Received: 15 April 2021 | Revised: 16 June 2021 | Accepted: 18 June 2021

DOI: 10.1111/csp2.610

CONTRIBUTED PAPER

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access
WILEY

Reenvisioning the university education needs of wildlife conservation professionals in the United States

Tara L. Teel[1] | **Brett Bruyere**[1] | **Ashley Dayer**[2] | **Kathryn E. Stoner**[3] | **Chad Bishop**[4] | **Jeremy Bruskotter**[5] | **Stephanie Freeman**[6] | **Jennifer Newmark**[7] | **Corey Jager**[8] | **Michael J. Manfredo**[1]

[1]Department of Human Dimensions of Natural Resources, Colorado State University, Fort Collins, Colorado, USA

[2]Department of Fish and Wildlife Conservation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

[3]Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, Colorado, USA

[4]Wildlife Biology Program, W. A. Franke College of Forestry and Conservation, University of Montana, Missoula, Montana, USA

[5]School of Environment and Natural Resources, The Ohio State University, Columbus, Ohio, USA

[6]Department of Recreation, Park and Tourism Management, The Pennsylvania State University, University Park, Pennsylvania, USA

[7]Nevada Department of Wildlife, Reno, Nevada, USA

[8]Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, USA

Correspondence
Tara L. Teel, Department of Human Dimensions of Natural Resources, Colorado State University, Fort Collins, CO 80523.
Email: tara.teel@colostate.edu

Abstract

The future viability of wildlife conservation in the United States hinges on the field's ability to adapt to changing social–ecological conditions including shifting societal values and mounting pressures to engage a greater diversity of voices in decision-making. As wildlife agencies respond to calls to broaden their relevance amid such changes, there is a need to consider the role of university education programs in preparing future wildlife professionals to meet the challenges of this new era. We identify four core areas of competency (technical, leadership, administrative, and adaptive) for universities to consider integrating into new or existing programs to support the emergent needs of the wildlife profession. We focus on undergraduate degree programs as a critical foundation for wildlife-related careers but also recommend consideration of these skill sets in other areas of professional development including graduate education. Our approach acknowledges the importance of building on traditional areas of expertise such as biology and expanding them to include more interdisciplinary training in areas such as systems approaches, the social sciences, and organizational change. We conclude with recommendations for implementation, highlighting several successful examples, for universities to contemplate as they explore programmatic changes to help build greater capacity for wildlife conservation in the 21st century.

KEYWORDS

capacity building, conservation leadership, social–ecological systems, university education, wildlife agencies

1 | INTRODUCTION

Wildlife agencies in North America are at a critical juncture, given the myriad challenges redefining the social–ecological context of wildlife conservation. Challenges include climate change, biodiversity loss, and increased human–wildlife conflict. Also included are mounting social conflicts over wildlife-related issues, evidenced in growing public opposition to traditional forms of management (e.g., lethal control) and citizen ballot initiatives challenging agencies' decision-making authority (Manfredo et al., 2017; Manfredo, Teel, Don Carlos, et al., 2020), and declines in hunting that significantly impact agency funding (Jacobson & Decker, 2008; US Fish and Wildlife Service, 2016). Agencies and university programs preparing students for the agency workforce have been slow to respond to this changing context.

Forged from strong traditions of hunting and game management, the wildlife profession in the United States has long struggled to keep pace with societal changes at the root of many of these challenges (Jacobson et al., 2010; Wagner, 1989). The profession's origins trace back to the late 1800s when unchecked harvest led to declines in many wildlife species (Hays, 1999; Leopold, 1933; Shaw, 1985). The "North American Model" of wildlife conservation emerged from these circumstances (Organ et al., 2012), and by the early 1900s, state agencies were established as the centralized authority for regulating wildlife take. While this model has undoubtedly been successful in reversing effects of overharvest and creating a sound scientific field as the basis for wildlife policy (Geist & McTaggart-Cowan, 1995), its relevance is increasingly called into question as we enter a new era of wildlife conservation where providing opportunities for harvesting wildlife is but one of a multitude of goals (Decker et al., 2016; Vucetich et al., 2018).

Questions about the field's relevance largely center on concerns about continued reliance on traditional uses of wildlife such as hunting and fishing, which remain the primary funding mechanism for state wildlife agencies (Williams, 2010). The dominant culture within these agencies reflects the field's historical origins, defined by strong utilitarian values emphasizing such uses (Bruskotter et al., 2017; Metcalf et al., 2020; Organ & Fritzell, 2000; Wildes, 1995). This culture has not only permeated wildlife-governing institutions over time but has also been central to university programs and professional societies that train and support wildlife agency personnel (Gill, 1996). Societal values, however, are shifting away from this utilitarian emphasis, resulting in a growing divide between agency and public interests (Manfredo et al., 2018; Manfredo, Teel, Berl, et al., 2021; Manfredo, Teel, Don Carlos, et al., 2020). Tied to demographic changes such as urbanization, this shift has created pressure on agencies to engage new audiences while still being responsive to the needs of traditional stakeholders (i.e., hunters and anglers). Agencies are also needing to broaden their support base to ensure sustainable funding for wildlife conservation in the future (Jacobson et al., 2010).

Recognition of these pressures has resulted in greater attention to identifying strategies to achieve broader public relevance and support (Association of Fish and Wildlife Agencies & Wildlife Management Institute, 2019). Development of such strategies demands consideration of not only what actions can be taken in the short term to better engage diverse audiences but also how to facilitate meaningful change within agencies themselves that will have a lasting effect on agency–public relationships. This type of change requires critical reflection on the current and desired expertise of the agency workforce. Specifically, for agencies to adapt and remain relevant to an increasingly diverse constituency, there is a need to consider what skills are necessary and can be fostered through university education systems for agency employees to address the challenges of this new era. While training in the biological sciences is still a necessary foundation, building agency capacity will demand a much broader skill set, one that stems from interdisciplinary approaches that more explicitly embrace the social sciences and increasing complexity of conservation problems (Bennett, Roth, Klain, Chan, Christie, et al., 2017a; Dayer & Mengak, 2020; Mahajan et al., 2019).

Here, we identify core areas of competency that university education programs should consider integrating into existing and/or new program offerings to support the emergent needs of the wildlife profession in the United States. By doing so, these programs will be better equipped to prepare the next generation of leaders, and ultimately the organizations that employ them, to address contemporary wildlife conservation challenges. Prior to introducing our recommendations, we begin with a brief overview of the current state of university education, with a focus on undergraduate degree programs in fisheries and wildlife in the United States as a critical starting point for the field's reflection.

1.1 | Current state of wildlife undergraduate degree programs

While the curriculum of fish and wildlife undergraduate degree programs varies by university, emphasis tends to be on the natural and physical sciences, particularly the biological sciences. To inform our recommendations, in November–December 2020, we reviewed student learning

objectives from 16 undergraduate fish and wildlife degrees offered by members of the National Association of University Fisheries and Wildlife Programs (NAUFWP). We found that all degree programs included learning objectives related to knowledge and skills in the biological sciences. Training fisheries and wildlife biologists or wildlife managers indeed demands high levels of competency in the biological sciences as well as quantitative and communications skills (DeLany, 2004), which were also commonly articulated in learning objectives. However, despite recognition that greater capacity to address the human dimensions of conservation is necessary in natural resource agencies (e.g., Bennett, Roth, Klain, Chan, Clark, et al., 2017b; Sexton et al., 2013), less than half of the programs had objectives centering on knowledge and skills in the social sciences. Consistent with our observations, other research reviewing specific courses in all NAUFWP-associated universities' fish and wildlife degree programs found that all programs offer, and most require, at least one course related to human dimensions or the social sciences; yet, few offer or require multiple courses, minors, or tracks within programs (Dayer & Mengak, 2020). Additionally, we found that learning objectives related to other areas of expertise such as leadership and public administration were rare.

