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# A view of the global conservation job market and how to succeed in it

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**Abstract:** *The high demand for conservation work is creating a need for conservation-focused training of scientists. Although many people with postsecondary degrees in biology are finding careers outside academia, many programs and mentors continue to prepare students to follow-in-the-footsteps of their professors. Unfortunately, information regarding how to prepare for today's conservation-based job market is limited in detail and scope. This problem is complicated by the differing needs of conservation organizations in both economically developed and developing regions worldwide. To help scientists identify the tools needed for conservation positions worldwide, we reviewed the current global conservation job market and identified skills required for success in careers in academia, government, nonprofit, and for-profit organizations. We also interviewed conservation professionals across all conservation sectors. Positions in nonprofit organizations were the most abundant, whereas academic jobs were only 10% of the current job market. The most common skills required across sectors were a strong disciplinary background, followed by analytical and technical skills. Academic positions differed the most from other types of positions in that they emphasized teaching as a top skill. Nonacademic jobs emphasized the need for excellent written and oral communication, as well as project-management experience. Furthermore, we found distinct differences across job locations. Positions in developing countries emphasized language and interpersonal skills, whereas positions in countries with advanced economies focused on publication history and technical skills. Our results were corroborated by the conservation professionals we interviewed. Based on our results, we compiled a nondefinitive list of conservation-based training programs that are likely to provide training for the current job market. Using the results of this study, scientists may be better able to tailor their training to maximize success in the conservation job market. Similarly, institutions can apply this information to create educational programs that produce graduates primed for long-term success.*

**Keywords:** conservation education, international, graduate training, skills

Una Visión del Mercado Laboral de la Conservación Mundial y Cómo Ser Exitoso en Él

**Resumen:** *La alta demanda de trabajo en la conservación está generando la necesidad de un entrenamiento para los científicos enfocado en la conservación. Aunque muchas personas con grados diferentes en Biología están encontrando carreras fuera de la academia, muchos programas y mentores continúan preparando a los estudiantes para seguir las trayectorias de sus profesores. Desafortunadamente, la información con respecto a cómo prepararse para el mercado laboral basado en la conservación de hoy en día está limitada en cuanto a detalle y enfoque. Este problema se complica globalmente con las necesidades diferentes de las organizaciones de la conservación tanto en las regiones desarrolladas económicamente como en las que se encuentran en desarrollo. Para ayudar a los científicos a identificar las herramientas necesarias para los puestos de conservación a nivel mundial, revisamos el mercado laboral actual de la conservación e identificamos las habilidades requeridas para el éxito en carreras académicas, gubernamentales, y en organizaciones con y*

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**Article Impact Statement:** All sectors of the conservation job market require workers with strong disciplinary backgrounds and analytical and technical skills.

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*sin fines de lucro. También entrevistamos a profesionales de todos los sectores dentro de la conservación. Los puestos en las organizaciones sin fines de lucro fueron los más abundantes, mientras que los trabajos académicos sólo formaron el 10% del mercado laboral actual. La habilidad requerida más común entre los sectores fue una experiencia disciplinaria vasta, seguida de habilidades analíticas y técnicas. Los puestos académicos fueron los que más difirieron de los otros tipos de puestos ya que enfatizaron a la docencia como la principal habilidad. Los trabajos no-académicos enfatizaron la necesidad de una comunicación oral y escrita excelente, así como experiencia en el manejo de proyectos. Además de esto, encontramos diferencias puntuales entre las ubicaciones de los trabajos. Los puestos en los países en desarrollo enfatizaron las habilidades de lenguaje e interpersonales, mientras que los puestos en los países con economías avanzadas se enfocaron en el historial de publicaciones y en habilidades técnicas. Nuestros resultados fueron corroborados por los profesionales de la conservación que entrevistamos. Con base en nuestros resultados, compilamos una lista no-definitiva de programas de entrenamiento basados en la conservación que probablemente proporcionen preparación para el mercado laboral actual. Si utilizan los resultados de este estudio, los científicos pueden tener mayor habilidad para modificar su preparación y así maximizar su éxito en el mercado laboral de la conservación. De igual manera, las instituciones pueden aplicar esta información para crear programas educativos que produzcan graduados preparados para el éxito a largo plazo.*

