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Are We Preparing the Next Generation of Fisheries Professionals to Succeed in their Careers?: A Survey of AFS Members

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A SURVEY OF AFS MEMBERS

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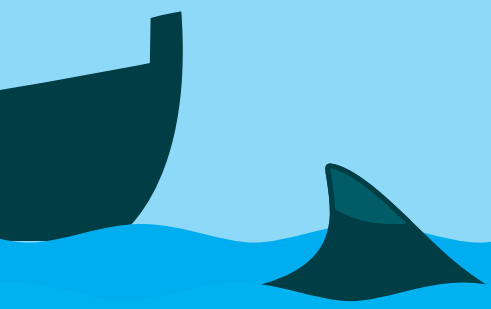

Natural resource professionals have frequently criticized universities for poorly preparing graduates to succeed in their jobs. We surveyed members of the American Fisheries Society to determine which job skills and knowledge of academic topics employers, students, and university faculty members deemed most important to early-career success of fisheries professionals. Respondents also rated proficiency of recently hired, entry-level professionals (employers) on how well their programs prepared them for career success (students and faculty) in those same job skills and academic topics. Critical thinking and written and oral communication skills topped the list of important skills and academic topics. Employers perceived recent entry-level hires to be less well-prepared to succeed in their careers than either university faculty or students. Entry-level hires with post-graduate degrees rated higher in proficiency for highly important skills and knowledge than those with bachelor's degrees. We conclude that although universities have the primary responsibility for developing critical thinking and basic communication skills of students, employers have equal or greater responsibility for enhancing skills of employees in teamwork, field techniques, and communicating with stakeholders. The American Fisheries Society can significantly contribute to the preparation of young fisheries professionals by providing opportunities for continuing education and networking with peers at professional conferences.

¿Estamos preparando a la siguiente generación de profesionales en pesquerías para que tengan éxito en sus carreras?: una encuesta a miembros de la AFS

Los profesionales de los recursos naturales, con frecuencia, han criticado a las universidades por la preparación deficiente de los graduados para tener éxito en sus trabajos. En este trabajo se encuestaron a miembros de la Sociedad Americana de Pesquerías para determinar qué conocimiento de tópicos académicos y habilidades laborales consideran los empleados, estudiantes y miembros de facultades universitarias como las más importantes en los profesionales de las pesquerías para tener éxito al inicio de sus carreras. Los encuestados también reconocieron las habilidades de los profesionistas regresados y contratados (empleados) o qué tan bien sus programas académicos los preparaban para tener éxito en sus carreras (estudiantes y facultad) en las mismas habilidades laborales y tópicos académicos. El pensamiento crítico y las habilidades de comunicación oral y escrita encabezaron la lista de habilidades y tópicos académicos importantes. Los empleadores percibieron a las contrataciones recientes como menos preparadas para tener éxito en sus carreras que los miembros de la facultad o los propios estudiantes. Los individuos recién contratados con posgrado fueron mejor calificados en cuanto a poseer el conocimiento y las habilidades más importantes que los titulados de licenciatura. Concluimos que si bien las universidades tienen la responsabilidad primordial de desarrollar el pensamiento crítico y las habilidades de comunicación en los estudiantes, los empleadores tienen la misma o mayor responsabilidad para fomentar las habilidades de sus trabajadores en lo referente a trabajo en equipo, técnicas de trabajo en campo, y comunicación con los involucrados en las pesquerías. La Sociedad Americana de Pesquerías puede contribuir significativamente a preparar a los jóvenes profesionistas de las pesquerías mediante el otorgamiento de oportunidades para continuar con su educación y el establecimiento de redes de contactos, durante conferencias, con pares y profesionales.

Préparons-nous la prochaine génération de professionnels de la pêche à réussir leur carrière?: Un sondage auprès des membres AFS

Les professionnels des ressources naturelles ont fréquemment critiqué les universités, car elles préparent mal les diplômés à réussir leur carrière. Nous avons interrogé les membres de l'American Fisheries Society pour déterminer quelles compétences professionnelles et quelles connaissances académiques les employeurs, étudiants et membres du corps professoral des universités jugent les plus importantes pour le succès des professionnels de la pêche au début de leur carrière. Les répondants ont également évalué l'aptitude des professionnels récemment entrés sur le marché du travail (employeurs) ou dans quelle mesure les programmes les ont préparés à réussir leur carrière (étudiants et professeurs) dans ces mêmes compétences professionnelles et sujets académiques. La pensée critique, les compétences en communication écrite et orale étaient en tête de la liste des compétences et des sujets académiques importants. Les employeurs ont perçu les professionnels récemment entrés sur le marché du travail moins bien préparés pour réussir dans leur carrière que les professeurs d'université ou les étudiants. Les employés au niveau d'entrée possédant des diplômes postuniversitaires étaient mieux notés dans la maîtrise des compétences et des connaissances très importantes que ceux ne possédant que des diplômes de baccalauréat. Nous concluons que, bien que les universités aient la responsabilité principale de développer la pensée critique et les compétences en communication de base des étudiants, les employeurs ont la responsabilité égale ou supérieure d'améliorer ces compétences dans le travail d'équipe, les techniques de terrain et la communication avec les parties prenantes. L'American Fisheries Society peut contribuer de manière significative à la préparation des jeunes professionnels de la pêche en offrant des possibilités de formation continue et de réseautage avec des pairs lors de conférences professionnelles.

INTRODUCTION

University programs that prepare students to enter the fisheries profession face a difficult task due to the complex and diverse nature of the field. Classmates in a single university program may become fisheries professionals but go into jobs with primary responsibilities in areas as diverse as fish ecology, population dynamics, population or habitat manipulation, water quality, human dimensions, economics, aquaculture, or numerous other specialty areas. Due to the complexity of the field, fisheries professionals (as well as other natural resource professionals) have debated the content of the "ideal" university curriculum for almost as long as the professions have existed (Leopold 1939).

Numerous symposia at professional conferences and publications in natural resource journals over the past 40 years have addressed the issue of how best to prepare students to become successful natural resource professionals. Several common themes that emerged from those symposia included discussions of the merits of broad and general undergraduate curricula versus more specialized curricula and frequent calls for more emphasis on communication skills. These themes are described in more detail below below.

First, the complexity and diversity of fisheries (and other natural resource fields) makes it impossible to adequately prepare students in basic sciences, humanities, communications, specific topics related to fisheries science and management, and critical job skills (e.g., ability to communicate effectively in writing and speaking, working in teams) during a four-year undergraduate program (Chapman 1979; Oglesby and Krueger 1989; Applegate 2009). Furthermore, employers frequently criticized universities for producing students they perceived as too narrowly focused on research questions and poorly prepared in basic skills needed by management-oriented employers (Donaldson 1979; Olmsted 1979; Cutler 1982).

Second, numerous authors suggested that undergraduate curricula should have a broad, interdisciplinary focus rather than a narrow, specialized focus (Hester 1979; Oglesby and Krueger 1989; Hard 1995), and that broad undergraduate programs should focus on developing critical thinking and problem-solving skills of students (Eastmond and Kadlec 1977; Donaldson 1979; Oglesby and Krueger 1989). Specialization should be left to graduate studies (Eipper 1973; Hester 1979). Bleich and Oehler (2000) suggested that more specialized undergraduate education leads to weaker, basic knowledge that hinders professional success of wildlife professionals.

