

Implementing the 2012 North American Waterfowl Management Plan: people conserving waterfowl and wetlands

DALE D. HUMBURG¹ & MICHAEL G. ANDERSON²

¹Ducks Unlimited, Inc., One Waterfowl Way, Memphis, Tennessee 38120, USA.

²Ducks Unlimited Canada, Institute for Wetland and Waterfowl Research,
P.O. Box 1160, Stonewall, Manitoba R0C 2Z0, Canada.

*Correspondence author. E-mail: dhumburg@ducks.org

Abstract

The North American Waterfowl Management Plan (NAWMP) is a continental ecosystems model for wildlife conservation planning with worldwide implications. Since established in 1986, NAWMP has undergone continual evolution as challenges to waterfowl conservation have emerged and information available to support conservation decisions has become available. In the 2012 revision, the waterfowl management community revisited the fundamental basis for the Plan and placed greater emphasis on sustaining the Plan's conservation work and on integration across disciplines of harvest and habitat management. Most notably, traditional and non-traditional users (*i.e.* hunters and wildlife viewers) of the resource and other conservation supporters are integrated into waterfowl conservation planning. Challenges ahead for the waterfowl management enterprise include addressing tradeoffs that emerge when habitat for waterfowl populations versus habitat for humans are explicitly considered, how these objectives and decision problems can be linked at various spatial and temporal scales, and most fundamentally how to sustain NAWMP conservation work in the face of multi-faceted ecological and social change.

Key words: conservation planning, habitat, harvest, human dimensions, hunters.

Conservation planning for waterfowl in North America has, for nearly 30 years, emphasised continent-scale population objectives and associated goals for populations, habitat, and users at various geographical scales, such as administrative Flyways and Joint Ventures of the North American Waterfowl Management Plan

(NAWMP). These linked features are not new to wildlife conservation and certainly not to waterfowl management. As modern waterfowl conservation was in its formative stages, Fredrick Lincoln, originator of the Flyways concept testified before the 75th Congress relating the key elements of populations, habitat and waterfowl

hunting (U.S. Government Printing Office 1937):

Populations: *“It is my opinion at the present time that we have about a third of the number of ducks and geese that we had 10 or 15 years ago.”*

Habitat: *“Furthermore, I am not satisfied that we can have the population we had 10 or 15 years ago, as I am not sure we could accommodate them all.”*

Hunters: *“Nevertheless, I am satisfied that we are steadily progressing toward the time when we can enjoy reasonable sport.”*

Efforts to develop a U.S. national waterfowl management plan during the late 1970s and early 1980s also included a focus on habitat, populations and recreational use of the resource. Richard Myshak, presenting a summary of the emerging national plan at the 1981 International Waterfowl Symposium in New Orleans (Myshak 1981), listed the goals for waterfowl management as: 1) preserve and manage the habitat needed to maintain and increase waterfowl numbers; 2) achieve optimum waterfowl population levels in relation to available habitat; and 3) provide optimum opportunity for people to use and enjoy waterfowl.

With concerns about deteriorating habitat, persistent drought in the northern plains during the 1980s, declining populations and controversy over the effects of hunting on waterfowl populations, the Canadian government at the same time initiated strategic planning for waterfowl conservation (Patterson 1985). Together, these U.S. and Canadian efforts formed the vanguard for negotiations that ultimately led to completion of the NAWMP in 1986. The

NAWMP established explicit, continental scale, numeric objectives for waterfowl populations. In a summary statement, NAWMP’s authors proposed:

“Meeting these goals would provide opportunity for 2.2 million hunters in Canada and the United States to harvest 20 million ducks annually. The harvest would include 6.9 million mallards, 1.5 million pintails and 675,000 black ducks. It would also provide benefits to millions of people interested in waterfowl for purposes other than hunting” (U.S. Department of the Interior and Environment Canada 1986, page 6).

Concerning specific habitat goals, the authors stated:

“The overall aim of this continental habitat program is to maintain and manage an appropriate distribution and diversity of high quality waterfowl habitat in North America that will (1) maintain current distributions of waterfowl populations and (2) under average environmental conditions, sustain an abundance of waterfowl consistent with [population] goals ... (U.S. Department of the Interior and Environment Canada 1986, page 13).