**Palabras Clave:** educación de la conservación, entrenamiento de graduados, habilidades, internacional

## Introduction

With the ushering in of the Anthropocene and depletion of natural resources, the need for conservation-focused work continues to grow (Crutzen & Stoermer 2000; Caro et al. 2011; Corlett 2015). Conservation is now a primary goal of most national governments as indicated by the International Union for Conservation of Nature's implementation of the strategic plan for biodiversity conservation (Convention on Biological Diversity 2011) and with 187 countries committing to decreasing carbon emissions at the 2015 Intergovernmental Panel on Climate Change Conference. With these extensive commitments to conservation worldwide, the need for well-trained scientists and managers in the field of conservation is at its highest. Despite the increased demand for conservation scientists, conservation-based training has lagged, with limited information describing how to receive appropriate training (Jacobson 1990; Touval 1994; Graybill et al. 2006; Blickely et al. 2013; Hunter et al. 2016).

The lack of opportunities for conservation-focused training is particularly problematic in the context of the current academic job market. Availability of traditional academic positions is limited, which increases the importance of other conservation-based careers (Edmonds 2015; Kolata 2016; Mcdowell 2016). Recent work highlighted in the "fool's gold of a PhD" by Mcdowell (2016) points out that only 1 in 6 new biological science PhD graduates find a long-term position in academia. Furthermore, 70% of current college faculty are employed part time or in nontenure-track positions (Edmonds 2015). Although it is unclear how student career preferences versus the availability of academic positions contribute to the current job market, it is obvious that nonacademic professional appointments are the dominant pathway for today's students.

With this shift in the job market, student training and extramural learning experiences must be adjusted to make students competitively marketable (Muir & Schwartz 2009). Although the call for a revision of conservation-based training is not new (e.g., Hale 1962; Jacobson & Robinson 1990; Martinich et al. 2006), detailed information (e.g., conservation-focused courses and internships) regarding how to cross the research-implementation gap (Pietri et al. 2013) or collaborate with the public and policy makers (Meffe & Viederman 1995; Brewer 2002) is still lacking (Muir & Schwartz 2009). If successful conservation requires a range of skill sets, then it is imperative that well-informed and focused training begins early to ensure that conservation scientists are equipped to combat Earth's conservation needs and find employment.

Furthermore, due to the global nature of conservation, positions in conservation management and research are based in countries with different levels of economic development (hereafter development). Level of development often has a large impact on a country's strategy and ability to address conservation challenges. For example, countries with developing economies often struggle with a perceived trade-off between economic growth and conservation (Czech 2008), and may not have sufficient funds to meet conservation needs. Conversely, advanced economies may have more funds available, and organizations frequently collaborate with the private sector to create positive conservation outcomes (Robinson 2012). These fundamental differences in resources and historic presence of conservation likely necessitate different types of skills and training to succeed as a conservationist. Despite these presumed differences, few resources identify the specialized skills or training necessary to succeed across a global market (Jacobson & McDuff 1998; Shaw 2000; Blickely et al. 2013). Properly educating students on how to prepare for international positions and

collaborations will increase both their future prospects and the quality of conservation efforts worldwide.

Our study expands on previous work (Muir & Schwartz 2009; Blickley et al. 2013) to provide insight on how to best prepare for positions in a variety of sectors and countries at different levels of development. We examined conservation job announcements for positions in developed and developing economies to provide a snapshot of the conservation job market. We assessed the skill sets required by academic, nonprofit, governmental, and private organizations to inform students of particular training to pursue. By understanding differences across job sectors and international locations, individuals can tailor their education, extracurricular activities, and resumes to maximize their success. We also conducted interviews with conservation professionals working in a variety of countries to determine how individuals found their current positions, whether skills emphasized in announcements were truly indicative of the skills required for success, and to identify differences in conservation positions among countries. Finally, we compiled a list of specific programs specialized to supplement traditional graduate programs and maximize employment success in conservation fields. We focused on students and early-career scientists, but we expect that understanding nuanced differences across job locations and sectors is universally beneficial for conservation scientists. Furthermore, our study provides administrators, professors, and other mentors with insight on how to tailor their educational opportunities to meet the shifting job market and career interests of their students.

