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Learning for the future: educating career fisheries and wildlife professionals

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Abstract. Demand for career professionals in the fish and wildlife professions is expected to increase over the next 10–12 years. I discuss education and training of fisheries and wildlife career professionals including who colleges and universities need to educate to meet the professions' needs. I provide a perspective on what these career professionals will need to know and how we will educate and train them. I suggest that we need to educate a more diverse workforce and a workforce that adopts an international perspective on fisheries and wildlife conservation. Designing curricula to meet the professions' needs will require on-going dialog with state, provincial, and federal agencies and will require innovative approaches that integrate knowledge requirements for these jobs with skill development. The ideal curriculum will have bounded flexibility, accommodate multiple career goals, integrate essential skills and incorporate conservation-relevant concepts throughout, meet professional certification requirements, accommodate study abroad opportunities, and will include at least two internships.

Key words: biologists, careers, curriculum, education, training.

The knowledge, skills, and abilities needed to become successful and effective fish and wildlife biologists have changed over time as our professions have evolved. The national and international demand for professionals trained in these fields has also changed with increasing interest in environmental protection and changes in environmental policy and national economies. Regardless of demand, these careers have increased in popularity over the past 10–15 years with the advent of television programming featuring wildlife and the work of fish and wildlife professionals (Dingwall and Aldridge 2006).

The demand for fish and wildlife biologists is difficult to determine from an international perspective because most countries do not publish statistics that project the future needs within these careers. More data are available within the United States, which regularly publishes statistics on current and projected occupations. In the United States, employment in occupations that typically employ college graduates with degrees in natural resources is projected to increase between 0.5% and 20% from now until 2022 depending on the specific occupation (Table 1). I assume that these trends are similar in most developed countries with substantial levels of environmental protection and related governmental institutions. Job growth is

probably less robust in underdeveloped countries, but is likely to expand rapidly as additional environmental protections are enacted, as was seen in the United States in the 1970s and 1980s. The United States also is anticipating what has been called a “retirement tsunami” in the fisheries and wildlife professions because 25–30% of the workforce is retirement eligible (Julian and Yeager 2002).

In this paper, I present my views on educating future career professionals in the fisheries and wildlife professions. I discuss who we need to educate to meet the professions' needs as well as what these career professionals will need to know and how we will need to educate and train them. My perspective is predominately North American and is based on my 25-year career as an academic. My perspective is also colored by my membership in The Wildlife Society and the American Fisheries Society, 13 years as a university administrator and eight years as a member of the Oregon Fish and Wildlife Commission. This paper primarily focuses on formal secondary educational programs and institutions, but I acknowledge the huge demand and need for science education targeting the general public and primary education (Hallerman et al. 2014).

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Table 1. Current (2012) and projected (2022) employment (numbers in thousands) by occupations typical of college graduates in natural resources degree programs (U.S. Bureau of Labor Statistics 2015)

Occupations	Employment		Change, 2012–22		Job openings due to growth and replacements, 2012–22 Number
	Number		Number	Percent	
	2012	2022			
Natural sciences managers	51.6	54.5	2.9	5.7	13.7
Zoologists and wildlife biologists	20.1	21.1	1.0	4.9	6.7
Conservation scientists	22.1	22.3	0.1	0.5	6.6
Biological technicians	80.2	88.3	8.0	10.0	32.1
Biological science teachers, postsecondary	61.4	73.4	12.0	19.5	21.2
Forestry and conservation science teachers, postsecondary	3.1	3.4	0.3	9.9	0.8
Environmental science teachers, postsecondary	6.3	7.1	0.8	13.2	1.8
Fish and game wardens	6.6	6.7	0.1	1.2	2.0

Who do we need to educate?

When I think about who we need to educate for the future of the fisheries and wildlife profession, I believe the simple answer is everybody. If these professions are to survive we desperately need to broaden our support and clientele base. Fish and wildlife conservation programs are created, developed, and financed from the ground up when people are able to link their well-being to a healthy, sustainable environment. In the following section, I address the need to educate both the general public and more specifically our professional workforce. Fundamentally, I believe we need to take a global perspective and adopt diversity as a core principle in our educational efforts.