Subsequent Plan updates continued evolution of the NAWMP by expanding the continental partnership to include Mexico, expanding habitat objectives to sustain growing waterfowl populations (NAWMP Committee 1994), broadening conservation strategy to regional landscapes, diversifying partnerships, and managing adaptively relative to environmental and human dynamics (NAWMP Committee 1998), and strengthening the biological foundation of waterfowl conservation planning (NAWMP

Committee 2004). Despite relatively specific goals and assumptions outlined in the 1986 NAWMP and continued updates to the Plan, ambiguity remained concerning the definition of “average environmental conditions,” the extent to which harvest management should be used to achieve population goals, and lack of an explicit connection between habitat management and population goals (Runge *et al.* 2006).

Integration and efficiency were key themes as the waterfowl management community strived to develop coherence among habitat management, population management, and harvest (Runge *et al.* 2006; Anderson *et al.* 2007). Expanding dialogue about integrated management planning for waterfowl led to the Future of Waterfowl Management Workshop in August 2008 (Case & Sanders 2008) where participants agreed that work on human dimensions of waterfowl management should continue and that the next update of NAWMP should develop increasingly coherent goals for waterfowl harvest and habitat management.

Focus on integration and reassessment of fundamental goals for waterfowl management meant the 2012 NAWMP was viewed as a revision rather than as an update of the Plan (NAWMP Committee 2012a). An extensive series of stakeholder workshops during 2009–2011 was designed to break down administrative silos across waterfowl management public and private sectors. The workshops identified three strategic foci for NAWMP 2012: 1) relevance to contemporary society; 2) adaptable to changing ecological and social systems; and 3) effective and efficient with limited funding and staff resources. Ultimately,

the consultation process yielded three fundamental goals for North American waterfowl management: 1) abundant and resilient waterfowl populations to support hunting and other uses without imperilling habitat; 2) 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) growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation. These goals are important in two ways, firstly for the continued emphasis on healthy waterfowl populations and habitat to support them and secondly, in providing the new explicit goal for waterfowl supporters.

The context of the 2012 Plan was notably different than in the 1980s when a “duck crisis” was extant with record low numbers of breeding waterfowl and also deteriorating habitat conditions. In contrast, breeding waterfowl populations in the traditional survey areas in North America were at record levels during 2011–2013 (USFWS 2013) and with > 15 years of liberal hunting seasons and bag limits, the sense of urgency was less apparent. However, mid-continent breeding ground conditions aided by years of above average moisture masked the underlying deterioration of waterfowl habitat due to wetland drainage and the loss of grasslands. Additionally, growing impacts on the once pristine boreal forests in Canada, water challenges in the south and west United States, and Gulf Coast marsh loss due to sea-level rise and subsidence will likely soon have an effect on birds and in turn wildfowlers. Overall, waterfowl habitat in key North

American landscapes is being lost faster than it is being conserved, and threats to these landscapes are growing as human populations increase, water quality and quantity continue to erode, energy issues often dominate land use decisions, and a changing climate presents long-term pressures that exacerbate current threats. Moreover, numbers of waterfowl hunters have declined to half of 1970s levels (Vrtiska *et al.* 2013; Raftovich & Wilkins 2013) and conservation budgets are not keeping pace with challenges facing waterfowl. Indeed, the growing detachment of North Americans from nature (*e.g.* Louv 2006) is also a great concern for future conservation. Clearly, the need for continued focus on waterfowl conservation through NAWMP is paramount.

Priorities for implementation are found in > 30 key actions in the 2012 NAWMP Action Plan and in the following seven recommendations (NAWMP Committee 2012b):

1. **Develop, revise or reaffirm NAWMP objectives** so that all facets of North American waterfowl management share a common benchmark.
2. **Integrate waterfowl management** to ensure programs are complementary, inform resource investments and allow managers to understand and weigh tradeoffs among potential actions.
3. **Increase adaptive capacity** so structured learning expands as part of the culture of waterfowl management and programme effectiveness increases.
4. **Build support for waterfowl conservation** by reconnecting people

with nature through waterfowl and by highlighting environmental benefits associated with waterfowl habitat conservation.

5. **Establish a Human Dimensions Working Group** to support development of objectives for people and ensure actions are informed by science.
6. **Focus resources on important landscapes** that have the greatest influence on waterfowl populations and those who hunt and view waterfowl.
7. **Adapt harvest management strategies** to support attainment of NAWMP objectives.

Here, we consider recommendations 1–3. Building support for waterfowl conservation (#4 above) has become primarily the responsibility of a new “Public Engagement Team” formed under the international NAWMP Committee. The Plan Committee and the National Flyway Council also have recently founded a new Human Dimensions Working Group (#5 above) for the purpose of providing social science technical support and advice to waterfowl conservation. Efforts to focus resources on the most important landscapes (#6 above) have been initiated by the NAWMP Science Support Team; and work to adapt harvest strategies relative to revised NAWMP goals (#7 above) is pursued by the existing Harvest Management Working Group chaired by the U.S. Fish & Wildlife Service.