Somewhat surprisingly, we found that few degree programs articulated specific objectives related to wildlife *conservation*. Reflecting this finding, the names of most programs emphasized a biological science focus (e.g., Fisheries/Wildlife Science, Aquatic Science, Wildlife Biology) rather than Fish and Wildlife Conservation or Wildlife Management. In line with other patterns detailed above, these names may reflect an ongoing focus on educating students to be biologists and researchers rather than conservation professionals in myriad other jobs that may demand more diverse skill sets.

2 | CAPACITIES TO ADDRESS CONTEMPORARY WILDLIFE CONSERVATION CHALLENGES

Recognizing the need for greater diversity in curricula to extend beyond just the biological sciences, we identified four core areas of competency, or capacities, for university programs to consider as they prepare students for future careers in the wildlife profession: technical, leadership, administrative, and adaptive capacity (Figure 1). These capacities were formulated through a series of meetings among the authors, whose collective experience is in both academic (wildlife and human dimensions programs) and wildlife agency settings, and further informed by our review of existing degree programs (see previous section) and relevant literature. Our efforts were also informed by two workshops in 2019–2020 involving university researchers and wildlife agency leaders to develop a systems model that could help agencies identify areas of intervention to affect change in the current system (see Berl et al., 2021; Jacobson et al., 2021). University education was one such area that, if targeted, could ultimately contribute to meaningful changes in agency culture and capacity to address current/future conservation challenges. The following sections provide overviews of the four capacity types we identified, including the different components of each, which are also summarized in Table 1.

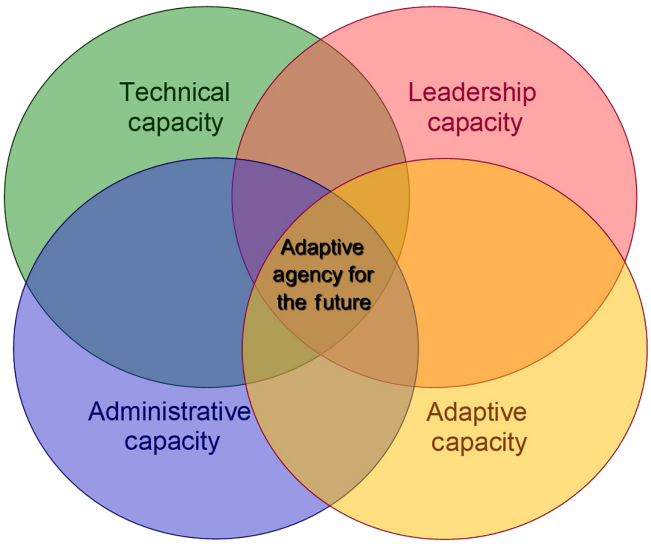

FIGURE 1 Capacities representing core areas of competency, or expertise, needed for wildlife agencies or organizations to adapt to current and future conditions

2.1 | Technical capacity

Technical capacity fosters development of discipline-specific knowledge and skills enabling individuals and organizations to accomplish the technical aspects of their responsibilities. We conceptualize this capacity in a broad sense to represent training needed to achieve desired biological, ecological, and social outcomes. Thus, it includes many of the traditional aspects of wildlife education programs, as well as more contemporary content, including in the social sciences.

Wildlife professionals apply *biological and ecological principles* to management decisions, often with the goal of balancing the needs of wildlife and people (Bolen & Robinson, 2003). Wildlife management entails the planned use, protection, and control of wildlife through application of these principles

TABLE 1 Descriptions and components of each type of capacity needed for wildlife agencies or organizations to adapt to current and future conditions

Capacity type	Description	Components
Technical capacity	Discipline-specific knowledge and skills enabling individuals and organizations to accomplish the technical aspects of their responsibilities. Includes many of the traditional aspects of wildlife education programs as well as more contemporary skills and content.	• Fundamentals of wildlife biology and ecology • Fundamentals of the social sciences in conservation • Fundamentals of social–ecological systems approaches/systems thinking • Communication and marketing • Natural resource governance • Economics/ecosystem services • Research methods for scientific literacy • Conservation planning/recreation planning
Leadership capacity	Skills to positively influence willing individuals to work toward an envisioned future with defined and shared goals. Includes both internal (i.e., within the organization) and external audiences.	• Self-awareness • Active listening • Equity, inclusion, and justice • Emotional intelligence • Empathy • Stakeholder outreach • Collaborative processes • Partnership building • Conflict management
Administrative capacity	Practical skills for effective and efficient management of organizations and knowledge about the role of government and nongovernmental sectors in wildlife conservation.	• Philosophies of public service and public administration • Fundamentals of public-sector structure and function • Fundamentals of nongovernmental sector structure and function • Personnel management and supervision • Project management • Budgeting
Adaptive capacity	Skills to adjust to and promote change, take advantage of opportunities, and respond to adversity.	• Organizational change • Decision-making under uncertainty • Innovation

(Chiras & Reganold, 2013a). Biological science informs understanding of wildlife habitats, edge effects, corridors, home ranges, and territories as well as animal movement, mortality factors, and game and nongame species management (Chiras & Reganold, 2013a). Ecological science provides broader understanding of how organisms interact with their environment and other organisms, including levels of organization, energy flows, ecosystem functioning and dynamics, and biomes (Chiras & Reganold, 2013b).

Since every ecosystem is affected by human actions (Vitousek et al., 1997), ecosystems are best understood and managed by integrating social dimensions into these biophysical domains and seeing natural resources as embedded in complex *social–ecological systems* (Collins et al., 2011; Ostrom, 2009). Applying interdisciplinary, *systems-thinking* approaches creates a necessary shift away from viewing humans as merely agents of change and toward seeing them in more complex, reciprocal relationships as agents that also depend on resources spanning multiple scales and feedback cycles (Carlson et al., 2020; Collins et al., 2011; Liu et al., 2007; Mace, 2014; Mahajan et al., 2019).

The *social sciences* are critical to achieving this holistic view of wildlife conservation, which is nested within broader systems of human–wildlife relationships and interactions (Lischka et al., 2018). While attention is increasingly given to the importance of the social sciences in conservation, capacity within conservation organizations to employ social science (and broader systems) approaches is limited (Bennett, Roth, Klain, Chan, Clark, et al., 2017b). Barriers to social science integration include a lack of understanding of how social science information can be used in diverse contexts, ranging from conservation problem definition to planning and decision-making, as well as broader issues of organizational culture that may fail to acknowledge the value of the social sciences (Bennett, Roth, Klain, Chan, Clark, et al., 2017b; Sexton et al., 2013). University education can help address these barriers by providing a solid

foundation in social science applications to conservation and examples of successful cases where social science information is applied. Further, education should incorporate real-world problem-solving activities wherein students integrate social and ecological science perspectives to analyze systems and identify implications for wildlife conservation.

Another barrier to social science integration is a lack of awareness regarding the multiple disciplines and applied fields that can inform social science applications in conservation (Bennett, Roth, Klain, Chan, Christie, et al., 2017a). As opposed to representing a single discipline (e.g., sociology), which is frequently assumed by those who lack social science training, the social dimensions of conservation are best understood through interdisciplinary approaches *within* the social sciences. Interdisciplinary, according to our conceptualization, would thus involve collaboration not only between natural and social scientists but also among social scientists themselves with different areas of expertise. These areas could include classic social science disciplines such as anthropology, economics, political science, psychology, and sociology as well as the more interdisciplinary and applied fields such as political ecology and conservation and development studies (see Bennett, Roth, Klain, Chan, Christie, et al., 2017a for detailed overview).