A global perspective

As a society and as a profession we need to adopt a global perspective on education. The grand challenges of our time—sustainability, water, energy, climate change, and agriculture (Association of Public and Land-grant Universities 2014)—are all global in nature and will require global collaborations to resolve. Our educational programs need to do a better job of informing the general public of the linkages among natural resources on a global scale. Urban families in Atlanta, Georgia and New Delhi, India need to understand how their air conditioning units are linked to climate change. Fishing families the world over need to be mindful of the sources of freshwater that support their fisheries and how these rivers and lakes commonly span multiple international jurisdictions.

Fish and wildlife professionals also need to adopt a global perspective and as educators we have a principal role in that effort. This can be accomplished in a number

of ways including training international students, study abroad programs, international conferences and collaborations, international research, and incorporation of a global perspective in our university curricula.

Training international students is an important role that educators in developed countries can play (Edge 1990). The demand for training opportunities is at an all-time high and can be accomplished in a number of ways. Increasing the capacity for underdeveloped nations to train their own biologists should be a top priority, but the amount of aid needed is not usually available for institutions focusing on natural resources. Although focused on agriculture, the Rwanda Women's Leadership Project (http://cgc.msu.edu/projects/rwanda_womens_leadership_project; Accessed 14 March 2016) is an example of this type of capacity building. However, we frequently are constrained to training one to several biologists at a time. The most comprehensive training occurs when an international student can afford an education in a developed country and is able to complete either a bachelor's degree or preferably an advanced degree. Many countries provide and support these opportunities for their citizens and numerous nongovernmental organizations and international aid agencies also provide educational support. Less costly are shorter term training programs and workshops of 1–10 weeks in duration. These training programs can be conducted for an individual agency in a developing country (Edge 1993), or they may be offered at a regional center or in a developed country where biologists from numerous countries travel to for the program. These training programs can typically train 10–20 or more biologists for substantially lower cost than a college degree might cost a single international student.

Study abroad programs represent another important

opportunity to instill global perspectives in high school and college students. Study abroad programs are widely recognized as transformative educational experiences that consistently improve retention and graduation rates. These programs may involve reciprocal exchanges among universities in different countries, or may be one-way experiences either led by faculty from the students' institutions or they may be programs offered by the host country. Study abroad programs may last a term or even a year, or may be short-term experiences lasting two weeks or less and frequently occur during intercession periods. Regardless of the format or duration, students almost invariably report that study abroad programs were transformative experiences that enhanced their knowledge and appreciation of different countries' resources, politics, and cultures. The number of students that study abroad has increased from about one million in 1975 to almost five million in 2012 (Organization for Economic Co-operation and Development 2014). The United States and European countries are the top destinations for students studying abroad and students primarily come from Asia, Europe, the United States, and the Middle East (United Nations Educational, Scientific and Cultural Organization 2015). Study abroad programs that sent students to and from developing countries are likely to have the greatest long-term impact on fish and wildlife conservation.

International conferences and collaborations and international research are additional ways that global perspectives can be instilled in the profession. International meetings such as the International Wildlife Management Congress provide exceptional opportunities for biologists from around the globe to meet, discover common interests, develop collaborative research, and focus on conservation challenges (Bissonette and Krausman 1995; Ballard 2004). International research projects that employ students transfer substantial knowledge regarding local cultures and issues, and usually produce research outputs that can be immediately used in a local management context.

Incorporating global perspectives in our university curricula is another way of teaching students about global conservation issues. The study abroad programs that I discussed previously are probably the best mechanism to incorporate international perspectives in university curricula, but these programs frequently are expensive and are not accessible to most students in fisheries and wildlife university programs. University curricula typically have general education requirements that have some cultural diversity or global perspective requirements, but

frequently these concepts are not incorporated in a coordinated way. Incorporating examples of international management issues or use of case studies in required lower and upper level courses (Ryan and Campa 2000) can effectively instill global perspectives and all fisheries and wildlife degrees should incorporate material that builds global competencies in graduates. International degrees that include study abroad, second (or third) language proficiency, and a research program in a natural resources degree are common at many institutions.