Initial progress toward implementing the 2012 NAWMP Revision requires focus on recommendations 1–3 that will define

actions by the waterfowl management community toward integration across populations, habitat, and waterfowl supporters. Chief among these is the need to revisit objectives established in the 1986 Plan. As an essential feature of structured decision-making and adaptive management (Williams *et al.* 2009), objective setting provides context for identifying management alternatives, monitoring and the future review of objectives. Thus, the focus for initial implementation will be on fundamental objectives and means to accomplish these objectives.

Objectives serve three primary purposes in conservation planning: 1) they operate as a communication and marketing tool to demonstrate the need for conservation; 2) they provide a biological basis and planning foundation; and 3) they function as a performance measure for assessing conservation accomplishments. Thus, managers must be clear about how best to craft and communicate revised objectives. Objectives should be linked at administrative and implementation scales whereby tradeoffs can be identified and efficiencies gained with available resources.

Population objectives

Objectives for waterfowl populations have remained largely unchanged since 1986. Benchmarks for several goose populations have been amended due to dramatic changes in abundance and distribution of geese; however, most duck objectives have not been revisited despite changes in bird numbers, breeding and non-breeding landscapes, and the hunter population. Experience gained since the mid-1980s

provides perspectives on appropriateness of revisions in population objectives. Substantial land-use changes have occurred in some landscapes resulting in variation in the capacity of habitats to support waterfowl. Managers recognise the extent of variation in annual environmental conditions and question utility of striving for population averages. In addition, the degree of management influence on population dynamics remains uncertain. Finally, managers have increased their knowledge and experience of the responses of birds to habitat restoration and management and the impacts of harvest regimes.

Numeric population objectives have been particularly important for habitat managers who translated resource requirements of birds into objectives for protection, restoration and management of habitat. Population objectives, framed as averages, remain problematic as management targets because of variation in wetland conditions and other key environmental influences on waterfowl populations. Moreover, active, adaptive management requires sophisticated monitoring to track population vital rates and environmental conditions. Additionally, population objectives should also be consistent with goals for habitat and human use. Because these criteria frequently have not been met, a more rigorous conceptual perspective on population status, interaction of birds with their habitat and expectations for resource use is required.

As NAWMP population objectives are reassessed, legitimate alternatives will be considered. Among these are establishment of an objective at a relatively high level, a minimum level below which managers are

concerned about sustaining populations, a “normal” operating range that reflects variation in population size and distribution attributable to uncontrolled environmental processes and the simultaneous management of multiple species and populations. Gains in management outcomes will be limited by the level of technical support required, data needed to inform decisions and the degree of complexity in the process. Although daunting, progress on these fronts has been made. For example, life-cycle modelling for Northern Pintail (*Anas acuta*; Mattson *et al.* 2012), scaup species (*Aythya affinis* and *A. marila*; Austin *et al.* 2014; Osnas *et al.* 2014) and American Black Duck (*Anas rubripes*; Devers & Collins 2011) has already seen considerable progress.

Objectives for waterfowl supporters

The 2012 NAWMP Revision explicitly acknowledged people as fundamental to the Plan. The decline in wildfowling is acknowledged and integrated into management planning. Considerable changes in social structure, an aging population and a shift to urban residence all contribute to this decline (Louv 2006; Wentz & Seng 2000). Most managers recognise the need to increase the relevance of waterfowl conservation to constituencies beyond hunters; however, this need is poorly understood and not accepted as important by the entire waterfowl management community. Three interest groups are specifically mentioned in the 2012 revision of the Plan – waterfowl hunters, bird-watchers and waterfowl conservation supporters. The particular weight placed on

each in the management process is largely dependent on subjective values placed on numbers of birds, distribution, harvest opportunity, viewing and ecological services provided by landscapes that support birds and humans. There will not be a “right” answer with respect to objectives related to people. The emerging question is “Whose values matter and to what degree?” Values of waterfowl hunters, harvest managers, bird-watchers and landowners are different but all are legitimate, so tradeoffs inevitably will be necessary.