Of particular relevance among the applied realms is *human dimensions of wildlife* (or human dimensions of natural resources, more broadly), a field that emerged largely out of the natural resource management tradition in the United States (Manfredo, 2008). It focuses on the social aspects of wildlife-related issues, aiming to understand how and why people value wildlife, what benefits people seek and derive from wildlife, and how people affect and are affected by wildlife and wildlife management (Decker et al., 2012). While its origins were more narrowly focused on certain disciplines (e.g., social psychology), the field has evolved alongside more global traditions in conservation to incorporate a broader suite of disciplinary and interdisciplinary lenses (Manfredo, 2008). The intent with university wildlife programs would not be to make students experts in all of these areas but to provide some exposure to the diverse array of social science perspectives that could be applied to wildlife conservation. This would go beyond universities' general education requirements (Association of American Colleges and Universities; AAC&U, 2016), which often include one or more social science courses, to provide more in-depth experience with conservation social science applications.

Beyond training in the fundamentals of social science applications in conservation, we argue that certain areas of emphasis that draw upon the social sciences deserve particular attention in building technical capacity. These include communication, governance, and ecosystem services. *Communication* skills are often a competency that conservation organizations desire in employees (Blickley et al., 2013) and that employees themselves feel are needed for success in conservation (Sexton et al., 2013). These foundational skills are also critical to other types of capacity discussed in sections below, including leadership, stakeholder outreach and collaborative processes, and conflict management. Communication, from our perspective, would consist of basic oral and written communication skills as well as knowledge about theory and concepts from communication-related fields (e.g., environmental communication; Pezzullo & Cox, 2018) that can be applied to conservation. This includes emphasis on how to understand audiences and design tailored messaging across different purposes such as conservation behavior change (Clayton et al., 2013; Schultz, 2011). We also envision marketing strategies as part of this, relying upon techniques from business, psychology, and behavioral economics fields, for example, as well as practical applications in conservation such as community-based social marketing (McKenzie-Mohr et al., 2012).

Governance, broadly, is the purposeful effort to steer, manage, or control society (Kooiman, 1993). Environmental governance, more specifically, is "the set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes" (Lemos & Agrawal, 2006, p. 298). Government and management are not the same as governance, which not only consists of government actors such as wildlife agencies but also communities, businesses, nongovernmental organizations, and so forth. Governance challenges are core to many of the struggles that conservation organizations currently face (Armitage et al., 2012). Examples in the US wildlife context include declines in public trust of agencies, concerns about agency accountability and legitimacy, power struggles over who has a say in wildlife decision-making, and how to capture diverse voices in stakeholder engagement processes, especially as societal values toward wildlife are shifting (Decker et al., 2016; Manfredo et al., 2017).

The concept of *ecosystem services* draws from the fields of environmental and ecological economics. It bridges a gap between natural and social science concepts by creating knowledge around ecological systems providing services, economic systems benefiting from those services, and institutions managing their sustainable use (Braat & de Groot, 2012). Ecosystem services are the benefits that people acquire from nature, ranging from provisioning (e.g., water) and regulating (e.g., flood control) to cultural (e.g., recreation) and supporting (e.g., nutrient cycling, habitat provision) services (Millennium Ecosystem Assessment, 2005). Greater recognition of these

services can help identify synergies between ecosystem and human health and well-being, which may in turn help build more support for conservation (Bratman et al., 2019; Sandifer et al., 2015). Further, knowledge of ecosystem services and stakeholders' willingness to pay for those services can contribute to policy formation (e.g., payments for ecosystem services) by determining the economic value of natural resources to meet environmental and social objectives (Tacconi, 2012).

Final topics we incorporate under technical capacity are *research methods* and *conservation planning*. Training students as biologists in university wildlife programs has placed obvious emphasis on scientific methods for biological research (Kroll, 2007). While this focus is still clearly important, we recommend broadening the scope to include a diverse range of research methods in the biological and social sciences. Rather than training students to be proficient in these varied methods, the goal would be to achieve greater scientific literacy, which consists of a basic understanding of and ability to engage with—and think critically about—scientific information and processes (National Academies of Sciences, Engineering, and Medicine, 2016). This includes being able to comprehend and evaluate the quality of scientific information and formulate evidence-based arguments. Exposure to diverse methods could also help debunk the false separation often made between "hard" and "soft" sciences, showing how social science techniques, including quantitative and qualitative approaches, can be just as rigorous as those employed in biological research when held to discipline-specific standards of quality and integrity (St. John et al., 2014; Teel et al., 2018). Likewise, it is valuable for students to develop familiarity with social assessment techniques (e.g., surveys), addressing the common misperception that "anyone can do a social survey" (Teel et al., 2018).

Exposure to conservation planning processes (e.g., structured decision-making, adaptive management, Open Standards for the Practice of Conservation; McCarthy & Possingham, 2007; Schwartz et al., 2018) is fundamental to understanding how decisions and priorities are made in various settings. Also important is knowledge of how social dimensions can be incorporated in different planning stages. Skills in *recreation planning* (e.g., see Manning, 2004), more specifically, are also needed as agencies are challenged to provide opportunities for people with diverse backgrounds and preferences to experience the outdoors (Bruyere et al., 2009). In particular, with the shift in wildlife values, recreation opportunities are needed for nontraditional users who enjoy interacting with wildlife through activities other than hunting and fishing. With increased reliance on technology and the growing distance between urban residents and nature, coupled with recent impacts of COVID-19, connecting to the public and garnering greater support for conservation through provision of these opportunities will demand new and innovative strategies (e.g., virtual experiences; for more on *innovation*, see adaptive capacity section).

2.2 | Leadership capacity

There is wide variety in usage of the terms "leader" and "leadership," ranging from an accomplished scientist who might be considered a "leader" in their field to the head of an agency who is the designated organizational "leader." The study of leadership is relatively recent, starting in the 1940s, though the practice of leadership has existed for centuries (Bolden, 2004). We define leadership as the skills to positively influence willing individuals to work toward an envisioned future with defined and shared goals. It has a dual focus predicated on an assumption that a collaborative and inclusive *process* leads to better decision-making and *future conditions* (Mango, 2018).

Leadership is not limited to the behavior of positional leaders or the people "in charge." Rather, the act of positively influencing others can occur from a multitude of roles and positions within a group or organization. We conceptualize leadership as a learned behavior rather than an inherent trait or skill set (Hung, 2015; Kouzes & Posner, 2017). It is achievable by people with varying styles and preferences but with a common purpose of establishing environments wherein everyone's contributions are valued. Effective leadership begins with a high level of *self-awareness* or recognition of personal strengths and limits to determine what is best for a team or agency (George, 2007; Tekleab et al., 2008). Leaders also need various interpersonal skills that enable them to understand and empower others (Engelfield et al., 2019). These include *active listening*, *establishing inclusive environments*, and utilizing personal strengths to produce positive outcomes and overcome challenges, or *emotional intelligence*. When practiced effectively, these skills place leaders in a position to demonstrate *empathy* for others' perspectives. Capable leaders are also able to design and facilitate processes that solicit others' contributions—including *stakeholder outreach* and *collaborative decision-making*—and *build partnerships* to leverage shared goals (Bruyere, 2015). Finally, effective leaders can *manage conflict* well, even seeing conflict as a vehicle to catalyze change.

Leadership capacity can be built through a prolonged series of experiences and activities, with emphasis on self-examination and reflective learning. To start, many instruments exist for building self-awareness, including

values clarification activities, communication and conflict style preference surveys, and decision-making instruments (e.g., Myers-Briggs Type Indicator, 2021; Clifton Strengths Assessment [Gallup, 2021]). We foresee student learning initiated by a single course that transitions from self-awareness to its implications for interpersonal leadership skills. There are numerous experiential activities that create opportunities for students to reflect about themselves and how they support and lead others, which can collectively result in development of a personal leadership plan that can follow a student throughout their undergraduate experience.