Diversity—a core principle for the fisheries and wildlife professions

Our lack of human diversity is probably the greatest barrier to participation in and support of fish and wildlife conservation. The challenge of increasing diversity is not unique to the fish and wildlife professions and extends throughout the Science, Technology, Engineering, and Math (STEM)-related professions. Diversity needs to become a core principle if fisheries and wildlife professions are to progress and garner increasing support. Lopez and Brown (2011) argued that only by increasing diversity in the profession will we broaden stakeholder support, which will in turn increase financial support and commitment and result in greater support of conservation initiatives and policies. Furthermore, diversifying our profession and stakeholders will help to break down barriers between disciplines, incorporate new concepts and perspectives, expand our knowledge base and experiences, and increase the potential for new combinations of ideas and innovative solutions (Aslan et al. 2014). Our commitment to diversity needs to extend to the workplace, our formal educational programs, and our outreach and engagement programs. All educators, students, and employees in natural resources fields should receive training that emphasizes the benefits of diversity and identifies institutional biases.

The lack of diversity in the fisheries and wildlife professions is not a new challenge and has been a topic of discussion for many years. The natural resources agencies in the United States government have developed numerous programs to increase workforce diversity (Tuggle 2011). The Wildlife Society's Gender and Ethnic Working Group was founded in 2006 and developed a position statement on workforce diversity in 2011 (The Wildlife Society 2011). Despite such efforts, statistics regarding inclusion (Lopez and Brown 2011) remain grim. Within the United States, more women receive bachelor's degrees in natural resources than men, yet they are under-

represented in the natural resources professions. Disparities in ethnic diversity are even more pronounced. Non-whites are substantially under-represented among college degree recipients and even more so within the profession. These challenges are likely to be even more pronounced in countries that are inherently less diverse.

What do career fisheries and wildlife professionals need to know?

Academics and employers in any profession struggle with the question, what do people entering a profession need to know? Answering this question is particularly problematic today for several reasons. First, career demographers predict that young adults beginning secondary education today will have, on average, five different careers during their working lifetimes, not just five different jobs in the same career. A person might be a biologist, teacher, business owner, accountant, and a nurse depending on changing interests and opportunities throughout their lifetime. The fisheries and wildlife professions may be their first, third or fifth career, which means they may be starting their scientific training at very different ages and with very different backgrounds and skill sets. Second, a degree in fisheries or wildlife sciences can lead to very different career opportunities ranging from natural resources manager, conservation officer, environmental educator, consultant, nature or recreational guide, zoo keeper, and many others. The necessary knowledge, skills, and abilities won't be the same among these career options. Finally, because fisheries and wildlife science and technology are expanding and changing rapidly, professional development and lifelong learning are absolute requirements for staying current. Therefore, as educators, we need to acknowledge that we cannot teach new professionals all they need to know, and a portion of what we have taught them will be irrelevant or obsolete soon after they leave our tutelage. It will be necessary for employers to provide on-the-job training for young professionals in order to enhance skills and abilities and supplement knowledge deficiencies. Partnerships between universities and major employers will be necessary to develop a joint responsibility for education and training.

Who says what career professionals need to know?

The question of who determines what a career fisheries and wildlife professional needs to know to be successful is difficult to answer because of the many different careers that are possible. It would be much simpler if we trained

only fisheries and wildlife enforcement officers or fisheries and wildlife biologists—then there would be a more specific set of knowledge, skills, and abilities our graduates would need. But even then there probably would be substantial variation in curricula among colleges and universities because the fisheries and wildlife professions do not have professional closure. Professional closure occurs when someone's competence is certified by a professional association or board, as is the case for lawyers, doctors, or certified public accountants. Professions with professional closure tend to have very specific, uniform learner outcomes that result in very similar curricula wherever the degree is offered. Nevertheless, we could be more purposeful with respect to our curricula design using a backwards design approach that starts with competencies and learner outcomes, which then informs the development of courses that incorporate these elements in a more systematic way. This design approach coupled with assessment strategies that align with learner goals can ensure that our students are learning what we intend them to.