Objectives for waterfowl habitat

Protection, restoration and management of habitat are primary conservation tools affecting the capacity of North American landscapes to support waterfowl and waterfowl enthusiasts. Substantial gains over the period of NAWMP implementation, estimated at nearly 7 million ha (<http://www.fws.gov/birdhabitat/NAWMP/index.shtm>), have not necessarily kept pace with net changes in landscapes, but these are poorly quantified (NAWMP Assessment Steering Committee 2007). When developing habitat objectives, managers should take into account the association between waterbird numbers and the carrying capacity of the landscape, as well as the influence of variable environmental conditions on population demography and distribution.

Stepping-down continental objectives for habitat to regional or local scales is a logical process; however, it is largely dependent on selection of continental population objectives and an understanding of the influence of regional habitat on population processes. Thus, a key initial step for the

revised NAWMP is to establish population objectives, despite considerable uncertainty about factors regulating populations of different species and the influence of habitats in different landscapes. Efficient allocation of conservation budgets also requires acknowledgment of the on-going status of habitats – whether secure or at risk in the near or long-term. Stepping-down revised population objectives will not be a trivial matter. Trends in land use and agricultural markets worldwide represent significant influences on waterfowl conservation efforts, and sustaining habitat carrying capacity for continental waterfowl populations will be challenging, especially with added complexity to satisfy objectives from all waterfowl enthusiasts. For successful waterfowl conservation, needs of human users of the resources must be considered and addressed using balanced strategies.

To date, most habitat management partnerships have considered waterfowl population objectives with only limited regard for human considerations except for addressing factors directly affecting habitat delivery (*e.g.* funding for conservation and for landowners' acceptance of programme options). Additionally, habitat for those other than traditional users (hunters) has been considered only rarely. Complexity in planning habitat management for the benefit of waterfowl will increase as managers acknowledge that landscapes valuable for waterfowl also have values beyond the interests of ducks and hunters. Habitat objectives that integrate goals for waterfowl, other wildlife, and humans present tradeoffs that may be quite different across landscapes. For instance, factors

affecting waterfowl recruitment and survival versus those that determine engagement by users vary considerably among regions. Strictly from a waterfowl perspective, emphasis on breeding habitat is appropriate because the factors primarily affecting population growth rates occur during the breeding season (see Hoekman *et al.* 2002; Koons *et al.* 2006; Coluccy *et al.* 2008). Human populations, however, are distributed differently (*e.g.* most reside outside the breeding grounds), and habitat managed for users will present considerations beyond the traditional mission of habitat delivery for waterfowl alone. Waterfowl managers therefore will be challenged to formulate habitat objectives in the context of consumptive and non-consumptive human use plus continental waterfowl population objectives.

From individual objectives to an integrated system – challenges at multiple scales

The 2012 NAWMP Revision accepted that successful management of waterfowl populations, conservation of waterfowl habitat, and engagement of waterfowl users and supporters are inseparably linked components of waterfowl conservation. To manage the different components effectively and responsively, a management system that embraces these interrelationships should be employed. Such a coherent system will help focus on things that matter most for efficient achievement of all NAWMP goals.

An integrated management system should inform resource investment decisions by allowing managers to understand and weigh

tradeoffs among potential actions. This approach will require increased adaptive capacity, and institutions and processes that enable united action. Features of an integrated management system should include quantifiable, coherent objectives; an overarching framework comprised of linked models; decision tools that help inform resource allocations at multiple spatial and temporal scales; coordination among multiple management authorities and decision nodes; and monitoring and assessment to track progress and enable adaptation.

As NAWMP planners proceed with development of an integrated system they face two immediate technical and process challenges: firstly, how will multiple objectives for waterfowl management be established? Can they rely on existing institutions and do they need the assistance of a new entity with overarching facilitation functions? Whatever the process, it will need to be iterative and adaptive. Secondly, how will managers monitor progress toward achieving expanded NAWMP objectives and adapt actions to results? For instance, what technical and human resources will be needed, and who will make the many adaptive decisions going forward? Indeed, no existing entity possesses clear responsibility for all interrelated decision-making that will emerge in an integrated system – not the Flyway Councils, not the Service Regulations Committee, not the Plan Committee, and not any single country.

During development of the 2012 Revision an *ad hoc* technical team tried but abandoned efforts to develop a singular formal structured decision making (SDM)

framework for waterfowl management decisions. They recognised a daunting number of decision nodes, many decision makers and decision cycles operating at multiple spatial and temporal scales (Fig. 1), and noted that analytical challenges consistent with multiple objectives under the Plan were not independent. The team involved in preparing the Revision therefore advocated instead “linked decision processes” and a continuing commitment to adaptive management. However, how to link various nodes and scales is not readily apparent, and this need might vary greatly among individual management decision problems (NAWMP Action Plan 2012).