Poorly conducted stakeholder outreach and collaboration is one of the most common contributors to failed conservation initiatives (Giakoumi et al., 2018). Building partnerships, facilitating collaborative processes, and designing stakeholder outreach require a blend of technical *and* leadership skills. Building leadership capacity therefore requires a blended approach of teaching tactical skills for extending opportunities for others to influence decisions as well as self-awareness to keep personal values, biases, and tendencies in check. We suggest that the more technical skills in areas such as collaborative processes be taught separately from and after content about leadership fundamentals (e.g., self-awareness), with the two skill types eventually converging in a setting where students must synthesize and apply their learning. The latter could consist of a capstone experience where students collaborate with local partners to produce a deliverable that demonstrates their competencies and ability to apply those competencies to wildlife conservation problems in the field.

2.3 | Administrative capacity

Our view of administrative capacity includes practical skills for effective and efficient management of organizations (El-Taliawi & Van Der Wal, 2019) as well as knowledge about the social value and civil society benefits of constituent services commonly provisioned by public and nongovernmental sectors (Ellis, 2010). While our conceptualization primarily emphasizes applied job skills, it also includes theoretical and philosophical approaches to *public administration* addressing the role of government and bureaucracies in society (Burnier, 2018), given that a considerable amount of wildlife conservation work in the United States occurs within the public sector. With the increased prominence of nongovernmental actors in wildlife conservation, administrative capacity should also address skills and knowledge relevant to that sector, including managing organizational boards and volunteers, and nonprofit fundraising (Macdonald, 2017). Further, we posit that, as future wildlife professionals, students should consider their role as civil servants, while also gaining basic understanding of *how government and nongovernmental organizations function* to comprehend how decisions are made within their workplaces.

Philosophies of public service and administration in the US wildlife context are tied to the notion of public trust, a core tenet of the North American Model of Wildlife Conservation (Organ et al., 2012). According to this tenet, wildlife agencies are entrusted with the responsibility of safeguarding and managing wildlife, a publicly owned resource, in the interest of all citizens (Blumm & Paulsen, 2013). While many in the wildlife profession may have entered the field based on a desire to work with wildlife and other natural resources, agency jobs demand that their efforts ultimately serve the public interests, which may at times come into conflict with their own personal values and what they deem is "good" for the resource. Training in public service and administration, we believe, can help address these challenges by fostering greater understanding of the role of agencies as public institutions. Also important to address is recent criticism of the North American Model for failure to adequately represent the diverse interests of contemporary society, which go beyond the traditional focus on wildlife as a consumptive resource (Decker et al., 2016; Jacobson & Decker, 2008; Peterson & Nelson, 2017; Serfass et al., 2018). Education should include consideration of the field's history, along with challenges and opportunities for change based on an understanding of the current system (see Berl et al., 2021, and adaptive capacity section).

Skills in *employee supervision* (also drawing upon leadership), *project management*, and *budgeting* are additional components of administrative capacity. While individuals starting their careers often will not be in supervisory roles or positions that require writing budgets or managing large projects, requirements of the job can include these demands as their careers progress. It also may be difficult for early-career professionals to relate to these administrative tasks that can seem more mundane or outside the scope of what motivated them to enter the field, but the reality is that a functioning agency needs employees who can manage the day-to-day operations of the organization. Business management skills are applicable here, ranging, for example, from budgeting, obtaining, and managing grants to advocating for funding support from legislatures, government and nongovernmental organizations, and citizens. Greater emphasis on training in such areas as grant writing, fundraising, and report writing could help both professionals and the organizations they work for be more successful in their conservation endeavors. Given the increasing financial constraints of conservation efforts, particularly within the public sector, skills are also needed in how to plan and manage cost-effective projects.

2.4 | Adaptive capacity

Adaptive capacity is the ability to adjust to and promote change, take advantage of opportunities, and respond to adversity (Intergovernmental Panel on Climate Change, 2014). Although wildlife management in the United States was once seen simply as "the art of making land produce sustained annual crops of wild game for recreational use" (Leopold, 1933, p. 3), this definition falls short of the varied aims and activities of contemporary wildlife conservation. In practice, wildlife conservation involves managing diverse aspects of social–ecological systems that shape how humans and wildlife use and interact in various habitats (Lischka et al., 2018). In such systems, an agency's adaptive capacity is defined by its ability to "read" complex and dynamic system conditions and then mobilize resources to adapt to those conditions to provide desired end states (Bettini et al., 2015). This requires breadth (e.g., ability to think across systems) and depth (e.g., detailed knowledge of "sub" systems) of understanding. Tied to our earlier discussion of technical capacity, cultivating a *systems-thinking* mindset among future wildlife professionals is a necessary prerequisite for building greater adaptive capacity in agencies and in the conservation field more broadly (Mahajan et al., 2019).

Adaptive capacity also demands knowledge of the inner workings and dynamics of organizations or agencies, which can be viewed as complex systems themselves (see Berl et al., 2021). Systems approaches to *organizational change* aim to understand interactions and feedbacks between different components of the organizational system (Cameron & Green, 2015; Dooley, 1997; Foster-Fishman et al., 2007). These approaches can allow for identification of "leverage points" or target areas within the system that can lead to meaningful change (Chan et al., 2020; Meadows, 1999). Training in this area could therefore help facilitate inward reflection on the current state of wildlife agencies (e.g., their structure, processes, culture) and where real changes could be made to adapt to changing conditions.

Another important component of adaptive capacity involves needing to *make decisions under substantial uncertainty* to achieve desired outcomes and shift courses of action as science provides more information. As societal values toward wildlife shift (Manfredo, Teel, Berl, et al., 2021), the future of agencies and agency–public relationships becomes ever more uncertain and challenged by current conditions. Being able to define, navigate, and adapt to those conditions that are creating considerable social and political pressures for agencies is critical for long-term sustainability of the wildlife conservation institution in the United States.

The capacity to make sound decisions under uncertainty demands being able to quantify and reduce sources of uncertainty and also to anticipate different scenarios, assess risks associated with those scenarios, and evaluate likely trade-offs under different management options (Jones et al., 2014). According to Jones et al. (2014), "good" decisions are likely to emerge from processes guided by science and agreed-upon norms, with clearly defined goals, a range of management alternatives, and consideration of trade-offs and diverse viewpoints. In effect, the decision-making *process*, which can be just as crucial as inputs to inform the decision, is a key element of adaptive capacity. Thus, it is important for students to receive explicit training in planning and decision-making processes (see technical capacity section) including multi-party decision processes (e.g., structured decision-making) and ways to account for uncertainty in those processes. Scenario planning, a technique applied in a variety of fields and organizational settings for thinking about the future under conditions of rapid change and uncertainty, is a specific tool to consider incorporating here (Chermack, 2011).

Related to organizational change, a final component we include under adaptive capacity is *innovation* (Heifetz, 1994; Heifetz et al., 2009). Innovation can be defined as exploring new alternatives (e.g., management approaches, decision processes, technologies) and learning mechanisms (e.g., bringing together different types of thinking) that apply new knowledge or ways of "doing business" within the system (Bettini et al., 2015; Westley et al., 2013). Innovation is key to an organization's or system's ability to adapt and undergo transformative change (Westley et al., 2013), which may be difficult for agencies deeply entrenched in historical traditions and bureaucracies. Cultivating a culture of support for innovation arguably begins with training future wildlife professionals in how to think more like "entrepreneurs." This includes fostering ideas around creativity, taking risks, embracing diverse ways of understanding, and collaborative knowledge-building and problem-solving (Sawyer, 2006). Establishing organizational cultures that value innovation inevitably means accepting risks and the possibility of failure, which is generally not the norm in public institutions.