Several groups are likely to have input on the design of university curricula. Ultimately, the employer determines what employees need to know when they are recruited. Most jobs in the fisheries and wildlife professions are with state, provincial, and federal agencies. In the United States, federal job classifications require minimum degree levels, work experience, and a specific set of courses, and most university programs attempt to model curricula so that graduates take those classes. Professional associations such as The Wildlife Society (<http://certification.wildlife.org/learn/professional-development-certification/certification-programs/>) or the American Fisheries Society (<http://fisheries.org/certification-professional-development>) have certification programs that also require a college degree with a specific set of courses and a prescribed amount of work experience. A job in one of these professions does not require certification and thus the profession does not have professional closure. Nevertheless, most fisheries and wildlife university programs in the United States offer a set of classes that would enable a graduate to become certified. Finally, universities and faculty members in individual programs also influence what a graduate learns because of university-level general education requirements and faculty perceptions of what is important in a degree program. Over the past 20–25 years in the United States there has been an increase in the number of general education requirements for a degree and also an effort to reduce the total number of credits

required for a degree, thus constraining the amount of major-specific course work. Ultimately, it is the link between employers and curriculum designers that keep a degree program relevant and up-to-date, and because so many of these jobs are in state and federal agencies it is important that university programs continue to engage agency partners in curriculum design (Bleich and Oehler 2000; Rupp 2012). Advisory boards made up of a broad spectrum of potential employers can be an effective approach to incorporating agency needs and perspectives into curriculum design.

Curriculum design for fisheries and wildlife professionals

Curriculum design for the fisheries and wildlife professions is a challenging exercise. Our students have changed dramatically over the past two decades, from being primarily rural with substantial field and natural resources experience to being mostly urbanites, many with little or no experience in the out-of-doors (Louv 2005). Educators cannot therefore assume that incoming students will be able to identify animal tracks, navigate in the field with map and compass, drive a four-wheel-drive vehicle, or have other skills that may have been commonplace in previous generations. On the other hand, today's students have many skills and abilities that previous generations lacked, such as computer and information technology skills, and their "group think" skills positions them to be problem solvers. Curriculum designers also debate basic education versus more specialized training. Undergraduates should be provided a basic education with more focus on transferable skills (so called T-shaped professional) than a focus on specialization, which is more appropriate for post-graduate training such as graduate certificates, Master's or Doctor of Philosophy degrees. Because the scientific knowledge underlying our professions is expanding so rapidly, I believe curriculum designers need to recognize that we cannot cram it all in an undergraduate degree and we need to continually refocus curricula via learner outcomes and assessment. However, Matter and Steidl (2000) argue that careful design of curricula can impart both substantial knowledge needed for the profession and the skills necessary to be successful.

Curriculum designers for most natural resources professions attempt to incorporate learner outcomes that are known as soft, essential, or transferable skills. These essential skills include team work, leadership, oral and written communications, critical thinking and problem solving, self-management, and professionalism. These skills are highly desired by employers, many of whom

believe recent graduates are not well trained in these skills (The Wildlife Society 2009; Crawford et al. 2011). These essential skills are learner outcomes that will be needed in any career and because we know that the students we train are highly likely to change careers, as educators we are doing our students a huge disservice if we graduate students who are poorly trained in these skills.

What is the ideal Bachelor of Science curriculum?

Although natural resources curricula vary substantially from university to university, I believe modern curricula should contain several common components (Table 2). First, students need a curriculum that provides bounded flexibility (Millenbah and Wolter 2009). Providing students with choices in topic areas is important for several reasons. Students are entering our degree programs with different career goals, and flexibility within topic areas provides an opportunity to design a curriculum that best meets those goals. A student wishing to be a fisheries and wildlife enforcement officer might choose different human dimensions classes than someone who wants to be an environmental educator. Flexibility within a curriculum also better enables students to make timely progress, which is critical given the cost of a college education. Second, curricula should be designed to accommodate multiple career goals. Few 18 year olds know what they want to do when they start college and many, perhaps most will change majors at least once. Many may want to include minors or complete more than one degree and curricula should be designed to meet those needs, perhaps with common tracks the first two years. Third, curricula should integrate essential skills throughout (Millenbah and Wolter 2009). Any class can be designed to include one or more of the essential skills and these skills should be thoughtfully integrated throughout a curriculum so that students become progressively more competent in these areas. Fourth, an effective natural resources curriculum incorporates conservation-related topics throughout.