So what might comprise an integrated management system? Certainly, coherent quantifiable objectives would be one component, along with some concept of tradeoffs amid pursuit and fulfilment of multiple objectives. Multiple decision processes required for management of habitats, populations, harvest, users and supporters are likely to be diverse in nature, and we may be well-served by trying various approaches. Several candidate approaches have already been mentioned including elaboration of the Joint Task Group (JTG; Anderson *et al.* 2007) framework, SDM, scenario planning, decision-criteria matrices, resilience thinking and others (Appendix A in NAWMP Committee 2012). Each has advantages and limitations but can provide a basis for prediction, learning and improved decision making over time. In any case, a commitment to monitoring and assessment is critical for progress in understanding system dynamics and improving management performance.

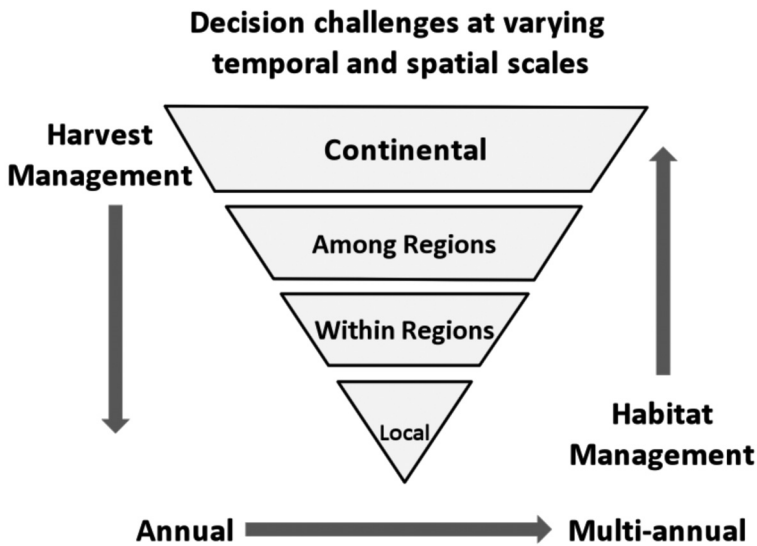


Figure 1. Schematic representation of waterfowl management decisions which are made by different managers and decision-making bodies at multiple spatial and temporal scales. Linking these decisions to bring coherence to the overall management of waterfowl populations is challenging. (Illustration by John M. Eadie, University of California-Davis).

Learning how to achieve multiple objectives simultaneously may be particularly challenging. Using a suite of different conservation projects, or at least some explicit tradeoffs in how individual parcels of habitat are managed, may be valuable. These kinds of tradeoffs need to be addressed in multiple places, as the nature of these tradeoffs will vary among environmental and social regions and over time.

When objectives are selected, an important next step will be to identify main sources of uncertainty that face attainment of objectives. These are likely to include matters of management control and weaknesses in our present knowledge of system dynamics. These uncertainties may also be expressed at multiple spatial and temporal scales and involve multiple human institutions.

Prioritizing among many monitoring and assessment efforts will be challenging, but we may find some approaches that inform multiple questions. Then managers must create the commitment to undertake this vital adaptive management work. A necessary related step will be to identify the main coordination challenges among existing administrative processes and institutions and ensure these are addressed in a manner that allows effective adaptive management for multiple, interrelated objectives.

Linking adaptive management cycles among spatial scales (Fig. 2) would be advantageous. Perhaps the easiest way to visualise this linkage is with a single suite of objectives for habitat conservation (Fig. 2). Adding objectives for waterfowl populations and users should work the same