Third, universal recognition of the importance of good written and oral communication skills in contributing to career success (for example, see Royce 1973; Stauffer and McMullin 2009; Blickley et al. 2012) has not resulted in desired proficiency in communication skills of students. Employers frequently cite communication skills of newly hired employees as their greatest deficiency (Cannon et al. 1996; Machnik et al. 2008; CNRS 2011; Sundberg et al. 2011; Sample et al. 2015).

Fourth, the broad category of people skills (e.g., interpersonal communication skills, working in teams, project management, human dimensions, policy processes) received almost as much attention as written and oral communication skills and, as with communication skills, nearly all authors believed that young professionals lacked well-developed people skills (Eastmond and Kadlec 1977; Hester 1979; Kelso and Murphy 1988; Crawford et al. 2011).

Fifth, authors frequently cited the lack of practical field skills among newly hired employees. Lack of experience in the field came up less frequently than the deficiencies in communication skills (Chapman 1979; Applegate 2009; Miller et al. 2009). Nevertheless, complaints about college graduates lacking field skills go back as far as Leopold's (1939:156) lament that "too few schools offer good instruction in the field operations of wildlife management and administration; too many offer indifferent training in wildlife science and research."

Finally, numerous authors suggested that employers should share in the responsibility of developing skills critical to career success of young professionals. Employers' contributions should focus on on-the-job training and support for continuing education (e.g., see Hester 1979; Kelso and Murphy 1988; McMullin et al. 2009).

As the first decade of the 21st century gave way to the second decade, this suite of concerns for the adequacy of university programs in preparing future natural resource professionals took on greater urgency as employers paid increasing attention to generational change in the workplace and workforce planning (McMullin 2005; Millenbah et al. 2011). Workforce planning involves more than supplying enough workers to replace those who retire; it also involves recruiting talented new employees and developing skills of existing employees so that they may move into positions of leadership vacated by retiring senior employees (Pynes 2004). Bieda (2011) attributed some of the persistently high unemployment in the United States workforce to a deficiency in the number of qualified workers to fill existing job openings.

Three major natural resource professional societies have addressed the adequacy of academic preparation of the next generation of natural resource professionals. A special committee of The Wildlife Society (TWS) assessed forces affecting university programs (McDonald et al. 2009) and reviewed university websites to determine that more than 400 universities in the United States offered wildlife, natural resource, or environmental science/management degrees (Wallace and Baydack 2009). The special committee also surveyed TWS members to assess perceptions of employers in the governmental, nongovernmental, and private sectors regarding the importance of various topics to the career success of entry-level hires, including how well-prepared recent entry-level hires were in those same topic areas (Stauffer and McMullin 2009). A few years later, the American Fisheries Society (AFS) followed a similar path when President John Boreman appointed the Special Committee on Educational Requirements and charged it with similar tasks, including assembling a list of North American colleges and universities offering degrees in fisheries and fisheries-related disciplines, conducting a survey of employers to determine what university coursework expectations they have for newly hired employees, and comparing university curricula with employer expectations for expertise of newly hired employees and with the U. S. Office of Personnel Management standards for entry into the federal 480 job series (Essig, this issue). In 2015, the Society of American Foresters devoted an entire issue of the *Journal of Forestry* to forestry education and employer expectations (Bullard 2015).

In this article, we present the results of a survey of AFS members conducted in response to the charge by AFS President Boreman and designed to address the following research questions:

1. What knowledge and job skills do students, university faculty members, and employers deem most important in contributing to early career success of entry-level hires?
2. Are students adequately prepared to succeed as fisheries professionals, and do students, faculty, and employers agree on how well students are prepared?
3. Does postgraduate education contribute significantly to perceptions of how well prepared students are to succeed as fisheries professionals?
4. What should be done to better prepare future fisheries professionals to succeed in their careers, and who should take primary responsibility to improve their preparation?

METHODS

During summer 2013, we invited all 9,214 members of the AFS listserv to participate in an online survey. Sampling from the AFS listserv membership allowed us to secure a broadly representative sample of employers, students, and university faculty in the fisheries profession, including adequate samples of employers in the federal, state, and nongovernmental organization (NGO) sectors, as well as private-sector employers (e.g., utility companies, consulting firms), university faculty, and students. We also hoped to receive enough responses from tribal/First Nation representatives to enable valid analyses.

We could not assign individual passwords, so two follow-up reminders were sent to all listserv members. Because we could not distinguish between respondents and nonrespondents in the listserv population, we relied upon comparison of key demographic characteristics of respondents and all AFS members to assess representativeness of the sample.

The first question of the survey asked the respondents to identify their employers (state/provincial agency, federal agency, tribal/First Nation entity, NGO, private-sector employer, university, student). University faculty members' and students' responses to the first question led them to unique sections of the survey that asked them to rate the importance to career success of 14 topics related to AFS academic requirements for certification as an Associate Fisheries Professional. Six topics in the survey related specifically to fisheries, four topics related to other biological sciences, and single items addressed each of the physical sciences, mathematics/statistics, communications, and human dimensions categories of the AFS professional certification framework. In addition to the certification-related academic topics, we asked respondents to rate the importance of seven other job-related skills to career success: written communication, oral communication, communicating to nontechnical audiences, critical thinking, working in teams, practical field skills, and a general assessment of technical knowledge of fisheries/aquatic sciences. We also asked students and university faculty to rate how well they thought their academic programs prepared them to succeed as fisheries professionals. We asked students to respond with respect to the degree sought (B.A./B.S., M.A./M.S., Ph.D.). University faculty at institutions with graduate programs answered two identical sets of questions: one for their undergraduate program and one for their graduate program. All nonacademic respondents answered a similar set of questions designed for employers. However, we asked employers to rate the perceived proficiency of recently hired entry-level employees (with the degree most commonly required of entry-level hires by their organization) in each of the certification topics and job-related skills. We compared perceptions of proficiency of recently hired B.S.-level graduates to perceived proficiency of M.S.-level graduates for state agency and NGO employers using a *t*-test. We compared perceived proficiency of recently hired B.S.-, M.S.-, and Ph.D.-level graduates in federal agencies and private-sector employers using analysis of variance, followed by a post-hoc Duncan's multiple range test.

All respondents answered questions near the end of the survey designed to assess the level of responsibility of universities, employers, and professional societies in developing knowledge and job skills of fisheries professionals. We also asked all respondents to rate perceived effectiveness of various strategies for developing knowledge and job skills (e.g., revising university curricula, continuing education, participating in AFS, revising the AFS Professional Certification Program).

RESULTS AND DISCUSSION

Response Rate and Respondent Characteristics

Sixteen percent of all listserv members (n = 1,490) responded to the survey. Although the low response rate raises the possibility of nonresponse bias, both the geographic distribution of respondents (Figure 1; χ^2 test, df = 1, P = 0.32), and the mix of students and working professionals in our sample closely matched the overall AFS membership. Students comprise 16.1% of AFS members and made up 15.5% (n = 231) of our sample. These comparisons suggest that our sample reasonably represented the members of AFS.

State, federal, and NGO employers hired entry-level professionals predominately at the master's degree level (Figure 2). Tribal/First Nation employers hired mostly at the bachelor's degree level. Only federal and private-sector employers hired a significant number of entry-level employees at the Ph.D. level. Although we report responses of NGO and tribal/First Nation employers, the reader should exercise caution in drawing conclusions about those employer groups due to small sample sizes.