Table 2. Components of an ideal curriculum for a Bachelor's of Science in fisheries and wildlife science

Provides bounded flexibility
Accommodates multiple career goals
Integrates essential skills throughout
Incorporates conservation-relevant concepts throughout
Can meet professional certification or occupation course requirements
Accommodates study abroad opportunities
Includes at least two internships

Faculty should work with their colleagues in other departments to encourage them to use natural resources-relevant examples in their classes. For example, a calculus class might demonstrate rates of population change of an animal species rather than changes in interest rates of a hedge fund. Fifth, curricula should enable students to qualify for specific federal job series (<http://www.federaljobs.net/occupations.htm>) or to become professionally certified (The Wildlife Society, <http://certification.wildlife.org/learn/professional-development-certification/certification-programs/>; American Fisheries Society, <http://fisheries.org/certification-professional-development>). Students may not choose to become certified, but curricula should contain the flexibility that would allow them to do so. Sixth, curricula should be designed to encourage and enable students to study abroad for all of the reasons mentioned previously. Finally, all natural resources curricula should require at least two internships. These are critically important in helping students understand what an occupation really entails. Furthermore, internships allow students to refine skills that are introduced in class, helps them better understand the utility of what they are learning, and in many cases provides skills that are not included as part of a university curriculum. For example, most fisheries and wildlife programs provide demonstrations of radio telemetry equipment, but I doubt that many would claim their graduates know how to radio track an animal as a result of those demonstrations. That ability is acquired after many hours of practice on a job or internship. How many university curricula provide training in driving four-wheel-drive vehicles over rough terrain, or backing up a boat trailer?

How will we educate or train fisheries and wildlife professionals?

Approaches to educating fisheries and wildlife professionals vary among universities, even among institutions with very similar required course work. Many faculty who are committed to providing a quality educational experience readily adopt new approaches to curriculum delivery. Approaches that are becoming widespread include flipped classrooms, multiple university or multiple discipline consortia, and courses that combine essential skills with knowledge sets. Flipped classrooms, where students are required to study course materials before class and then discuss, debate, and critically analyze issues, data, or examples during class, have been around for decades, but are now widespread in university classes.

This approach has been shown to be highly effective at enabling teachers and students to work together on achieving higher levels in Bloom's Taxonomy of learning (Mazur 1997).

Teleconferencing and other forms of distance learning now enable multiple universities or multiple disciplines to form consortia for delivering specialized parts of university curricula (Pollock et al. 2013). Most universities sustained substantial budget cuts during the past two decades and many have been unable to refill critical positions. Consortia among institutions may allow programs to collaborate in curriculum delivery and thereby take advantage of each institution's specializations, especially for low enrollment classes.

As previously noted, Matter and Steidl (2000) argued that university curricula can be designed to confer both substantial amounts of knowledge and essential skills. Many education-related papers in fisheries and wildlife journals over the past 10–15 years have detailed examples of these types of classes or curricula. Ryan and Campa (2000) reviewed approaches to teaching that promoted learner-based mastery and retention of content knowledge and the development of essential skills. They recommended these learner-based pedagogies for better preparing students for careers as natural resource problem-solvers and encouraged educators to experiment with these methods and share what they learn in professional publications. Lopez et al. (2006) detailed a course at Texas A&M where teams of students worked with private landowners and natural resources agencies in developing conservation plans that landowners could use to obtain a wildlife management tax valuation. This course provided students with team building, leadership, writing, and public speaking skills as well as practical applications of techniques such as vegetation sampling, land surveying, and Geographic Information Systems. Kroli (2007) argued that producing graduates who can bridge the science-management gap requires integrated training that exposes students to nontraditional coursework while developing essential skills.