Linking adaptive cycles across spatial, temporal and institutional scales

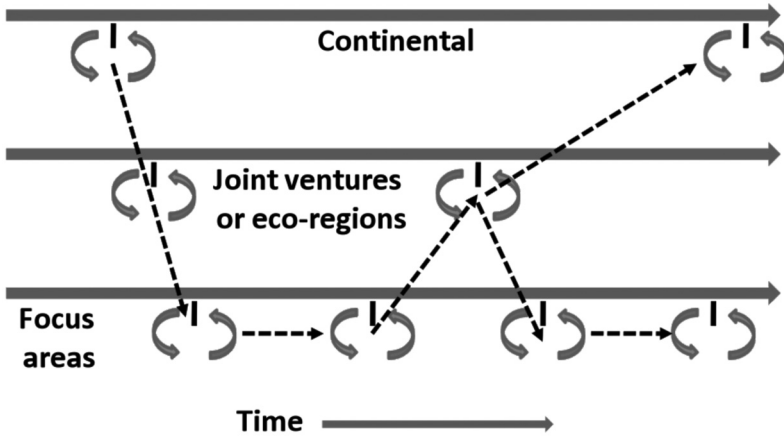


Figure 2. Links between adaptive management cycles at different spatial scales, required to ensure coherence and efficiency in waterfowl habitat management in North America. The left-hand set of links reflects the downward decision-making from continental to local scales; to the right, frequent decisions and feedback at the local scale contribute to regional and ultimately continental decisions and outcomes.

in principle although with added complexity. Adaptive cycles should work most rapidly at the smaller spatial scales where scale-relevant responses should be detectable relatively quickly. Also, existence of many small focal areas presents opportunity for innovation and experimentation in ways that can accelerate learning about system dynamics and veracity of planning assumptions. At the continental and largest scale of interest for NAWMP, cycles of adaptation will happen more slowly but will have great impact when learning and change occur. Clearly, progress is made in well-connected learning organisations (Senge 1990, 2006; Bennis & Biederman 1997). Therefore, we must nurture strong linkages of information exchange between scales

and among management units at equivalent scales, which should foster efficient and effective responses of the whole system to changes and acquisition of new knowledge.

Most of these linked system models are likely to be designed as decision-support tools for specific purposes and at various scales, and no single model is likely to serve the purpose for all decision-support needs. Linkage of decisions seems most important where true co-dependencies exist, such as between harvest potential and habitat carrying capacity or between demographic metrics such as winter survival rates and hunter access and success. Such linked system models should provide a means to predict consequences of management actions for attaining multiple objectives

while resolving uncertainty. Some models will be empirically based and rigorous, relying on long-term data and well-documented demographic responses to management actions. Other models for poorly understood species or processes may be more qualitative or hypothetical.

Increasing adaptive capacity

Once objectives have been established, and key decisions identified and linked, the next logical step is to develop adaptive frameworks and actions that will allow waterfowl managers to learn from management efforts (North American Waterfowl Management Plan Committee 2012). The job of “increasing adaptive capacity,” has at least two major components: 1) developing technical framework and plans to achieve increased capacity, and 2) mustering political and financial support and acquiring leadership to ensure implementation of the plan. Existing technical working groups should be able to address the technical framework, but new collective action seems necessary to garner resources and organise processes amongst institutions so that needed adaptive loops actually function.

With adoption of population, habitat and human goals in the new Plan, there is additional need for integration of goal-setting, modelling, monitoring activities and institutional support systems. The Plan Committee was adequately structured for its initial tasks of overseeing creation of the Joint Ventures, coordinating with the Flyway Councils, and generally guiding evolution of the 1986 Plan. However, changes began with the creation of the NAWMP Science

Support Team (NSST) in 1999. The NSST, with an unfunded science-support mandate, struggled to generate deliverables requested by the Plan Committee. Appointments of JV science coordinators in the US and their part-time assignments to work on the NSST brought much-needed capacity to bear. Coupled with the work of temporary task groups like the NAWMP Continental Assessment team (NAWMP Assessment Steering Committee 2007), the NSST has made several advancements to guide habitat delivery of the Joint Ventures, but have proceeded well short of their plans and potential. Funding important research and planning activities that over-arch multiple JVs has remained particularly challenging.

Today, the broader vision of the 2012 NAWMP Revision has moved waterfowl management and the Plan Committee into a new realm. This new vision includes science support for social and ecological sciences and underscores the importance of the new Human Dimensions Working Group, the NSST and the Harvest Management Working Group. The time is rapidly approaching when increased, adaptive capacity under NAWMP will be mission-critical. When waterfowl managers have renewed explicit objectives to drive integrated decision frameworks, the adaptive capacity needed to support waterfowl management should become both more obvious and urgent.

In summary, by 2016 our collective high-priority waterfowl management goals should be to:

1. **Establish quantifiable objectives** for population and habitat conservation,

harvest opportunity and user participation at appropriate spatial scales and with acknowledged tradeoffs among them.