Graduate students provided 87% of the student responses, and 70% of students responding attended public land grant universities. Seventy-four percent of students were enrolled in fisheries programs, combined fisheries and/or wildlife programs, or marine biology programs. The other 26% of students were enrolled in biology/zoology, environmental science, or conservation biology programs. University faculty responses closely resembled those of students, with 61% employed by public land grant universities and 56% housed in fisheries and/or wildlife departments.

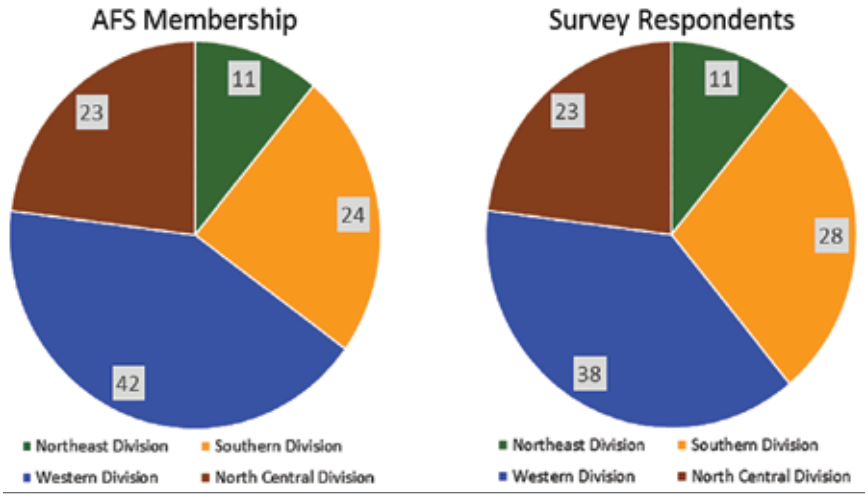

Figure 1. Percentage of AFS members in each of the four geographic Society-level Divisions and percentage of survey respondents in each of those Divisions.

Table 1. Mean ratings of the importance of job skills (A) and knowledge of academic topics addressed by the AFS certification program (B) in contributing to successful careers for entry-level professionals (biologists/scientists/managers) in the fisheries profession by undergraduate (UG), master's (MS), and Ph.D. students; university faculty (Faculty); and employers in state/provincial agencies (State), federal agencies (Fed), tribal/first nation organizations (Tribe), nongovernmental organizations (NGO), and the private sector (Private). Rating scale was 1 = not at all important to 10 = very important.

	Universities				Employers				
A. Skill/knowledge area	UG n = 30	MS n = 105	Ph.D. n = 88	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Effective written communication skills	9.1	9.2	9.0	9.2	9.0	9.2	8.4	9.3	9.1
Effective oral communication skills	9.4	9.3	9.0	9.2	9.0	9.1	8.6	9.2	9.0
Ability to communicate effectively with nontechnical audiences	9.2	9.1	8.8	8.9	8.9	8.5	8.1	9.1	8.4
Critical thinking skills	9.5	9.3	9.2	9.3	9.0	9.0	8.8	9.3	9.0
Working in teams	8.8	8.9	9.0	9.0	8.7	9.0	8.4	9.1	8.8
Practical field skills	9.1	9.0	8.5	8.6	8.5	8.1	8.4	7.4	8.5
Technical knowledge of fisheries/aquatic sciences	8.8	8.9	8.8	8.7	8.5	8.6	8.6	7.9	8.4
	Universities				**Employers**				
B. AFS certification area	UG n = 30	MS n = 105	Ph.D. n = 88	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Fisheries management	8.5	8.9	8.6	8.5	8.6	7.6	7.4	7.4	6.2
Fish ecology	8.8	8.9	8.9	8.8	8.1	8.3	8.3	7.8	7.7
Fisheries techniques	8.3	8.6	8.4	8.3	8.5	7.8	8.2	5.9	8.1
Aquaculture	7.0	5.9	5.8	5.4	5.1	4.4	5.7	4.5	3.7
Limnology/aquatic/marine ecology	8.0	7.5	7.9	7.8	6.6	6.8	6.0	5.9	6.9
Population dynamics	8.6	8.2	8.6	8.2	7.8	7.4	7.1	6.2	6.2
Conservation biology	8.4	7.6	8.0	7.6	6.6	7.8	6.8	7.8	6.3
Ichthyology	8.5	7.5	7.2	7.9	7.0	6.5	5.8	6.1	6.7
Aquatic entomology/invertebrate zoology	7.5	6.2	6.2	6.7	5.2	5.7	5.1	5.3	5.8
Other biological sciences	8.4	7.6	8.2	8.2	6.9	7.3	6.0	7.4	7.1
Physical sciences	7.2	6.6	7.0	7.2	5.7	6.2	5.5	5.5	6.1
Mathematics/statistics	8.2	8.5	8.6	8.4	7.5	7.3	6.6	6.5	7.2
Communications courses	8.4	8.6	8.9	9.0	8.7	8.4	7.5	8.3	8.6
Human dimensions/policy	7.5	7.5	7.9	7.5	7.5	7.0	5.8	7.4	6.6

Research Questions 1 and 2: What knowledge and skills contribute most to early career success, and how well prepared are students to succeed?

Overall, employers rated critical thinking skills and oral and written communication skills as the most important contributors to career success of entry-level employees. Communication courses and fisheries-specific topics rated highest in importance among academic topics, whereas aquaculture, aquatic entomology/invertebrate zoology, and physical sciences rated lowest in importance (Figure 3). Overall mean importance ratings for all job skills and academic topics, with the exception of aquaculture, exceeded the midpoint (5.5) of the 1–10 scale, suggesting that respondents considered all of those topics as at least moderately important. Differences in importance rankings of job skills and academic topics among students at every degree level, faculty members, and employers in every category were minor and generally consistent with the missions of employers (Table 1). For example, whereas all employers included communication courses and fish ecology among their five highest-rated academic topics, state agency employers rated fisheries management among their top five academic topics. Federal agency employers, which frequently deal with conservation of imperiled species, rated conservation biology among their five most important topics. Nongovernmental organizations ranked conservation biology and human dimensions/policy among their five most important topics.

Regardless of the level of education at which employers hire entry-level employees, what employers desire most includes the ability to think critically and to communicate effectively in

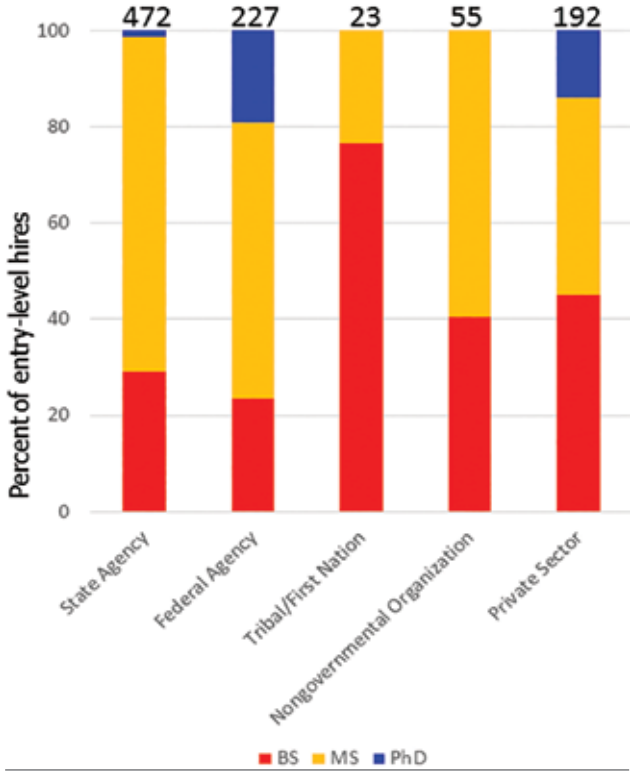

Figure 2. Percentage of entry-level hires with B.S., M.S., and Ph.D. degrees by employer. Numbers at the top of the bars are sample sizes for each employer type.

