

APPLIED ECOLOGY

Artelle *et al.* (2018) miss the science underlying North American wildlife management

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Artelle *et al.* (2018) conclude that “hallmarks of science” are largely missing from North American wildlife management based on a desk review of selected hunting management plans and related documents found through Internet searches and email requests to state and provincial wildlife agencies. We highlight three fundamental problems that compromise the validity of the conclusions posited: missing information to support selection of “hallmarks of science,” confusion about the roles and nature of science and management, and failure to engage effectively with the scientists and managers actively managing wildlife populations in North America.

Artelle *et al.* (1) conclude that “hallmarks of science” are largely missing from North American wildlife management based on a desk review of selected hunting management plans and related documents found through Internet searches and email requests to state and provincial wildlife agencies. Although several conceptual, methodological, and interpretation errors are evident in Artelle *et al.* (1), we highlight three fundamental problems that compromise the validity of conclusions posited: missing information to support selection of hallmarks of science, confusion about roles and nature of science and management, and failure to engage effectively with scientists and managers actively managing wildlife populations in North America.

The article refers to review of “a broad literature spanning the process and theory of science” but did not cite that literature, making it impossible to discern how hallmarks of science were identified (certainly not repeatable given the lack of process description). In dispelling myths about science, McComas (2) pointed out that there is no single scientific method, and therefore scientists regularly approach and solve problems with imagination, creativity, previous knowledge, and perseverance. Thus, the hallmarks of science identified by Artelle *et al.* (1) may not necessarily be expected to occur in every scientific or science-based inquiry applied to decision-making in wildlife management. Failure to identify process-based hallmarks of science in the documents that they reviewed does not necessarily indicate that science was lacking in development of recommendations or program decisions.

Artelle *et al.* (1) have apparently interpreted the assertion “wildlife management is science-based” to mean “the wildlife management process itself follows the scientific method.” Managing resources differs from imperatives of a scientific method. Management agencies rely on systems, knowledge, and practices, or management tools and methods, grounded in peer-reviewed scientific literature (3–6).

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Artelle *et al.* (1) state: “Our results provide limited support for the assumption that wildlife management in North America is guided by science. Most management systems lacked indications of the basic elements of a scientific approach to management.” This conclusion illustrates fundamental confusion within Artelle *et al.* (1) as to whether management is “guided by science” (as a source of inputs or insight) or follows “a scientific approach” (suggesting a particular process). Wildlife and natural resource managers and trustees consider results of scientific investigations as one source of input in making management recommendations (3, 4). Hunted species are managed within a broader sociopolitical system rarely discussed in detail within species management plans (3). Under a “public trust” framework (5), state agencies routinely invite public and expert review and critique of conservation plans through multiple mechanisms (3). Conservation actions by state and provincial agencies are science-informed, meaning that decisions are typically made using best available information and insight from ecological and social science, while also incorporating expertise and wisdom of agency staff, subject experts, stakeholders interested in or affected by the issue, and decision-makers (for example, state wildlife commissioners) (3–6).

This overall process includes the following: defining the need for action; articulating clear objectives, surfacing, understanding, and weighing competing values; considering multiple alternatives; understanding immediate or subsequent consequences of those alternatives; and weighing trade-offs of those consequences against objectives (3–6).

The analyses presented by Artelle *et al.* (1) are based entirely on responses to emails and Internet searches by “one informed non-specialist.” The article does not report any effort to directly engage agency biologists or others [for example, Association of Fish and Wildlife Agencies; Canadian Wildlife Service; U.S. Fish and Wildlife Service (USFWS); U.S. Geological Survey (USGS)] in personal meetings to aid in study design and to help validate whether the approach used would reveal the extent that science underlies management of hunted species. Management plans accessible on agency Internet sites often are intended primarily for lay public and may not include all relevant information about species biology, population dynamics, and harvest management strategies derived from peer-reviewed literature or from direct consultations with wildlife scientists. These documents also may not include all details of processes used to develop the plan. Hence, limited information from a limited search presages conclusions.

Given the disparate sources of information reviewed for the study (harvest statistics, management plans, agency websites about hunting

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regulations, hunter survey results, status, and trends reports), it is difficult to apply the proposed hallmarks systematically and problematic to translate results into practical suggestions for wildlife managers. We suggest that a more robust analysis of these same management systems may very well lead to different conclusions. For example, the article suggests that the reason more hallmarks were identified for big game species is due to the greater significance of these species to hunters. An alternative explanation is that these species may have potentially greater need for current science relative to vulnerability to harvest than other commonly hunted taxa such as leporids and sciurids (7–9), where ample scientific evidence on effects of hunting pressure exists dating back decades, thereby requiring limited investment in additional context-specific science.

Substantial direct and indirect evidence exists to indicate that state fish and wildlife agencies value science and scientific information, as demonstrated by science-focused programs created to support wildlife management, including the USGS Cooperative Fish and Wildlife Research Unit Program (10), which exists to provide state and federal natural resource agencies with management-relevant research. Of more than 550 current investigations in this program in 2017, at least 120 were directed to harvested fish and wildlife species, at the request of and funded by management agencies, with the remainder focused on other science themes and priorities (10). Individual state and provincial agencies also have significant in-house scientific capacity [including more than 700 staff members at the Florida Fish and Wildlife Research Institute (11)] that informs management decision-making. For example, applied research on Newfoundland caribou has been nearly continuous for half a century, emphasizing the following questions: population ecology (12); census techniques (13); habitat selection (14–16); human disturbance (17); food limitation (18); predation, predator ecology, and predator manipulations (17, 19); climate effects (17, 20–22); and morphological change (23). Furthermore, important review mechanisms are provided through the Wildlife and Sport Fish Restoration Program at USFWS to ensure that proposed state research, survey, and management work is substantial in character and design, meaning that current science has informed their actions (24). We believe that efforts to improve and incorporate science into management should be ongoing and championed; Artelle *et al.* (1), while highlighting the importance of science, have failed to accurately describe current conditions.

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