Research experience for undergraduates is another effective way to instill both engagement in scientific learning as well as developing essential skills. Although research experiences typically cannot be offered to all undergraduates in most programs, these opportunities become transformative educational experiences that increase retention rates, graduate rates, and the likelihood that students will go to graduate school (Lopatto 2009). Millspaugh and Millenbah (2004) discussed the merits of

undergraduate research and offered advice in structuring and developing such programs. They suggested that these opportunities enable students to develop key career skills and acquire important experience for professional success. Kinkel and Henke (2006) found that undergraduate research projects increased students' grade point average and graduation rates, reduced time to graduation, and increased job placement over students who did not participate in research.

Technology enhanced pedagogy continues to offer innovative educators means of better engaging students in classroom and field exercises. SCALE-Up (Student-Centered, Active Learning Environment with Upside-down Pedagogies. Available at <http://scaleup.ncsu.edu/>; Accessed 14 March 2016) classrooms are being widely adopted at universities allowing faculty and students to more effectively engage in course concepts and collaboratively solve problems or issues (Foote et al. 2014). Mobile platform technology enables educators and students to engage digital media and interact with lecture materials from anywhere in the classroom, freeing the teacher from the podium and increasing interactions with students. Requiring students to "bring your own device" (BYOD) is another means of engaging students. Rather than complaining about students using digital devices in class, require them to BYOD and use them in exercises such as modelling and displaying data, integrating information from multiple sources, and for polls and queries where clickers were commonly used. Field and laboratory exercises can also be enhanced if students BYOD because they can record data, take photographs, videos or audio recordings, consult field guides, and develop their own digital study notes. Digitized natural history collections that include specimens, data, and information can help transform undergraduate lab classes from passive to active learning environments (Cook et al. 2014).

Laboratory and field courses will continue to be hallmarks of natural resources programs. These classes offer students engagement with course materials and enable teachers to easily incorporate skill development with knowledge. However, laboratory and field classes have declined at many institutions because of class sizes, costs, and risk concerns (McDonald et al. 2009). Nevertheless, more innovative fisheries and wildlife programs will continue to offer or even expand these opportunities for students. A backward design approach to curriculum development may allow programs to reprioritize learner outcomes that laboratory and field courses provide, which may in turn result in additional resources for supporting

these curriculum elements.

Distance education will continue to play an increasingly important role in educating fisheries and wildlife professionals. Online education in both the United States and the European Union has been increasing much more than on-campus programs over the last several years (Allen and Seaman 2014). Online programs offer students access to a broader array of classes than typical on-campus programs (Edge and Sanchez 2011) and provide opportunities for multiple institutions to collaborate in program delivery (Pollock et al. 2013). Edge and Sanchez (2011) also found that distance education programs provide educational opportunities to a different demographic than on-campus programs. They reported that distance students were on average nine years older than on-campus students, and that 40% of distance students already had one college degree and 20% had jobs with natural resources agencies. Distance education will also play an increasingly important role in professional development as declining travel budgets decrease professionals' opportunities to attend conferences and workshops.

Finally, internships need to become part of every fisheries and wildlife curriculum. Internships frequently serve as transformative educational experiences that increase retention and graduation rates and employment success. Students engaged in internships gain technical skills that complement theoretical or conceptual knowledge that they receive in classes. Internships enable students to learn from practicing professionals. And in some cases, internships are invaluable in helping students understand what they do not want to do.

Conclusions

The demand for career professionals in the fisheries and wildlife professions will increase over the next 10–12 years. Educators will be challenged to provide both the knowledge base and essential skills required to be competent professionals. In my view, all students will need to understand and adopt an international perspective of fish and wildlife conservation. Our professions and employers will need to adopt diversity as a core principle and will need to attract a much more diverse workforce if we are to remain relevant and increase our impact. Innovative educators can design curricula that will develop essential skills and deliver substantial discipline-specific knowledge. The ideal undergraduate curriculum will provide bounded flexibility, accommodate multiple career goals, integrate essential skills and incorporate conservation-

relevant concepts throughout, meet professional certification requirements, accommodate study abroad opportunities, and will include at least two internships. Innovative curricula will be developed and delivered in several ways, including research experience for undergraduates, new technologies for teaching, lab and field courses, online classes, and experiential learning via internships. Using these approaches to curriculum design and delivery, we can effectively train future career fish and wildlife professionals as well as provide our students transferable skills that will allow them to move among careers as their interests and life situations change.

