systems (Lee 1993, Levin 1999). Usually it is creative individuals or small groups that challenge the status quo and provide the novel ideas that are the "mutations" upon which selection acts.
2) Sustain modularity, but build bridges. Connections, linkages, and integration are useful and necessary, but only up to a point (Levin et al. 2013). Excessive interconnections mean that crises can cascade through the system (e.g., the global economy). A process in which many management decisions are tightly linked can be prone to system-wide failure if only a small number of the individual decision-making processes fail for some reason (e.g., political intervention). Waterfowl managers can benefit from the fact that conservation decision-making is modular (i.e., it is highly context-dependent and scale-specific). Even when different decision-makers share a common set of objectives, the tradeoffs they make and actions they take can involve juggling multiple levels of governance, from local stakeholders to regional institutions and national politics; the view of this governance landscape will vary widely among decision-makers (Gunderson and Holling 2002). This context dependency imposes limits on linkages and integration and helps sustain modularity. Of course, too much modularity—the silo problem—is not beneficial either (Levin et al. 2013). Managers can build bridges to share information and experiences and increase the diversity of ideas, so solutions to broader problems can emerge. This function may be best served by a third-party individual or group without a vested interest in the desired linkages—sometimes called a bridging or boundary organization, or an honest broker (Pielke 2007, Berkes 2009). The Joint Task Group exploring coherence in waterfowl management was an example of a bridging organization (http://nawmprevision.org/sites/default/files/jtg_final_report.pdf). Another role, evident in the creation of the NAWMP Interim Integration Committee (http://nawmprevision.org/), is a group of "boundary runners" who work across institutions, maintaining the trust to represent their "silo" while seeking integrated alternatives.
3) Promote diversity. Without diversity, selection has nothing to act upon. A diversity of functional groups, as well as diversity within groups, can help generate novel ideas (Gunderson and Holling 2002, Walker et al. 2006). Many at the forefront of waterfowl research and management share similar backgrounds and experiences. As a result, this community can lack diversity, and homogeneity can be paralyzing when faced with challenges beyond the realm of collective experience (Levin et al. 2013). Useful institutional change can be fostered by including those who have a different relationship with waterfowl and wetlands with those who have more traditional training and experience in consumptive resource use.
4) Manage adaptively. The waterfowl management community could better foster adaptive management (Johnson and Williams 2015), including both single and double-loop learning (Pahl-Wostl 2009), at small spatial and temporal scales where the lessons of success and failure are more recognizable and tangible (Humburg and Anderson 2014). Perhaps of more interest to framers of the NAWMP Revision is triple-loop learning, sometimes referred to as adaptive governance (Folke et al. 2005, Pahl-Wostl 2009). Adaptive governance occurs not by design but by messy processes of restructuring and renewal (Gunderson and Holling 2002, Folke et al. 2005). Some scholars have argued that adaptive management and adaptive governance are co-dependent (Folke et al. 2005). If so, the search for a more adaptive mode of governance could be enhanced by broader application of adaptive management. For this broader application to occur, those within the waterfowl management enterprise would need to consider changes in governance before triple-loop learning and adaptation can ensue.
5) Tighten feedback loops. Feedback is essential to learning. Managers should be able to quickly recognize what works and what does not and modify their actions accordingly. Decision-makers can ill afford to continue practices that are clearly not beneficial or have outlived their usefulness. If the cost of this malpractice is spread too widely, however, there may be little incentive to change. This is the tragedy of the commons (Hardin 1968). As problems become broader in scale/scope, feedback to those exploring change becomes looser, individuals see their actions as less relevant, motivation declines, and change becomes more difficult (Levin 1999). This is why bottom-up processes can be more effective than top-down ones; problems are more tightly bounded, relevant, and the consequences of decisions more meaningful to the participants (Folke et al. 2005).
6) Timing is everything. The capacity for change depends on where you are in the adaptive cycle (Holling 2001, Folke 2006). Transformative change is frequently preceded by increasingly brittle institutions that lack the capacity to cope with disturbance and surprise. After 20 years of seeking efficiency, the U.S. adaptive harvest-management program finds itself asking whether we are doing the right things (Johnson et al. 2015). Although the harvest-management institution might be ripe for renewal, it remains unclear whether other aspects of the management enterprise are in the same phase of the adaptive cycle and, therefore, positioned for transformation. In fact, because waterfowl habitat management is fundamentally

decentralized, nonregulatory, and populated by a plurality of actors operating in informal networks, it can be relatively resilient to disturbance (or crisis; Holling 2001, Levin et al. 2013). This resilience can be an asset if the adaptive capacity of the institution is sufficient to absorb the disturbance (or crisis) without disrupting its basic functions. It can be a liability, however, if transformative change is required to remake the institution. What seems critical at this time is whether the institutions of harvest and habitat management can agree on the extent of the paradigm shift needed to confront the changing social and ecological contexts of waterfowl conservation. Perhaps contributing to this lack of clarity is the NAWMP Revision's call for more management efficiency through an integrated program designed to simultaneously address objectives for populations, habitat, and people. Remember that increasing efficiency is the growth phase of the adaptive cycle, where operating protocols are developed and refined based on a common frame of reference. The ongoing NAWMP Revision notwithstanding, a broadly accepted, common frame of reference has yet to emerge.

CONCLUSIONS

It is not surprising that years after publication of the NAWMP Revision, decision-makers are still struggling with what the future of waterfowl conservation might look like (Humburg and Anderson 2014). Institutional changes of the magnitude envisioned in the NAWMP Revision are necessarily slow, messy processes, involving many actors who at a minimum must agree on the need for change. A critical mass is needed to tip the scale toward change. How is this critical mass achieved? It is worth remembering that ideas for change in social systems take hold not only because they are sensible, prudent, or rational; they must also "feel right" (Gunderson and Holling 2002). Those in the waterfowl conservation community may not pursue a course of action, no matter how sound, unless they can make the cause their own. Therefore, the waterfowl community might consider spending less time asking how to do integrated management and more time debating whether it is needed and, if so, why it should be the priority.

Waterfowl conservation today finds itself in the "groan zone" between business-as-usual and a new mode of operation (Kaner et al. 2014). There are 2 different perspectives of the groan zone: one focuses on process, accountability, and planning for change; and another focuses on creative solutions generated from an organic process of creativity, information sharing, and risk-taking. Both views have something to offer, but scientists and managers may be biased toward the first view. We suggest that the waterfowl community could benefit from also embracing the other view, recognizing that it can provide the seeds of change. The process of institutional change often resembles an organized anarchy, in which a loosely interacting set of actors, ideas, and institutions exist in a "primordial soup," where what happens is as much a matter of chance as design, and where timing and luck matter a great deal (Lee 1993). As such, transformation lies at the boundary of order and chaos where learning and adaptation flourish (Waldrop 1992, Kauffman 1995).

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