Table 2. Mean ratings by undergraduate students (UG) and university faculty (Faculty) of how well university undergraduate curricula prepare students in job skills (A) and academic topics addressed by the AFS certification program (B) and perceptions of employers in state/provincial agencies (State), federal agencies (Fed), tribal/first nation organizations (Tribe), nongovernmental organizations (NGO), and the private sector (Private) who hire primarily B.S.-level graduates of the proficiency of B.S. graduates as entry-level professionals (biologists/scientists/managers) in the fisheries profession. Rating scales were 1 = very poorly to 10 = very well (for students and faculty) and 1 = not at all proficient to 10 = very proficient (for employers).

	Universities		Employers				
A. Skill/knowledge area	UG n = 30	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Effective written communication skills	8.2	6.8	5.6	5.4	5.6	6.1	6.2
Effective oral communication skills	7.8	6.9	5.7	5.5	5.7	5.8	5.9
Ability to communicate effectively with nontechnical audiences	6.7	6.1	5.8	5.7	6.6	6.2	5.7
Critical thinking skills	8.2	6.8	5.7	5.4	6.1	6.2	6.2
Working in teams	7.4	7.2	7.1	6.5	6.4	7.2	7.0
Practical field skills	7.9	6.9	6.6	6.2	6.3	5.2	6.4
Technical knowledge of fisheries/aquatic sciences	8.1	7.1	6.3	6.4	5.6	4.9	6.3
	Universities		**Employers**				
B. AFS certification area	UG n = 30	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Fisheries management	7.6	6.9	5.4	5.2	4.8	4.1	4.6
Fish ecology	7.8	7.3	5.8	6.0	6.2	5.5	5.5
Fisheries techniques	7.1	6.6	5.9	6.2	6.0	4.3	5.1
Aquaculture	5.2	4.4	3.9	3.3	4.4	3.4	3.2
Limnology/aquatic/marine ecology	7.7	7.2	4.9	4.7	4.8	4.2	5.0
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Conservation biology	7.6	7.0	5.6	5.0	5.4	4.6	4.9
Ichthyology	8.5	7.0	5.5	5.2	4.7	4.3	4.8
Aquatic entomology/invertebrate zoology	7.3	6.0	3.8	4.5	4.6	4.1	4.5
Other biological sciences	9.0	8.0	6.2	5.6	5.7	5.4	6.3
Physical sciences	7.6	7.1	5.2	4.9	5.0	4.4	5.4
Mathematics/statistics	7.8	6.9	4.9	4.8	4.9	4.4	5.3
Communications courses	7.8	6.6	4.9	5.1	5.2	5.0	5.1
Human dimensions/policy	6.4	6.2	4.4	4.5	4.1	4.8	4.7

In addition to the desire for greater quantitative skills, employers desire graduates who understand and appreciate the social science, policy, and administrative aspects of fisheries conservation.

both writing and speaking. Although employers, university faculty, and students also identified fisheries-specific courses and quantitative courses as highly important, all employers rated all of the 14 academic topics and seven basic job skills (with few minor exceptions) as at least somewhat important. These findings are consistent with several of the themes found throughout the literature for at least 40 years, including the need for a broad, interdisciplinary undergraduate education that stresses critical thinking, problem-solving, and communication skills (e.g., Royce 1973; Donaldson 1979; Oglesby and Krueger 1989; Hard 1995; Stauffer and McMullin 2009).

Undergraduate students generally believed that their university curricula prepared them well to succeed in entry-level positions for all job skills and academic topics except aquaculture (Table 2). University faculty members also tended to rate their programs' undergraduate curricula as preparing students well to succeed in entry-level positions, with only aquaculture receiving a preparation rating less than 6.0 on the 10-point scale (4.4). However, faculty members rated every item lower than undergraduate students. Undergraduate students and faculty members differed most in perceptions of how well their curricula prepared students to succeed in entry-level jobs for ichthyology, critical thinking skills, and effective written communication skills.

Employers who hired entry-level employees primarily at the bachelor's degree level rated the proficiency of recently hired graduates substantially lower compared to both undergraduate students' and faculty members' ratings of how well their undergraduate programs prepared them to succeed in all job skills and academic topics (Table 2). Nongovernmental organization employers rated proficiency on all 14 academic topics below the midpoint of the 10-point scale and private-sector employers rated all but one of the items below the midpoint. All employer groups rated proficiency of recent entry-level hires below the midpoint on more than half of the 14 academic topics. Employers rated recent entry-level hires approximately two to three points lower than undergraduate students and one to two points lower than faculty members for critical thinking skills, effective written communication skills, effective oral communication skills, and technical knowledge of fisheries/aquatic sciences. Although job skills and academic topics that rated highest and lowest in importance tended to follow similar patterns for proficiency, the difference between importance and proficiency ratings differed notably for population dynamics, mathematics/statistics, and human dimensions/policy (Figure 4).

Respondents consistently rated proficiency (or in the case of

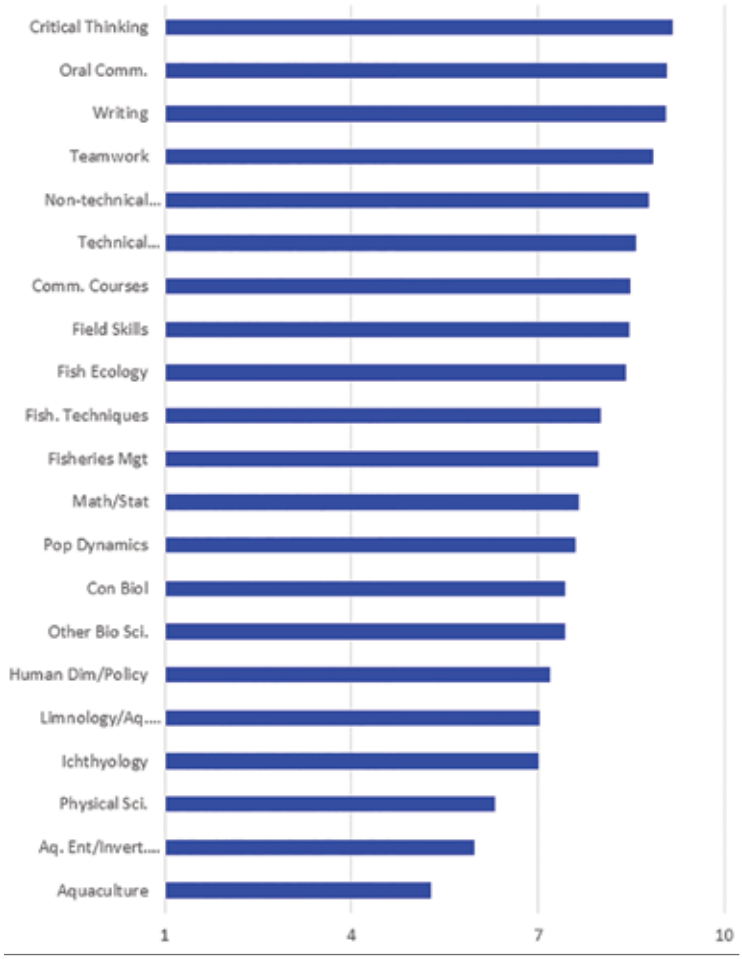

Figure 3. Overall ratings by all employers of the importance of job skills and academic topics to career success of entry-level hires.

faculty and students, preparation) lower on a 10-point scale than they did importance (also on a 10-point scale) of job skills and academic topics. Although the response scales are similar, they do not provide exact matches for comparisons. Nevertheless, the lower proficiency ratings (often by two or more points) suggest that employers do not feel that entry-level hires perform as well in basic job skills and academic topics as desired. Stauffer and McMullin (2009) found a similar pattern in responses of wildlife professionals. The greatest differences between importance and proficiency ratings occurred for the most important job skills: critical thinking, written communication, and oral communication.