3 | DISCUSSION

The context of wildlife conservation in the United States has changed dramatically in recent decades. It is defined by ecological changes, such as climate change, as well as broad-scale social changes affecting how people think about and interact with wildlife (Manfredo, Teel, Don Carlos, et al., 2020). The field is also currently confronted

with unprecedented societal challenges of a global pandemic (COVID-19), massive polarization in American politics, social and environmental injustices, and needing to keep pace with technological innovation, including widespread use of social media (Furlich, 2020; Lee, 2020). As the world changes, the wildlife profession, like many institutions forged in a different era, has remained remarkably stable (Wildes, 1995). This can also be said for many university education programs supporting the profession which were developed to meet the needs of an earlier time period (Gill, 1996). The field carries forth strong remnants of a culture rooted in utilitarian values toward wildlife and management paradigms wherein sound science is believed to provide the technical solutions needed to address complex management challenges. Largely ignored in these paradigms, and even in the definition of what constitutes "sound science" oftentimes, is the role of the social sciences (Manfredo et al., 2019) as well as other considerations such as social–ecological systems approaches that are warranted for addressing management complexity. While progress has been made, institutional change is slow, resulting in a widening gap between wildlife agencies and their ability to respond to the realities of wildlife conservation in the 21st century.

The broad impetus for our paper stems from needing to consider the role of university education programs in how the wildlife profession can adapt to rapidly changing conditions. While calls for improved training of conservation professionals abound in recent literature (e.g., Blickley et al., 2013; Kelley et al., 2019; Muir & Schwartz, 2009; Schwartz et al., 2017), little attention has been given to wildlife degree programs specifically (but see Kroll, 2007; Dayer & Mengak, 2020), particularly in terms of cultivating agency response to societal change. Key questions guiding our approach include the following: (1) As wildlife agencies confront the need to broaden their relevance to the diversity of public interests in a changing society, how can university programs better prepare future wildlife professionals? (2) What expertise do these professionals need to help agencies adapt to the changing social–ecological context of wildlife conservation? In response, we identified core areas of competency for university programs to consider as they explore ways to better prepare students for careers in the wildlife profession. Our approach acknowledges the importance of building on traditional areas of expertise emphasized in these programs (e.g., biology) and also expanding them to include more interdisciplinary training in areas such as human dimensions and systems approaches. We organized our competencies into four categories identified as "capacities" needed for an adaptive agency for the future (Figure 1; Table 1). Inherent in this approach is a need to rethink capacity to go beyond just what individual professionals can do to consider what agencies and other conservation organizations can collectively achieve. Accordingly, we do not anticipate that *every* individual will be proficient or even competent in each capacity; rather, the profession may benefit from training that allows individuals to emphasize different capacities or skill sets to the degree that they are able.

Our list of competencies is intended to be comprehensive, with levels of proficiency within categories ranging from basic awareness-building to mastery. To illustrate, we believe students should have high levels of self-awareness (leadership capacity) and knowledge of social–ecological systems (technical capacity) upon graduation, while more expertise in areas such as personnel management (administrative capacity) and decision-making under uncertainty (adaptive capacity) may be gained through graduate school and career experience. At a minimum, we feel that every student should at least be introduced to the varied knowledge and skills in our competencies list. We recommend that this list be used, alongside other relevant information (e.g., knowledge of student career paths and preferences, surveys of potential employers and alumni, e.g., see Muir & Schwartz, 2009), in planning processes aimed at (re)defining program objectives and evaluating existing and possible new courses and programs in relation to those objectives.

We realize that changes to curriculum to support our recommendations may be difficult. Challenges we see, for example, in broadening the scope of existing programs include the typical 120-credit-hour degree cap (Johnson et al., 2012) and growing general education requirements (AAC&U, 2016) that limit the number of courses in degree programs. Further, these programs continue to respond to the American Fisheries Society (2020) and The Wildlife Society (TWS, 2020) certification requirements to ensure students can become certified after graduation. These certifications primarily emphasize biological competencies, though there are some requirements in communications, policy, and human dimensions (Dayer & Mengak, 2020). TWS certifications are especially constraining with their large number of prescribed course credit hours (e.g., 81 for Associate Wildlife Biologist). Given that breadth of training in diverse areas comes at the cost of depth of expertise, modifying these certifications to accommodate different specialties could be beneficial and help increase capacity by providing more wide-ranging expertise throughout agencies. Additionally, fish and wildlife degree programs often strive to ensure graduates are prepared for US Fish and Wildlife Service 401-job series (Wildlife Biologist) positions, which requires extensive biological coursework with inadequate attention to other capacities including technical content in the social sciences.

Irrespective of these challenges, major shifts in curriculum will need to be considered alongside other possible strategies for imparting a more diverse skill set. Innovation, as we discussed, is an important component of agencies' adaptive capacity, and the same is true for universities as they explore how to make changes to (or create new) degree programs. Fortunately, there are successful examples of implementation, not all of which require overhauls of existing programs. One example is Virginia Tech's Human Dimensions Option within their Fish Conservation and Wildlife Conservation undergraduate degrees. In this Option, which targets students interested in fish and wildlife careers outside of biology, students take five courses in human dimensions–related areas (i.e., education, outreach, and interpretation; ethics and humanities; social sciences; stakeholder engagement and conflict resolution; tourism, recreation, and management). Different degree tracks like this, created within existing programs, allow students to receive similar training in foundational content and then specialize in certain areas based on interests and career preferences. General education requirements could also be tailored in this way to meet the needs of individual programs and their students.

Other programs, such as those at University of Montana, Michigan State University, and Mississippi State University, in partnership with the Boone and Crockett Club, seek out policy internship opportunities for undergraduate students where they spend a summer interning in Washington, DC, with federal natural resource agencies, nonprofits, or members of Congress. These examples suggest that fish and wildlife degree programs can provide broader training by creating additional opportunities for students as an alternative to curricular modifications. Other strategies include new degree programs or programs developed to provide added options for students beyond existing degree offerings (e.g., multiple majors). Where possible, these efforts could be pursued through collaboration between relevant academic units (e.g., wildlife biology, human dimensions) to develop joint degree programs, bringing in expertise from current offerings in each unit to provide a more comprehensive array of training. This collaboration could also consist of codevelopment and team-teaching of select courses (e.g., capstone experiences), with instructors from different disciplinary backgrounds.

Another tactic is the use of 4 + 1 programs that combine a 4-year bachelor's degree with immediate enrollment into a 1-year accelerated master's degree. The University of Montana offers such an option via a Bachelor of Science (BS) degree in Wildlife with a Masters in Public Administration, as does Texas A&M University with a BS in Wildlife and Fisheries Sciences and a Master of Public Service and Administration. These types of programs can help build leadership and administrative capacities less common in traditional fish and wildlife degree programs. These capacities may also be developed to some extent through extracurricular activities, such as involvement in TWS/AFS Student Chapters, or service-learning courses with real-world conservation projects in the community. This may be a logical way to infuse fish and wildlife degree programs with other important areas of competency without eliminating key biological coursework.

We envision undergraduate degrees as a launching point for careers in wildlife conservation, careers that should include further professional development (e.g., trainings, graduate study) and lifelong learning (Ryan & Campa, 2000; Wals & Benavot, 2017). A broader educational foundation at the outset, combined with that additional learning, will be imperative to finding new ways to adapt to the ongoing social–ecological changes that are redefining wildlife conservation.