2. **Design an integrated framework** for making linked harvest, habitat and user-supporter management decisions where important dependencies exist among management objectives.
3. **Design and implement monitoring and evaluation programmes** to track progress toward objectives and inform each key decision problem.
4. **Seek ways to fund the process.**

In doing this we should recognise that we are unlikely to “get it right” from the outset, so we must plan to re-plan. We would be foolhardy to expect that a revised set of NAWMP objectives will serve our needs for the next 28 years as have the original 1986 objectives. This new endeavour will be challenging, technically and administratively – the valuing exercises, the modelling, the adaptive management frameworks, coordinated execution and finding fiscal support for the Plan will be needed to ensure its success. False starts or dead ends seem likely, so there may be advantages in exploring multiple options, especially at smaller scales where relatively rapid replication and learning may be most achievable. In this light, a commitment to managing adaptively may be more important than ever.

Acknowledgments

Co-authors of individual presentations at the 2012 NAWMP session at the Ecology and Conservation of North American

Waterfowl Symposium included Ray Alisauskas, Mike Anderson, Tim Bowman, Bob Clark, John Eadie, Jody Enck, David Fulton, Dale Humburg, Kevin Hunt, Mark Koneff, Andrew Raedeke, Jim Ringelman, Greg Soulliere. Contributors to the 2012 NAWMP revision and to past and future waterfowl conservation include the countless scientists, managers and policy makers who will inform, apply and decide on the path forward. We thank Lisa Webb and Rick Kaminski for helpful comments on an earlier draft of this manuscript.

References

- Anderson, M.G., Caswell, F.D., Eadie, J.M., Herbert, J.T., Huang, M. Humburg, D.D., Johnson, F.A., Koneff, M.D., Mott, S.E., Nudds, T.D., Reed, E.T., Ringelman, J.R., Runge, M.C. & Wilson, B.C. 2007. *Report from the Joint Task Group for Clarifying North American Waterfowl Management Plan Population Objectives and Their Use in Harvest Management*. NAWMP Joint Task Group unpublished report, U.S. Fish & Wildlife Service and U.S. Geological Survey, Washington D.C., USA. Accessible at http://nawmprevision.org/sites/default/files/jtg_final_report.pdf (last accessed 10 July 2014).
- Austin, J.E., Slattery, S., & Clark, R.G. 2014. Waterfowl populations of conservation concern: learning from diverse challenges, models and conservation strategies. *Wildfowl* (Special Issue No. 4): 470–497.
- Bennis, W. & Biederman P.W. 1997. *Organizing Genius: The Secret of Creative Collaboration*. Basic Books, New York, USA.
- Case, D. & Sanders S. 2008. The future of waterfowl management workshop: framing future decisions for linking harvest, habitat and human dimensions. Report 10-9-08. D.J. Case and Associates,

- Mishawaka, Indiana, USA. Accessible at http://www.nawmprevision.org/sites/default/files/future_of_waterfowl_mgt_workshop_final_report.pdf (last accessed 10.07.14).
- Coluccy, J.M., Yerkes, T., Simpson, R., Simpson, J.W., Armstrong, L. & Davis, J. 2008. Population dynamics of breeding mallards in the Great Lakes states. *Journal of Wildlife Management* 72: 1181–1187.
- Devers, P.K. & Collins, B. 2011. *Conservation Action Plan for the American Black Duck, First Edition*. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Laurel, Maryland, USA.
- Hoekman, S.T., Mills, L.S., Howerter, D.W., DeVries, J.H. & Ball, I.J. 2002. Sensitivity analyses of the life cycle of mid-continent Mallards. *Journal of Wildlife Management* 66: 883–900.
- Koons, D.N., Rotella, J.J., Willey, D.W., Taper, M., Clark, R.G., Slattery, S., Brook, R.W., Corcoran, R.M. & Lovvorn, J.R. 2006. Lesser scaup population dynamics: what can be learned from available data? *Avian Conservation and Ecology* 1(3): 6. Accessible at <http://www.ace-eco.org/vol1/iss3/art6/> (last accessed 10 July 2014).
- Louv, R. 2006. *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*. Algonquin Books of Chapel Hill, Chapel Hill, North Carolina.
- Mattsson, B.J., Runge, M.C., Devries, J.H., Boomer, G.S., Eadie, J.M., Haukos, D.A., Fleskes, J.P., Koons, D.N., Thogmartin, W.E. & Clark R.G. 2012. A modelling framework for integrated harvest and habitat management of North American waterfowl: Case-study of northern pintail metapopulation dynamics. *Ecological Modelling* 225: 146–158.
- Myshak, R.J. 1981. National waterfowl management plans: United States viewpoint. *In Ducks Unlimited* (ed.), *Proceedings of the Fourth International Waterfowl Symposium, New Orleans, Louisiana*, pp. 50–52. Ducks Unlimited, Long Grove, Illinois, USA.
- North American Waterfowl Management Plan Assessment Steering Committee. 2007. North American Waterfowl Management Plan: continental progress assessment. Final report. Canadian Wildlife Service, U.S. Fish & Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales and Secretaria de Desarrollo Social. Accessible at <http://nawmprevision.org/sites/default/files/2007ContinentalAssessment.pdf> (last accessed 10 July 2014).
- North American Waterfowl Management Plan Committee. 1994. 1994 update, North American Waterfowl Management Plan: expanding the commitment. Canadian Wildlife Service, U.S. Fish & Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales and Secretaria de Desarrollo Social. Accessible at <http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm> (last accessed 10 July 2014).
- North American Waterfowl Management Plan Committee. 1998. 1998 update, North American Waterfowl Management Plan: expanding the vision. Canadian Wildlife Service, U.S. Fish & Wildlife Service and Instituto Nacional de Ecologia. Accessible at <http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm> (last accessed 10 July 2014).
- North American Waterfowl Management Plan Committee. 2004. North American Waterfowl Management Plan: 2004 strategic guidance strengthening the biological foundation. Canadian Wildlife Service, U.S. Fish & Wildlife Service and Secretaria de Medio Ambiente y Recursos Naturales. Accessible at <http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm> (last accessed 10 July 2014).