Fisheries curricula will, and should, continue to include a substantial component of liberal arts, consistent with the recommendations found in several previously published papers (Hester 1979; Oglesby and Krueger 1989). Employer responses to this survey suggested that the central focus of fisheries curricula should be in fisheries-specific courses, communications, and mathematics/statistics. Employer responses mirror the recommendations found in previous papers that emphasized the need for greater quantitative skills among fisheries graduates (Hard 1995; USDOC and USDE 2008). The greatest disparities between employers' perceptions of importance and proficiency relative to academic topics occurred in the areas of population dynamics, mathematics/statistics, and human dimensions. Thus, in addition to the

The message to students should be clear: they should view a bachelor's degree as a stepping stone on the way to postgraduate education if they wish to maximize their chances of becoming a successful fisheries professional.

desire for greater quantitative skills, employers desire graduates who understand and appreciate the social science, policy, and administrative aspects of fisheries conservation. The need for increasing knowledge of human dimensions in natural resources has long been recognized (Cutler 1982; Kelso and Murphy 1988; Peek 1989; Decker and Enck 1996). Of course, all of these needs compete with the desire to maintain a "hands-on" educational experience so that natural resource graduates develop strong field skills as well as topical knowledge (Sample et al. 2015).

Research Question 3: Does postgraduate education contribute significantly to perceptions of how well prepared students are to succeed as fisheries professionals?

Master's students also felt that their programs prepared them well for entry-level positions, especially in the basic job skills, where their ratings exceeded those of undergraduate students on five of the seven skills (Table 3). In contrast, master's students rated their program preparation lower than undergraduate students on all but one of the academic topics.

University faculty rated their programs' preparation of graduate students (both master's and doctoral degrees) for entry-level positions similarly to the master's students' ratings for basic job skills (Table 3). In contrast to their lower ratings for undergraduate students, faculty members rated master's students' preparation higher than the students did for critical thinking skills, practical field skills, technical knowledge of fisheries/aquatic sciences, and 11 of the 14 academic topics (Table 3). Curiously, master's students rated their programs substantially lower than faculty members in preparing them for entry-level jobs in the academic topics of population dynamics and mathematics/statistics, both of which receive substantial emphasis in most graduate fisheries programs.

Employers who hired entry-level employees primarily at the master's degree level rated the proficiency of recently hired employees higher than employers that hired at the bachelor's degree level. State agency employers that hired entry-level professionals with master's degrees rated proficiency of those employees significantly higher ($P < 0.05$) for four of the seven basic job skills, and all five academic topics they rated as most important to early career success (communication courses, fisheries management, fisheries techniques, fish ecology, population dynamics) compared to state agency employers hiring bachelor's degree entry-level hires (Table 4).

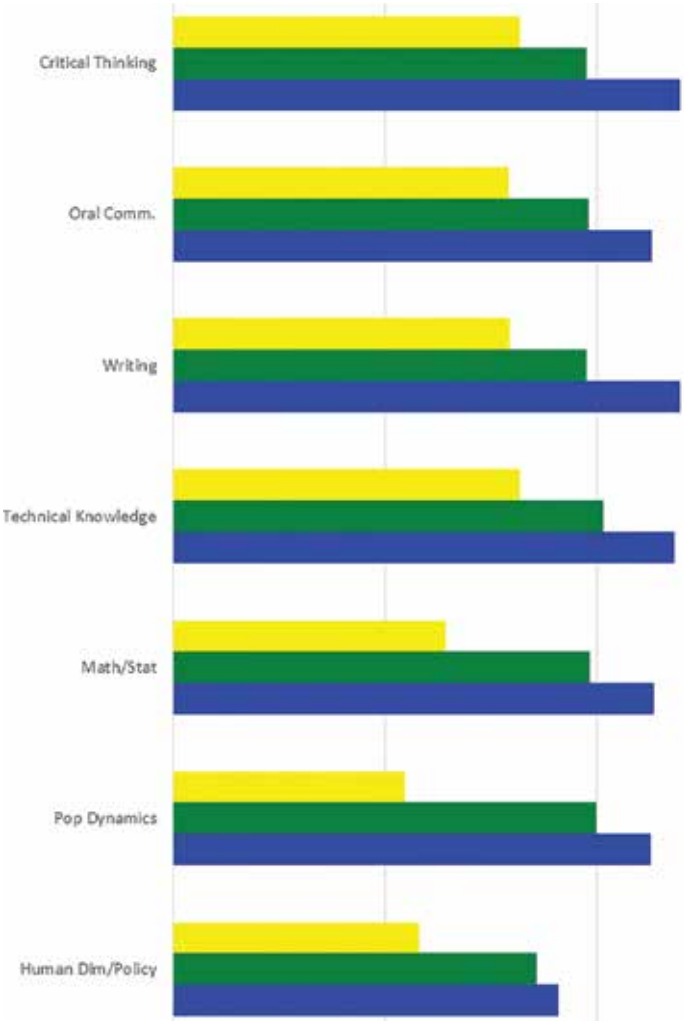

Figure 4. Comparison of employers' perceived proficiency of entry-level hires with B.S. degrees and the perceptions by university faculty and undergraduate students of how well their undergraduate curricula prepared them to succeed as entry-level professionals.

Federal employers also rated proficiency of entry-level employees with postgraduate degrees significantly higher than bachelor's degree entry-level hires ($P < 0.05$) for critical thinking, written communication, and oral communication skills (Table 5). Among the five academic topics federal employers rated as most important to early career success (communication courses, fish ecology, conservation biology, fisheries techniques, fisheries management), proficiency of entry-level hires with postgraduate degrees was rated higher only for fish ecology and conservation biology. Federal employer perceptions of the proficiency of entry-level employees with Ph.D. degrees did not differ greatly from perceived proficiency of master's students, with the exception of population dynamics and aquatic entomology/invertebrate zoology.

Although nongovernmental organization employers perceived large gains in proficiency among master's degree entry-level hires compared to employees with bachelor's degrees (range = 0.83 to 1.67; Table 3) in the five academic topics they deemed most important to career success (communications courses, fish ecology, fisheries management, conservation biology, human dimensions/policy), the differences did not differ significantly ($P > 0.05$), probably because of the small sample size of NGO respondents. Private-sector employers did not perceive significant gains in proficiency in the five academic topics they deemed most important to career success (communications courses, fish ecology, fisheries techniques, mathematics/statistics, other biological sciences) for any degree level ($P > 0.05$).