ACKNOWLEDGMENTS

Thanks to D. Smith, E. Haubold, and R. Stark for their input in formulation of ideas for this manuscript. Thanks also to C. Jacobson for feedback on an earlier draft.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Tara L. Teel led the writing of the manuscript. All authors were involved in conceptualization of the project, contributed to manuscript drafts, and approved publication.

DATA AVAILABILITY STATEMENT

As reported in the manuscript, data to inform our recommendations were obtained through a review of student learning objectives from a sampling of undergraduate fish and wildlife degrees offered by members of NAUFWP. No additional data were gathered for this manuscript.

ETHICS STATEMENT

We abide by the journal's publishing ethics guidelines. Since we did not collect data from human subjects, Institutional Review Board approval was not applicable.

ORCID

Tara L. Teel https://orcid.org/0000-0002-1944-1864

REFERENCES

American Fisheries Society. (2020). Professional certification. Retrieved December 1, 2020, from https://fisheries.org/membership/afs-certification/

Armitage, D., de Loe, R., & Plummer, R. (2012). Environmental governance and its implications for conservation practice. *Conservation Letters*, *5*, 245–255.

Association of American Colleges and Universities. (2016). Recent trends in general education design, learning outcomes, and teaching approaches. Key findings from a survey among administrators at AAC&U member institutions. Retrieved December 1, 2020, from https://www.aacu.org/sites/default/files/files/LEAP/2015_Survey_Report2_GEtrends.pdf

Association of Fish and Wildlife Agencies & Wildlife Management Institute. (2019). Fish and wildlife relevancy roadmap: Enhanced conservation through broader engagement (v1.0). M. Dunfee, A. Forstchen, E. Haubold, M. Humpert, J. Newmark, J. Sumners, & C. Smith (Eds). Retrieved November 20, 2020, from https://relevancyroadmap.squarespace.com/

Bennett, N. J., Roth, R., Klain, S. C., Chan, K. M. A., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J., Epstein, G., Greenberg, A., Nelson, M. P., Sandlos, J., Stedman, R., Teel, T. L., Thomas, R. E. W., Verissimo, D., & Wyborn, C. (2017a). Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation*, *205*, 93–108.

Bennett, N. J., Roth, R., Klain, S. C., Chan, K. M. A., Clark, D. A., Cullman, G., Epstein, G., Nelson, M. P., Stedman, R., Teel, T. L., Thomas, R. E. W., Wyborn, C., Curran, D., Greenberg, A., Sandlos, J., & Verissimo, D. (2017b). Mainstreaming the social sciences in conservation. *Conservation Biology*, *31*(1), 56–66.

Berl, R. E. W., Manfredo, M. J., Gasta, M., Smith, D., Sullivan, L., Jacobson, C. A., Bishop, C., Camuso, J., Eason, T., Hayes, J. P., Jacobson, R., Melcher, C., Newmark, J., Novotny, P., Pauley, S. P., Smith, C., Sparks, C., Stoner, K., Strong, J. D., & Ver Steeg, J. (2021). Building a systems framework to facilitate adaptive organizational change in state fish and wildlife agencies. *Conservation Science and Practice* (In Review), e591.

Bettini, Y., Brown, R. R., & De Haan, F. J. (2015). Exploring institutional adaptive capacity in practice: Examining water governance adaptation in Australia. *Ecology and Society*, *20*(1), 47.

Blickley, J. L., Deiner, K., Garbach, K., Lacher, I., Meek, M. H., Porensky, L. M., Wilkerson, M. L., Winford, E. M., & Schwartz, M. W. (2013). Graduate student's guide to necessary skills for nonacademic conservation careers. *Conservation Biology*, *27*, 24–34.

Blumm, M. C., & Paulsen, A. (2013). The public trust in wildlife. *Utah Law Review*, *6*, 1437–1504.

Bolden, R. (2004). What is leadership?. Centre for Leadership Studies, University of Exeter. Retrieved November 1, 2020, from https://ore.exeter.ac.uk/repository/bitstream/handle/10036/17493/what_is_leadership.pdf?sequence=1&isAllowed=y

Bolen, E. G., & Robinson, W. L. (2003). *Wildlife ecology and management* (5th ed.). Prentice-Hall.

Braat, L. C., & de Groot, R. (2012). The ecosystem services agenda: Bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosystem Services*, *1*(1), 4–15.

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochrans, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Jr., Kuo, M., Lawler, J. L., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., ... Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, *5*(7), eaax0903.

Bruskotter, J. T., Vucetich, J. A., & Nelson, M. P. (2017). Animal rights and wildlife conservation: Conflicting or compatible. *Wildlife Professional*, *11*, 40–43.

Bruyere, B. L., Teel, T., & Newman, P. (2009). Response to "more kids in the woods: Reconnecting Americans with nature.". *Journal of Forestry*, *107*(7), 378–379.

Bruyere, B. L. (2015). Giving direction and clarity to conservation leadership. *Conservation Letters*, *8*(5), 378–382.

Burnier, D. (2018). Reimagining performance in public administration theory and practice: Creating a democratic performativity of care and hope. *Administrative Theory & Praxis*, *40*(1), 62–78.

Cameron, E., & Green, M. (2015). *Making sense of change management: A complete guide to the models, tools and techniques of organizational change* (4th ed.). Kogan Page Limited.

Carlson, A. K., Eaton, M. J., Kaemingk, M. A., & Trudeau, A. (2020). A social-ecological odyssey in fisheries and wildlife management. *Fisheries*, *45*(5), 238–243.

Chan, K. M. A., Boyd, D. R., Gould, R. K., Jetzkowitz, J., Liu, J., Muraca, B., Naidoo, R., Olmsted, P., Satterfield, T., Selomane, O., Singh, G. G., Sumaila, R., Ngo, H. T., Boedhihartono, A. K., Agard, J., Aguiar, A. P. D., Armenteras, D., Balint, L., Barrington-Leigh, C., ... Brondízio, E. S. (2020). Levers and leverage points for pathways to sustainability. *People and Nature*, *2*, 693–717.

Chermack, T. J. (2011). *Scenario planning in organizations: How to create, use, and assess scenarios*. Berrett-Koehler.

Chiras, D. D., & Reganold, J. P. (2013a). Wildlife management. In *Natural resource conservation: Management for a sustainable future* (10th ed., pp. 459–488). London, UK.

Chiras, D. D., & Reganold, J. P. (2013b). Lessons from ecology. In *Natural resource conservation: Management for a sustainable future* (10th ed., pp. 70–105). London, UK.

Clayton, S., Litchfield, C., & Geller, S. E. (2013). Psychological science, conservation, and environmental sustainability. *Frontiers in Ecology and the Environment*, *11*(7), 377–382.

Collins, S. L., Carpenter, S. R., Swinton, S. M., Orenstein, D. E., Childers, D. L., Gragson, T. L., Grimm, N. B., Morgan, G. J., Harlan, S. L., Kaye, J. P., Knapp, A. K., Kofinas, G. P., Magnuson, J. J., McDowell, W. H., Melack, J. M., Ogden, L. A., Philip, R. G., Smith, M. D., & Whitmer, A. C. (2011). An integrated conceptual framework for long-term social-ecological research. *Frontiers in Ecology and the Environment*, *9*(6), 351–357.

Dayer, A. A., & Mengak, L. F. (2020). Human dimensions in undergraduate fisheries and wildlife degree programs in United States universities. *Human Dimensions of Wildlife*, *25*(5), 478–488.

Decker, D. J., Riley, S. J., & Siemer, W. F. (Eds.). (2012). *Human dimensions of wildlife management* (2nd ed.). Johns Hopkins University Press.