- North American Waterfowl Management Plan Committee. 2012a. North American Waterfowl Management Plan: People conserving waterfowl and wetlands. Canadian Wildlife Service, U.S. Fish & Wildlife Service and Secretaria de Medio Ambiente y Recursos Naturales. Accessible at <http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm> (last accessed 10 July 2014).
- North American Waterfowl Management Plan Committee. 2012b. NAWMP Action Plan: A Companion Document to the 2012 North American Waterfowl Management Plan. U.S. Fish and Wildlife Service, Washington D.C. Accessible at <http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm> (last accessed 10.07.14).
- Osnas, E.E., Runge, M.C., Mattsson, B.J., Austin, J.E., Boomer, G.S., Clark, R.G., Devers, P., Eadie, J.M., Lonsdorf, E.V. & Tavernia, B.G. 2014. Managing harvest and habitat as integrated components. *Wildfowl* (Special Issue No. 4): 305–328.
- Pahl-Wostl, C. 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change-Human and Policy Dimensions* 19: 354–365.
- Patterson, J.H. 1985. The Canadian plan. In Ducks Unlimited (ed), *Proceedings of the Fifth International Waterfowl Symposium*, Kansas City, Missouri, pp. 15–17. Ducks Unlimited, Long Grove, Illinois, USA.
- Raftovich, R.V. & Wilkins, K.A. 2013. Migratory bird hunting activity and harvest during the 2011–12 and 2012–13 hunting seasons. U.S. Fish and Wildlife Service, Laurel, Maryland, USA.
- Runge, M.C., Johnson, F.A., Anderson, M.G., Koneff, M.D., Reed, E.T. & Mott, S.E. 2006. The need for coherence between waterfowl harvest and habitat management. *Wildlife Society Bulletin* 34: 1231–1237.
- Senge, P.M. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization*. Doubleday, New York, USA.
- Senge, P.M. 2006. *The Fifth Discipline: the Art and Practice of the Learning Organization. Revised Edition*. Doubleday, New York, USA.
- U.S. Government Printing Office. 1937. Hearing before the Select Committee on Conservation of Wildlife Resources, House of Representatives. U.S. Government, Washington D.C., USA.
- U.S. Department of the Interior & Environment Canada. 1986. *North American Waterfowl Management Plan*. U.S. Department of the Interior, Washington D.C., USA.
- U.S. Fish and Wildlife Service. 2013. Waterfowl population status, 2013. U.S. Department of the Interior, Washington D.C., USA.
- Vrtiska, M.P., Gammonley, J.H., Naylor, L.W. & Raedeke, A.H. 2013. Economic and conservation ramifications from the decline of waterfowl hunters. *Wildlife Society Bulletin*. 37: 380–388.
- Wentz, J. & Seng, P. 2000. Meeting the challenge to increase participation in hunting and shooting. Final Report to the National Shooting Sports Foundation and International Hunter Education Association. Silvertip Productions, Ltd., Reynoldsburg, Ohio, USA.
- Williams, B.K., Szaro, R.C. & Shapiro, C.D. 2009. *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Adaptive Management Working Group, U.S. Department of the Interior, Washington D.C., USA.