Increases in perceived proficiency for entry-level employees hired at the postgraduate level in state and federal agencies provide evidence of the value of advanced fisheries education and may help to explain why the largest employers of fisheries professionals hire the majority of their entry-level professionals at the postgraduate level (Kaemingk et al. 2013). The message to students should be clear: they should view a bachelor's degree as a stepping stone on the way to postgraduate education if they wish to maximize their chances of becoming a successful fisheries professional. Although some professional-level jobs are available to graduates with bachelor's degrees, more often, the bachelor's degree provides preparation for graduate school or technician-level jobs. Employers valued critical thinking and communication skills above all else in their entry-level employees, and postgraduate education clearly enhanced the perception of proficiency in those skill areas.

Research Question 4: What should be done to better prepare future fisheries professionals to succeed in their careers and who should take primary responsibility to improve their preparation?

Overall, respondents indicated that both universities and employers should have major roles in developing important job skills of entry-level professionals, with professional societies playing a lesser role (Table 6). Respondents suggested that universities had greater responsibility than employers or professional societies for developing critical thinking and written and oral communication skills of young professionals. In contrast, respondents suggested that employers had equal or slightly greater responsibility than universities for developing the ability to communicate effectively with nontechnical audiences, working in teams, and practical field skills.

Respondents rated experiential learning opportunities, such as internships and student participation in undergraduate research, as most effective in enhancing the knowledge, skills, and abilities of entry-level fisheries professionals (Figure 5). Continuing education workshops, revising university curricula, and involvement in AFS also rated high as effective strategies, whereas establishing university program accreditation rated slightly lower, and revision of the AFS professional certification criteria ranked lowest in effectiveness.

Most of the literature addressing how to adequately prepare students and young professionals to become highly effective natural resource professionals focuses on how universities can do a better job of educating students (e.g., Chapman 1979; Donaldson 1979; Kelso and Murphy 1988; Oglesby and Krueger 1989; Bullard 2015). We submit that the responsibility for meeting the challenge of preparing the next generation of fisheries professionals rests with the entire profession, not only with universities. The high ratings by respondents for both universities and employers (and, to a lesser extent, professional societies) to our question about who should be responsible for developing job skills suggests that the majority of AFS members agree with us. To

Table 3. Mean ratings by master's students (MS) and university faculty (Faculty) of how well university graduate curricula prepare students in job skills (A) and academic topic addressed by the AFS certification program (B) and perceptions of employers in state/provincial agencies (State), federal agencies (Fed), tribal/first nation organizations (Tribe), nongovernmental organizations (NGO), and the private sector (Private) who hire primarily MS-level graduates of the proficiency of MS graduates as entry-level professionals (biologists/scientists/managers) in the fisheries profession. Rating scales were 1 = very poorly to 10 = very well (for students and faculty) and 1 = not at all proficient to 10 = very proficient (for employers).

	Universities		Employers				
A. Skill/knowledge area	MS n = 105	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Effective written communication skills	8.3	8.2	6.5	6.6	7.8	6.8	6.0
Effective oral communication skills	8.2	8.2	6.5	6.6	8.0	6.6	5.9
Ability to communicate effectively with nontechnical audiences	7.5	7.0	6.1	6.1	7.3	6.7	5.5
Critical thinking skills	8.2	8.3	6.5	6.4	7.0	7.1	6.5
Working in teams	7.6	7.5	7.3	6.9	9.0	7.3	7.2
Practical field skills	7.5	7.9	7.0	6.8	7.0	6.3	6.4
Technical knowledge of fisheries/aquatic sciences	7.8	8.1	7.2	7.0	7.3	6.4	6.7
	Universities		**Employers**				
B. AFS certification area	MS n = 105	Faculty n = 184	State n = 472	Fed n = 227	Tribe n = 27	NGO n = 55	Private n = 192
Fisheries management	7.4	7.5	6.8	6.5	6.0	5.5	5.0
Fish ecology	7.6	8.0	6.9	6.9	7.5	6.3	6.2
Fisheries techniques	7.4	7.0	6.8	6.4	7.0	4.9	6.1
Aquaculture	4.3	4.9	4.1	4.2	5.0	3.5	3.4
Limnology/aquatic/marine ecology	6.0	7.3	5.4	5.5	7.0	5.2	5.4
Population dynamics	7.0	8.0	5.9	5.5	7.3	5.1	4.7
Conservation biology	6.7	7.5	6.1	6.2	7.5	6.2	5.3
Ichthyology	6.1	6.4	6.3	5.7	7.5	5.0	5.1
Aquatic entomology/invertebrate zoology	5.2	5.9	5.0	4.7	7.0	4.1	4.7
Other biological sciences	7.1	7.6	6.8	6.9	7.3	7.4	6.3
Physical sciences	5.7	6.5	5.6	5.5	6.3	5.6	5.5
Mathematics/statistics	7.2	8.0	6.1	5.9	5.8	5.6	5.8
Communications courses	7.2	7.1	5.7	5.8	6.8	6.3	5.4
Human dimensions/policy	6.3	6.2	4.7	5.2	4.0	6.4	4.4

effectively prepare the next generation of fisheries professionals, members of the profession should understand the unique challenges that students, university programs, and employers face and then collaborate to develop strategies to address those challenges.

What Can Students Do?

Today's university students face greater economic pressures to complete their education more quickly than previous generations of students. For example, the total cost of tuition, fees, and room and board at public institutions of higher education in the United States (where the majority of fisheries students get their education) increased by 40% between the 2001–2002 and 2011–2012 academic years (USDE 2013). During that same time period, the Consumer Price Index increased 27% (USBLS 2014). The cumulative student loan debt (in constant 2009 dollars) for graduates with bachelor's degrees in 2008 averaged US$24,700, 65% more than that of 1993 graduates (Woo and Soldner 2013). As a result of that economic pressure, many students seek to minimize their total expenses by taking summer classes in an effort to shorten their degree programs by one or more semesters. However, taking classes in summer often prevents students from gaining the experiential learning they could acquire through summer employment in the fisheries field. Students who wish to be competitive for jobs (or graduate school) in the fisheries field must balance their desire to complete their education quickly with the enhancement of their résumés that results from internships, undergraduate research, and other forms of experiential learning (Kaemingk et al. 2013).

Although most undergraduate curricula in fisheries and wildlife are so packed with university-mandated general education requirements and degree-specific requirements that little room is left for elective courses, results of our survey suggest that students would be wise to focus on communication-related courses for the few elective courses they can take. Similarly, graduate students (especially at the M.S. level) usually have few opportunities for elective courses beyond the degree-specific requirements (which often include multiple courses in quantitative subjects in addition to fish and wildlife courses). Graduate students also could benefit from more coursework in communications. In recognition of this need, numerous universities have developed graduate courses specifically addressing communication of science to nonscientific audiences (e.g., see Alan Alda Center for Communicating Science, www.centerforcommunicatingscience.org).

The Millennial generation (those born between 1981 and 1995) of students currently in college and entering the profession may be less patient with "paying their dues" to acquire knowledge and skills that normally come with more formal education and experience (Millenbah et al. 2011). Millennials also tend to overestimate their abilities. Sixty-nine percent of college freshmen responding to the Cooperative Institutional Research Program's Freshman Survey in 2012 rated themselves among the top 10% or above average in academic ability (Pryor et al. 2012). Curiously (and perhaps ominously, given the importance employers attach to communication skills), 46% of those same students rated themselves among the top 10% or above average in writing ability.