Decker, D. J., Smith, C., Forstchen, A., Hare, D., Pomeranz, E., Doyle-Capitman, C., Schuler, K., & Organ, J. (2016). Governance principles for wildlife conservation in the 21st century. *Conservation Letters*, *9*(4), 290–295.

DeLany, B. W., Jr. (2004). Entry-level job skills needed by wildlife management professionals [LSU doctoral dissertations]. Retrieved November 5, 2020, from https://digitalcommons.lsu.edu/gradschool_dissertations/1515

Dooley, K. J. (1997). A complex adaptive systems model of organization change. *Nonlinear Dynamics, Psychology, and Life Sciences*, *1*, 69–97.

Ellis, B. A. (2010). Administrative capacity. The Jethro project. Retrieved October 30, 2020, from https://www.researchgate.net/publication/239918041_Administrative_Capacity

El-Taliawi, O. G., & Van Der Wal, Z. (2019). Developing administrative capacity: An agenda for research and practice. *Policy Design and Practice*, *2*(3), 243–257.

Engelfield, E., Black, S. A., Copsey, J. A., & Knight, A. T. (2019). Interpersonal competencies define effective conservation leadership. *Biological Conservation*, *235*, 18–26.

Foster-Fishman, P. G., Nowell, B., & Yang, H. (2007). Putting the system back into systems change: A framework for understanding and changing organizational and community systems. *American Journal of Community Psychology*, *39*, 197–215.

Furlich, D. (2020). *Conservation and race: A conversation with Dr.* Mamie Parker. Retrieved December 15, 2020, from. https://www.nature.org/en-us/magazine/magazine-articles/talking-about-conservation-and-racial-justice/

Gallup (2021). Clifton Strengths Assessment. Retrieved February 13, 2021, from https://www.gallup.com/cliftonstrengths/en/home.aspx

Geist, V., & McTaggart-Cowan, I. (1995). *Wildlife conservation policy*. Brush Education.

George, B. (2007). *True north: Discover your authentic leadership*. Jossey-Bass.

Giakoumi, S., McGowan, J., Mills, M., Beger, M., Bustamante, R. H., Charles, A., Christie, P., Fox, M., Garcia-Borboroglu, P., Gelcich, S., Guidetti, P., Mackelworth, P., Maina, J. M., McCook, L., Micheli, F., Morgan, L. E., Mumby, P. J., Reyes, L. M., White, A., ... Possingham, H. P. (2018). Revisiting "success" and "failure" of marine protected areas: A conservation scientist perspective. *Frontiers in Marine Science*, *5*, 223.

Gill, R. B. (1996). The wildlife profession subculture: The case of the crazy aunt. *Human Dimensions of Wildlife*, *1*, 60–69.

Hays, S. P. (1999). *Conservation and the gospel of efficiency: The progressive conservation movement, 1890–1920*. University of Pittsburgh Press.

Heifetz, R. A. (1994). *Leadership without easy answers*. Belknap Press.

Heifetz, R. A., Linsky, M., & Grashow, A. (2009). *The practice of adaptive leadership: Tools and tactics for changing your organization and the world*. Harvard Business Press.

Hung, H. T. (2015). Is leadership innate or learned? Implications for leadership development. *Hue University Journal of Science*, *113*(14), 65–72.

Intergovernmental Panel on Climate Change (2014). Annex II: Glossary. In *Climate change 2014: Synthesis report*. Contribution of working groups I, II and III to the fifth assessment report of the IPCC. Intergovernmental Panel on Climate Change.

Jacobson, C. A., Organ, J., Decker, D., Batcheller, G., & Carpenter, L. (2010). A conservation institution for the 21st century: Implications for state wildlife agencies. *Journal of Wildlife Management*, *74*(2), 203–209.

Jacobson, C. A., & Decker, D. J. (2008). Governance of state wildlife management: Reform and revive or resist and retrench? *Society and Natural Resources*, *21*, 441–448.

Jacobson, C. A., Sullivan, L., Gasta, M., Manfredo, M. J., Camuso, J., Novotny, P., Jacobson, R., & Witthaus, K. (2021). State fish and wildlife agency culture: Access points to leverage major change. *Conservation Science and Practice (In Review)*.

Johnson, N., Reidy, L., Droll, M., & LeMon, R.E. (2012). Program requirements for associate's and bachelor's degrees: A national survey. Commissioned by HCM Strategists, Austin, TX, for Complete College America.

Jones, R. N., Patwardhan, A., Cohen, S. J., Dessai, S., Lammel, A., Lempert, R. J., Mirza, M. M. Q., & von Storch, H. (2014). Foundations for decision making. In *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change* (pp. 195–228). Cambridge University Press.

Kelley, P. H., Dietl, G. P., & Visaggi, C. C. (2019). Model for improved undergraduate training in translational conservation science. *Conservation Science and Practice*, *1*(1), e5.

Kooiman, J. (1993). *Modern governance: New government-society interactions*. Sage.

Kouzes, J. M., & Posner, B. Z. (2017). *The leadership challenge: How to make extraordinary things happen in organizations* (6th ed.). John Wiley & Sons.

Kroll, A. (2007). Integrating professional skills in wildlife student education. *Journal of Wildlife Management*, *71*, 226–230.

Lee, A. (2020). Perspective: Nature has sent humanity a wake-up call. How will we answer? . Retrieved December 15, 2020, from https://www.moore.org/article-detail?newsUrlName=perspective-nature-has-sent-humanity-a-wake-up-call.-how-will-we-answer

Lemos, M. C., & Agrawal, A. (2006). Environmental governance. *Annual Review of Environment and Resources*, *31*, 297–325.

Leopold, A. (1933). *Game management*. University of Wisconsin Press.

Lischka, S. A., Teel, T. L., Johnson, H. E., Reed, S. E., Breck, S., Don Carlos, A., & Crooks, K. R. (2018). A conceptual model for the integration of social and ecological information to understand human-wildlife interactions. *Biological Conservation*, *225*, 80–87.

Liu, J., Dietz, T., Carpenter, S. R., Folke, C., Alberti, M., Redman, C. L., Schneider, S. H., Ostrom, E., Pell, A. N., Lubchenco, J., Taylor, W. W., Ouyang, Z., Deadman, P., Kratz, T., & Provencher, W. (2007). Coupled human and natural systems. *Ambio*, *36*(8), 639–649.

Macdonald, D. (2017). *21st century skills for non-profit managers: A practical guide on leadership and management*. Business Expert Press.

Mace, G. M. (2014). Whose conservation? Changes in the perception and goals of nature conservation require a solid scientific basis. *Science*, *345*, 1558–1560.

Mahajan, S. L., Glew, L., Rieder, E., Ahmadia, G., Darling, E., Fox, H. E., Masica, M. B., & McKinnon, M. (2019). Systems thinking for planning and evaluating conservation interventions. *Conservation Science and Practice*, *1*(7), e44.

Manfredo, M. J. (2008). *Who cares about wildlife: Social science concepts for exploring human-wildlife relationships and conservation issues*. Springer Press.

Manfredo, M. J., Salerno, J., Sullivan, L., & Berger, J. (2019). For US wildlife management, social science needed now more than ever. *Bioscience*, *69*(12), 960–961.

Manfredo, M. J., Sullivan, L., Don Carlos, A. W., Dietsch, A. M., Teel, T. L., Bright, A. D., & Bruskotter, J. (2018). *America's wildlife values: The social context of wildlife management in the U.S.* National report from the research project entitled "America's Wildlife Values". Fort Collins, Colorado: Department of

Human Dimensions of Natural Resources, Colorado State University.

Manfredo, M. J., Teel, T. L., Berl, R. E. W., Bruskotter, J. T., & Kitayama, S. (2021). Social value shift in favour of biodiversity conservation in the U.S. *Nature Sustainability*, *4*, 323–330.