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References

- Allen, I. E. and Seaman, J. 2014. Grade Level: Tracking Online Education in the United States. Online Learning Consortium. Available at <http://onlinelearningconsortium.org/read/survey-reports-2014/> (Accessed 15 July 2015).
- Aslan, C. E., Pinsky, M. L., Ryan, M. E., Souther, S. and Terrell, K. A. 2014. Cultivating creativity in conservation science. *Conservation Biology* 28: 345–353.
- Association of Public and Land-grant Universities. 2014. Science, education and outreach roadmap for natural resources. Association of Public and Land-grant Universities, Board on Natural Resources and Board on Oceans, Atmosphere, and Climate, Washington, D.C. Available at ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/47169/APLU_NRRoadmap_FINAL.pdf (Accessed 15 July 2015).
- Ballard, W. 2004. Why become more internationally involved? *Wildlife Society Bulletin* 32: 1.
- Bissonette, J. A. and Krausman, P. R. 1995. Integrating people and wildlife for a sustainable future. Proceedings of the First International Wildlife Management Congress, San Jose, Costa Rica, 19–25 September, 1993.
- Bleich, V. and Oehler, Sr., M. 2000. Wildlife education in the United States: thoughts from agency biologists. *Wildlife Society Bulletin* 28: 542–545.
- Cook, J. A., Edwards, S. V., Lacey, E. A., Guralnick, R. P., Soltis, P. S., Soltis, D. E., Welch, C. K., Bell, K. C., Galbreath, K. E., Himes, C., Allen, J. M., Heath, T. A., Carnaval, A. C., Cooper, K. L., Liu, M., Hanken, J. and Ickert-Bond, S. 2014. Natural history collections as emerging resources for innovative education. *BioScience* 64: 725–734.
- Crawford, P., Lang, S., Fink, W., Dalton, R. and Fielitz, L. 2011. Comparative analysis of soft skills: What is important for new graduates? Association of Public and Land-grant Universities, Washington D.C. Available at http://www.aplu.org/members/commissions/food-environment-and-renewable-resources/CFERR_Library/comparative-analysis-of-soft-skills-what-is-important-for-new-graduates/File (Accessed 15 July 2015).
- Dingwall, R. and Aldridge, M. 2006. Television wildlife programming as a source of popular scientific information: a case study of evolution. *Public Understanding of Science* 15(2): 131.
- Edge, W. D. 1990. International resource conservation: where's the challenge? *Transactions of the North American Wildlife and Natural Resources Conference* 55: 379–383.
- Edge, W. D. 1993. Design and implementation of a workshop on the conservation and management of Thailand wildlife resources. *Tigerpaper* 20(1): 9–14.
- Edge, W. D. and Sanchez, D. 2011. An online fisheries and wildlife degree: can you really do that? *Wildlife Society Bulletin* 35: 2–9.
- Foote, K. T., Neumeyer, X., Henderson, C., Dancy, M. H. and Beichner, R. J. 2014. Diffusion of research-based instructional strategies: The case of SCALE-UP. *International Journal of STEM Education* 1(1): 10.
- Hallerman, E., Blewett, T., Burke, I., Leopold, B., Sharik, T. and Stooksbury, D. 2014. Grand challenge: education. In (Fink, W. and Edge, W. D., eds.) *A Roadmap for Science, Education, and Outreach for Natural Resources*, pp. 66–83. Association of Public and Land-grant Universities, Board on Natural Resources and Board on Oceans, Atmosphere, and Climate, Washington D.C. Available at ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/47169/APLU_NRRoadmap_FINAL.pdf (Accessed 15 July 2015).
- Julian, G. J. and Yeager, A. B. 2002. Implications of massive agency retirements on future fish and wildlife employment and education. *Transactions of the North American Wildlife and Natural Resources Conference* 67: 129–142.
- Kinkel, D. and Henke, S. 2006. Impact of undergraduate research on academic performance, educational planning, and career development. *Journal of Natural Resources and Life Sciences Education* 35: 194–201.
- Kroli, A. J. 2007. Integrating professional skills in wildlife student education. *Journal of Wildlife Management* 71: 226–230.
- Lopatto, D. 2009. *Science in Solution: The Impact of Undergraduate Research on Student Learning*. Research Cooperation for Science Advancement, Tuscon, Arizona, USA.
- Lopez, R. R. and Brown, C. H. 2011. Why diversity matters: broadening our reach will sustain natural resources. *Wildlife Professional* 5(2): 20–27.
- Lopez, R. R., Hays, K. B., Wagner, M. W., Locke, S. L., McCleery, R. A. and Silvy, N. J. 2006. Integrating land conservation planning in the classroom. *Wildlife Society Bulletin* 34: 223–228.
- Louv, R. 2005. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Algonquin Books, Chapel Hill, North Carolina, USA, 334 pp.
- Matter, W. J. and Steidl, R. J. 2000. University undergraduate curricula in wildlife: beyond 2000. *Wildlife Society Bulletin* 28: 503–507.
- Mazur, E. 1997. *Peer Instruction: A User's Manual*. Series in Educational Innovation. Prentice Hall, Upper Saddle River, New Jersey, USA, 253 pp.
- McDonald, J. E., Jr., Jenks, J. A. and Willis, D. W. 2009. The changing face of university wildlife programs. *Transactions of the North American Wildlife and Natural Resources Conference* 74: 48–53.
- Millenbah, K. F. and Wolter, B. H. K. 2009. The changing face of natural resources students, education, and the profession. *The Journal of Wildlife Management* 73: 573–579.
- Millsbaugh, J. J. and Millenbah, K. F. 2004. Value and structure of research experiences for undergraduate wildlife students. *Wildlife*