Superior academic performance (actually being a high achiever rather than perceiving it to be true), combined

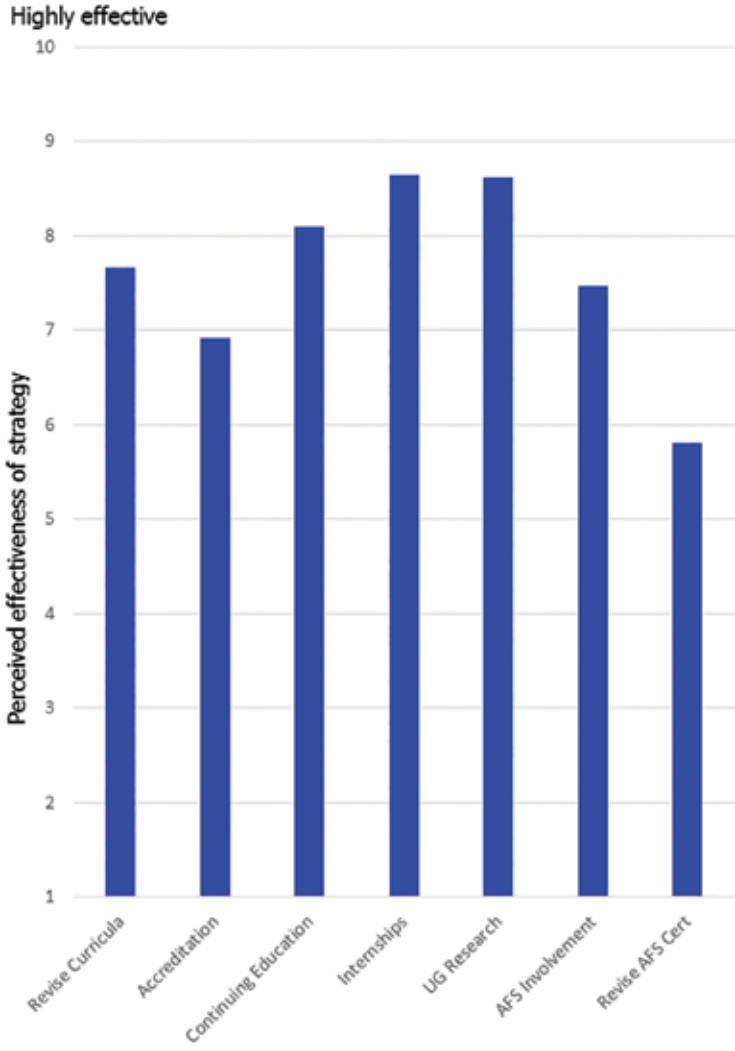

Figure 5. Perceived effectiveness of various strategies for enhancing the knowledge, skills, and abilities of entry-level fisheries professionals.

with practical experience gained through internships or undergraduate research, has always been key to opening the door to successful and rewarding careers in fisheries. Paying your dues through proven academic performance, practical experience, and postgraduate education is especially important in the highly competitive job market created by a backlog of graduates seeking jobs during the economic downturn that began in 2008–2009. Regardless of terminal degree, students and professionals at all levels in the fisheries profession should pursue lifelong learning. The knowledge and skills required of competent fisheries professionals change dramatically with time and technology, demanding continuous learning throughout one's career.

What Can Universities Do?

Universities face many challenges as they attempt to educate the next generation of fisheries professionals. Despite the rapidly rising cost of tuition, fisheries programs at many public universities have seen their budgets shrink as state governments have reduced their financial contributions to higher education. As the cost of a college education has shifted more to students and their families, pressure on universities to ensure that students can graduate in four years has intensified. For example, at the home institution of the lead author, today's students must complete 120 semester credits to earn a B.S. degree in fisheries conservation, 15 fewer credits than the degree required 20 years ago. The loss of an entire semester of courses increases the difficulty of simultaneously providing a broad undergraduate education and meeting the expectations of employers to produce competent fisheries professionals. Thus, university programs must choose between dropping liberal arts courses that broaden a student's perspective, science courses that may provide a broader foundation for fisheries education but may be less directly related to fisheries (for example, some physical sciences; see Gabelhouse 2010), or more directly related courses that emphasize hands-on, experiential learning but may be expensive to offer.

Universities cannot simply add more courses to address all of the skills and topics that employers cite as important to succeed as a professional. University-mandated general education requirements and basic science and mathematics courses that serve as prerequisites to fisheries-related courses often make up more than 80% of the total credits required to graduate. Adding required fisheries-related courses to the mix leaves little room for additional courses deemed important to career success. Applegate (2009) listed 68 university courses that he felt should be the minimum requirements to adequately prepare wildlife students for employment, more courses than most institutions require to earn B.S., M.S., and Ph.D. degrees. Instead, universities should employ pedagogical approaches that incorporate development of critical thinking, problem-solving, and communication skills across existing curricula. Fisheries educators today increasingly use case studies of real-world problems to force students to employ problem-solving techniques for interdisciplinary problems (Murphy et al. 2010). The case study approach, long a staple of teaching in business and law schools, forces fisheries students to integrate knowledge acquired (at least in theory) in previous courses, to work in teams, and to develop communication skills (Touval and Dietz 1994). Changing pedagogical approaches also requires university faculty to redirect some effort from research to the practice of teaching, something that many university promotion and tenure systems frequently do not reward (Nielsen 1987; Arlinghaus 2014).

What Can Employers Do?

Employers also must assume responsibility for continued development of their employees. Their responsibilities begin with having realistic expectations of entry-level employees at various levels of education; that is, not expecting an employee with a bachelor's degree to perform at the same level as an employee with a master's degree. Employers and universities should collaborate in the design and revision of fisheries curricula to ensure that graduates receive training in the topics of greatest importance to their future employers (CNRS 2011). Perhaps the most important responsibility of employers is to continue to invest in the development of their employees through continuing education and attendance at professional conferences.

The survey results indicated that employers should assume

Table 4. Comparison of perceived proficiency of recently hired entry-level employees in state agencies with bachelor's degrees and master's degrees (* $P < 0.05$, ** $P < 0.01$).

Skill/knowledge area	Bachelor degree entry-level hires (n = 104)	Master's degree entry-level hires (n = 247)	Master's degree hires – bachelor's degree hires
Effective written communication skills	5.6 (0.37)	6.5 (0.21)	0.9**
Effective oral communication skills	5.7 (0.36)	6.5 (0.20)	0.8**
Ability to communicate effectively with nontechnical audiences	5.8 (0.37)	6.1 (0.22)	0.3
Critical thinking skills	5.7 (0.37)	6.5 (0.21)	0.8**
Working in teams	7.1 (0.37)	7.3 (0.19)	0.2
Practical field skills	6.6 (0.41)	7.0 (0.22)	0.4
Technical knowledge of fisheries/ aquatic sciences	6.3 (0.37)	7.2 (0.2)	0.9**
Fisheries management	5.4 (0.4)	6.8 (0.24)	1.4**
Fish ecology	5.8 (0.38)	6.9 (0.20)	1.1**
Fisheries techniques	5.9 (0.37)	6.8 (0.23)	0.9**
Aquaculture	3.9 (0.44)	4.1 (0.26)	0.2
Limnology/aquatic/marine ecology	4.9 (0.4)	5.4 (0.25)	0.5*
Population dynamics	4.5 (0.43)	5.9 (0.26)	1.4**
Conservation biology	5.6 (0.43)	6.1 (0.26)	0.5
Ichthyology	5.5 (0.42)	6.4 (0.24)	0.9**
Aquatic entomology/invertebrate zoology	3.8 (0.41)	5.0 (0.26)	1.2**
Other biological sciences	6.2 (0.35)	6.8 (0.18)	0.6**
Physical sciences	5.2 (0.34)	5.6 (0.22)	0.4
Mathematics/statistics	4.9 (0.38)	6.1 (0.23)	1.2**
Communications courses	4.9 (0.37)	5.7 (0.22)	0.8**
Human dimensions/policy	4.4 (0.38)	4.7 (0.24)	0.3

Table 5. Comparison of perceived proficiency of recently hired entry-level employees in federal agencies with bachelor's degrees, master's degrees, and Ph.D. degrees (letters indicate significant ANOVA, $P < 0.05$, Duncan's post-hoc comparison).