Manfredo, M. J., Teel, T. L., Don Carlos, A. W., Sullivan, L., Bright, A. D., Dietsch, A. M., Bruskotter, J., & Fulton, D. (2020). The changing socio-cultural context of wildlife conservation. *Conservation Biology*, *34*(6), 1549–1559.

Manfredo, M. J., Teel, T. L., Sullivan, L., & Dietsch, A. M. (2017). Values, trust, and cultural backlash in conservation governance: The case of wildlife management in the United States. *Biological Conservation*, *214*, 303–311.

Mango, E. (2018). Rethinking leadership theories. *Open Journal of Leadership*, *7*, 57–88.

Manning, R. E. (2004). Recreation planning frameworks. In M. J. Manfredo, J. J. Vaske, B. L. Bruyere, D. R. Field, & P. J. Brown (Eds.), *Society and natural resources: A summary of knowledge* (pp. 83–96). Modern Litho.

McCarthy, M. A., & Possingham, H. P. (2007). Active adaptive management for conservation. *Conservation Biology*, *21*(4), 956–963.

McKenzie-Mohr, D., Lee, N. R., Schultz, P. W., & Kotler, P. (2012). *Social marketing to protect the environment: What works*. Sage Publications.

Meadows, D. H. (1999). *Leverage points: Places to intervene in a system*. The Sustainability Institute.

Metcalf, J. D., Karns, G. R., Gade, M. R., Gould, P. R., & Bruskotter, J. T. (2020). Agency mission statements provide insight into the purpose and practice of conservation. *Human Dimensions of Wildlife.*, *26*, 262–274.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Current state and trends*. Island Press.

Muir, M. J., & Schwartz, M. W. (2009). Academic research training for a non-academic workplace: A case study of graduate student alumni who work in conservation. *Conservation Biology*, *23*(6), 1357–1368.

Myers-Briggs Type Indicator. (2021). The Myers-Briggs Company, Sunnyvale, CA. Retrieved February 13, 2021, from https://www.themyersbriggs.com/en-US/Products-and-Services/Myers-Briggs

National Academies of Sciences, Engineering, and Medicine. (2016). *Science literacy: Concepts, contexts, and consequences*. National Academies Press.

Organ, J. F., & Fritzell, E. K. (2000). Trends in consumptive recreation and the wildlife profession. *Wildlife Society Bulletin*, *28*, 780–787.

Organ, J. F., Geist, V., Mahoney, S. P., Williams, S., Krausman, P. R., Batcheller, G. R., Decker, T. A., Carmichael, P., Nanjappa, R., Regan, R., Medellin, R. A., Cantu, R., McCabe, R. E., Craven, S., Vecellio, G. M., & Decker, D. J. (2012). The North American model of wildlife conservation. *The Wildlife Society Technical Review 12-04*. The Wildlife Society.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422.

Peterson, M. N., & Nelson, M. P. (2017). Why the North American model of wildlife conservation is problematic for modern wildlife management. *Human Dimensions of Wildlife*, *22*(1), 43–54.

Pezzullo, P. C., & Cox, R. (2018). *Environmental communication and the public sphere* (5th ed.). Sage.

Ryan, M. R., & Campa, H. (2000). Application of learner-based teaching innovations to enhance education in wildlife conservation. *Wildlife Society Bulletin*, *28*(1), 168–179.

Sandifer, P. A., Sutton-Grier, A. E., & Ward, B. P. (2015). Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosystem Services*, *12*, 1–15.

Sawyer, R. K. (2006). Educating for innovation. *Thinking Skills and Creativity*, *1*(1), 41–48.

Schultz, P. W. (2011). Conservation means behavior. *Conservation Biology*, *25*(6), 1080–1083.

Schwartz, M. W., Cook, C. N., Pressey, R. L., Pullin, A. S., Runge, M. C., Salafsky, N., Sutherland, W. J., & Williamson, M. A. (2018). Decision support frameworks and tools for conservation. *Conservation Letters*, *11*(2), e12385.

Schwartz, M. W., Hiers, J. K., Davis, F. W., Garfin, G. M., Jackson, S. T., Terando, A. J., Woodhouse, C. A., Morelli, T. L., Williamson, M. A., & Brunson, M. W. (2017). Developing a translational ecology workforce. *Frontiers in Ecology and the Environment*, *15*, 587–596.

Serfass, T. L., Brooks, R. P., & Bruskotter, J. T. (2018). North American model of wildlife conservation: Empowerment and exclusivity hinder advances in wildlife conservation. *Canadian Wildlife Biology and Management*, *7*(2), 101–118.

Sexton, N. R., Leong, K. M., Milley, B. J., Clarke, M. M., Teel, T. L., Chase, M. A., & Dietsch, A. M. (2013). The state of human dimensions capacity for natural resource management: Needs, knowledge, and resources. *The George Wright Forum*, *30*(2), 142–153.

Shaw, J. H. (1985). *Introduction to wildlife management*. McGraw-Hill.

St. John, F. A. V., Keane, A. M., Jones, J. P. G., & Milner-Gulland, E. J. (2014). Robust study design is as important on the social as it is on the ecological side of applied ecological research. *Journal of Applied Ecology*, *51*, 1479–1485.

Tacconi, L. (2012). Redefining payments for environmental services. *Ecological Economics*, *73*, 29–36.

Teel, T. L., Anderson, C. B., Burgman, M. A., Cinner, J., Clark, D., Estevez, R. A., Jones, J. P. G., McClanahan, T. R., Reed, M. S., Sandbrook, C., & St. John, F. A. V. (2018). Publishing social science research in conservation biology to move beyond biology. *Conservation Biology*, *32*(1), 6–8.

Tekleab, A. G., Sims, H. P., Jr., Yun, S., Tesluk, P. E., & Cox, J. (2008). Are we on the same page? Effects of self-awareness of empowering and transformational leadership. *Journal of Leadership and Organizational Studies*, *14*(3), 185–201.

The Wildlife Society. (2020). Certification programs. Retrieved February 13, 2021, from https://wildlife.org/learn/professional-development-certification/certification-programs/

US Fish and Wildlife Service. (2016). National survey of fishing, hunting, and wildlife-associated recreation. U.S. Department of the Interior and U.S. Department of Commerce, U.S. Census Bureau.

Vitousek, P. M., Mooney, H. A., Lubchenco, J., & Melillo, J. M. (1997). Human domination of Earth's ecosystems. *Science*, *277*(5325), 494–499.

Vucetich, J. A., Burnham, D., Macdonald, E. A., Bruskotter, J. T., Marchini, S., Zimmermann, A., & Macdonald, D. W. (2018).

Just conservation: What is it and should we pursue it? *Biological Conservation*, *221*, 23–33.

Wagner, F. H. (1989). American wildlife management at the crossroads. *Wildlife Society Bulletin*, *17*(3), 354–360.

Wals, A. E. J., & Benavot, A. (2017). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education*, *52*, 404–413.

Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, O. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society*, *18*(3), 27.

Wildes, F. T. (1995). Recent themes in conservation philosophy and policy in the United States. *Environmental Conservation*, *22*(2), 143–150.

Williams, S. (2010). Wellspring of wildlife funding: How hunter and angler dollars fuel wildlife conservation. *Wildlife Professional*, *4*, 35–38.

How to cite this article: Teel, T. L., Bruyere, B., Dayer, A., Stoner, K. E., Bishop, C., Bruskotter, J., Freeman, S., Newmark, J., Jager, C., & Manfredo, M. J. (2022). Reenvisioning the university education needs of wildlife conservation professionals in the United States. *Conservation Science and Practice*, *4*(2), e610. https://doi.org/10.1111/csp2.610