- Society Bulletin 32: 1185–1194.
- Organization for Economic Co-operation and Development. 2014. Education at a glance 2014: OECD indicators. OECD Publishing. Available at <http://dx.doi.org/10.1787/eag-2014-en> (Accessed 10 July 2015).
- Pollock, K. H., Loneragan, N. R. and Calver, M. C. 2013. Fisheries, wildlife, and conservation biology education in Australia: current challenges and future directions. *Australian Zoologist* 36: 413–423.
- Rupp, S. P. 2012. Practical dissonance: Bridging the gap between academia and agencies. *Wildlife Society Bulletin* 36: 796–801.
- Ryan, M. R. and Campa, III, H. 2000. Application of learner-based teaching innovations to enhance education in wildlife conservation. *Wildlife Society Bulletin* 28: 168–179.
- The Wildlife Society. 2009. The Future of the Wildlife Profession and Its Implications for Training the Next Generation of Wildlife Professionals. The Wildlife Society Ad Hoc Committee on Collegiate Wildlife Programs, Bethesda, MD.
- The Wildlife Society. 2011. The Wildlife Society Position Statement on Workforce Diversity. The Wildlife Society, Bethesda, MD. Available at <http://wildlife.org/documents/position-statements/workforce-diversity.05.29.12.pdf> (Accessed 10 July 2015).
- Tuggle, B. N. 2011. Making workforce diversity work. *Wildlife Professional* 5(2): 6.
- United Nations Educational, Scientific and Cultural Organization. 2015. Global flow of tertiary-level students. UNESCO Institute for Statistics. Available at <http://www.uis.unesco.org/EDUCATION/Pages/international-student-flow-viz.aspx> (Accessed 10 July 2015).
- U.S. Bureau of Labor Statistics. 2015. Employment Projections, Replacement Needs. U.S. Department of Labor, Bureau of Labor Statistics. Available at http://www.bls.gov/emp/ep_table_110.htm#top (Accessed 5 July 2015).

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