Skill/knowledge area	Bachelor's degree entry-level hires (n = 39)	Master's degree entry-level hires (n = 94)	Ph.D. degree entry-level hires (n = 30)	Master's degree hires – bachelor's degree hires	Ph.D. degree hires – master's degree hires
Effective written communication skills	5.4[a]	6.6[b]	7.1[b]	1.2	0.5
Effective oral communication skills	5.5[a]	6.6[b]	7.0[b]	1.1	0.4
Ability to communicate effectively with nontechnical audiences	5.7[a]	6.1[a]	5.9[a]	0.4	-0.2
Critical thinking skills	5.4[a]	6.4[b]	7.1[b]	1.0	0.7
Working in teams	6.5[a]	6.9[a]	6.9[a]	0.4	0.0
Practical field skills	6.2[a]	6.8[a]	6.8[a]	0.6	0.0
Technical knowledge of fisheries/ aquatic sciences	6.4[a]	7.0[ab]	7.6[b]	0.6	0.6
Fisheries management	5.2[a]	6.5[b]	6.0[ab]	1.3	-0.5
Fish ecology	6.0[a]	6.9[b]	6.9[b]	0.9	0.0
Fisheries techniques	6.2[a]	6.4[a]	6.1[a]	0.2	-0.3
Aquaculture	3.3[a]	4.2[ab]	4.4[b]	0.9	0.2
Limnology/aquatic/marine ecology	4.7[a]	5.5[ab]	6.3[b]	0.8	0.8
Population dynamics	4.5[a]	5.5[b]	6.6[c]	1.0	1.1
Conservation biology	5.0[a]	6.2[b]	6.5[b]	1.2	0.3
Ichthyology	5.2[a]	5.7[a]	5.9[a]	0.5	0.2
Aquatic entomology/invertebrate zoology	4.5[a]	4.7[a]	5.6[b]	0.2	0.9
Other biological sciences	5.6[a]	6.9[b]	7.4[b]	1.3	0.5
Physical sciences	4.9[a]	5.5[a]	5.6[a]	0.6	0.01
Mathematics/statistics	4.8[a]	5.9[b]	6.4[b]	1.1	0.5
Communications courses	5.1[a]	5.8[ab]	6.3[b]	0.7	0.5
Human dimensions/policy	4.5[a]	5.2[a]	4.7[a]	0.7	-0.5

Table 6. Perceived level of responsibility (1 = Low, 10 = High) of universities (U), employers (E), and professional societies (S) in developing knowledge and ability in various job skills (n = 1,490).

Job skill	U	E	S
Effective written communication skills	9.1	7.0	6.4
Effective oral communication skills	8.9	7.2	6.9
Ability to communicate effectively with nontechnical audiences	7.7	8.0	6.5
Critical thinking skills	9.0	7.0	5.6
Working in teams	7.7	8.2	5.4
Practical field skills	7.9	8.3	5.5
Technical knowledge of fisheries/ aquatic sciences	8.9	7.5	7.1

much of the responsibility for developing employees' ability to communicate effectively with nontechnical audiences, to work effectively in teams, and to enhance field skills. In addition, employees will likely gain more knowledge and skills in some areas (e.g., supervision, leadership, working with stakeholders) through continuing education, after they have gained some job experience and can better relate to those topics. As budgets shrink, employers often cut back on opportunities for employees to travel and attend conferences and workshops. Unfortunately, shrinking budgets also frequently result in fewer vacant positions being filled and additional responsibilities being shifted to employees. Employees who are expected to do more with less need more continuing education and professional involvement, not less. Some employers hesitate to invest in employees for fear that their investment to improve the skills of employees will result in those employees seeking employment elsewhere. Employers should ask themselves, "What if we don't invest in our employees and they stay?"

What Can AFS Do?

The American Fisheries Society can play an important role in ensuring that the next generation of fisheries students enters the profession well- prepared. Although survey respondents did not attribute great responsibility to AFS for developing the knowledge and skills that employers seek in entry-level employees, the Society has primary responsibility for setting the standards of professionalism in fisheries. The criteria established by AFS for certification as a fisheries professional significantly influence the content of university fisheries curricula because most universities want their students to qualify for certification upon graduation. Although revision of the AFS certification program rated low among the strategies for improving the knowledge and skills of fisheries professionals, periodic revision of the certification criteria will ensure that the standards of professionalism in fisheries remain current. Recent examples of changing expectations of fisheries professionals reflected in revision of the certification program include increased emphasis on human dimensions and allowance of geographic information systems courses to fulfill the physical sciences requirement. Certification criteria probably cannot address the desire of employers for better critical thinking skills among entry-level hires, but increasing emphasis on communication skills could be addressed by certification. AFS should consider increasing offerings of continuing education courses at Society meetings at all levels that address the communication skills deemed so important by employers. Furthermore, AFS-sponsored continuing education workshops could help to address areas of knowledge frequently lacking in entry-level employees, such as human dimensions and quantitative skills. Accreditation of fisheries programs by AFS also rated low as a strategy for improving knowledge and skills of entry-level employees. Scalet and Adelman (1995) suggested that accreditation of university fisheries and wildlife programs would be redundant with the certification programs of both AFS and TWS and, furthermore, that attempts to establish accreditation would encounter substantial resistance from universities. The Society of American Foresters has taken a different path, emphasizing the value of accreditation of university forestry programs (Redelsheimer et al. 2015).

The American Fisheries Society can continue to play a major role in improving the knowledge and skills of fisheries professionals by promoting interaction and sharing of information through its meetings at Chapter, Division, and Society levels. Chapters play a particularly important role, because they provide more convenient and economical opportunities for fisheries professionals to meet and learn than Division or Annual Meetings of the Society. For many state agency employees who face severe restrictions on out-of-state travel, Chapter meetings may provide the only realistic possibility of involvement in the Society. The American Fisheries Society should continue to explore opportunities to expand the availability of continuing education workshops and content of conferences beyond those physically attending, but for fisheries professionals who are serious about upgrading their credentials and staying current in the profession, actual participation and the associated networking far surpasses virtual participation.

CONCLUSION

The challenge of adequately preparing the next generation of fisheries professionals faces the entire profession, not just universities. Universities play a critical role in building the foundation upon which professionalism is built, but employers, AFS, and the individual members of the profession all share in the responsibility to develop the next generation of fisheries professionals. To be effective, future fisheries professionals must think critically, employ excellent problem-solving skills, and communicate effectively with nontechnical audiences, specialists in other disciplines, and other fisheries professionals. Of course, they still must have a solid foundation of knowledge of fisheries and aquatic sciences, basic sciences, and mathematics. In most cases, graduates with bachelor's degrees will have only begun the process of becoming professionals. Postgraduate education will enhance the knowledge and skills that lead to success as a fisheries professional, but regardless of the number of degrees earned, professionals must embrace lifelong learning.

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