## Methods

### Job Search

We analyzed 200 conservation-based job advertisements (100 U.S. announcements and 100 international announcements) from January through April 2016. We analyzed only positions that required a master's degree or PhD. We located advertisements on publically accessible databases (Supporting Information) to provide a snapshot of the general conservation job market at the time of data collection. Only job announcements located by searching for the keywords *conserve* or *conservation* were included in our analysis. We analyzed announcements from 40 different countries to ensure representation of the global market. All announcements were in English. We identified 100 U.S.-based positions during the initial one-third of the data-collection period, so to avoid overly biasing our results toward a single country we focused all remaining collection efforts on jobs based in other countries. All countries were designated as having either developed or developing economies based on the International Monetary Fund's criteria (IMF 2016).

All job advertisements were categorized into 1 of 4 sectors: academic, nonprofit organization, governmental organization, or private industry. General statistics were recorded for each posting (e.g., job location, pay range, educational requirement [Supporting Information]). We then analyzed each job posting to determine the variety and frequency of skills required. Skills were categorized into 1 of 24 different classes, 19 of which were previously identified by Blickley et al. (2013). To appropriately characterize academic and international positions, we added 5 commonly required skills: teaching experience, publication history, flexibility, passion for organization's mission, and physical requirements (Table 1). To account for differences in word counts and level of detail in announcements, we normalized skill counts by dividing the number of mentions of an individual skill by the total number of skills in that announcement. All advertisements were analyzed by J.L. to ensure consistency in classification.

### Statistical Analyses

We compared overall job requirements between levels of development and among sectors with PERMANOVA (PCORD, PRIMER 6). Skill requirements were not normally distributed, so we used nonparametric Kruskal-Wallis tests to determine which skills contributed most to differences among sectors and the Wilcoxon rank-sum test to compare skill requirements between developing and developed countries (R Core Team 2015). We did not compare sectors for developing countries because there were not enough postings in the market for robust analyses. To account for differences in the length of different job postings, skill counts were relativized by dividing each specific skill by the total number of mentioned skills in an advertisement. Consequently, we used basic Euclidean distance for PERMANOVA. To provide a clear picture of what skills make a competitive candidate within different conservation fields, we identified the 5 most important skills in each group (Table 2) and noted differences in these skills among sectors and between development types.

### Interviews with Conservation Professionals

To determine whether skills mentioned in job advertisements reflected successful conservation scientists, we interviewed 20 conservation professionals working in 16 countries. Five were from academia, 5 from government, 8 from NGOs, and 2 from private industry. We spoke with individuals in person, on the phone, or via an internet-based video call. Interviewees held a variety of conservation-based positions, but they all held a master's degree or higher, in accordance with our job search requirement. The majority (16 of 20) of the individuals we spoke with had experience working in both developed

**Table 1. List of definitions and keywords for each skill category used to examine and classify conservation job postings.**

Source <sup>a</sup>	Skill	Definition	Keywords <sup>b</sup>
1	general disciplinary	knowledge of general scientific principles, theories	science, principle
2	teaching experience	experience teaching, building course curricula	teach*, course
1	fundraising, monetary	experience applying for grants, raising money, or managing budgets	budget, grant
1	specific disciplinary	knowledge of a specific ecosystem, organism, or certified training	fauna, location,
1	inter-, multidisciplinary	experience working across traditional boundaries between academic disciplines or schools of thought	multidisc*, cross
2	publications	experience publishing scientific work in peer-reviewed journals	peer review, publish*
1	outreach communication	ability to translate scientific principles to broad audience	public, present*, outreach
1	interpersonal skills	successful at working within groups, variety of individuals	partner*, collabor*, team
1	oral communication	ability to speak publically, lead presentations	present, oral
1	written communication	ability to communicate effectively through written form	write, report
1	personnel leadership	experience managing and leading individuals to accomplish specific projects, goals	manag*, lead*, motivate
2	flexibility	ability to move and work in diverse locations, inconsistent scheduling	move, schedule
1	program leadership	experience managing and leading an organization, developing program mission	lead*, organiz*, design
2	physical	ability to physically accomplish particular tasks	physically, carry, hike
1	analytical, technical, or IT	competency analyzing data using basic or specific software	GIS, Word, software
1	networking	ability to identify and coordinate work with individuals across a variety of fields and mindsets	partner*, collab*, network*
1	independent	ability to conduct work, accomplish tasks independently	independ*, self*
1	project management	ability to manage projects, tasks	manag*, implement
1	field experience	previous experience working in field, outdoor setting	field, outdoor
1	complete tasks	ability to meet deadlines and finish projects	complet*, time manag*
1	international experience	experience working internationally, multilingual abilities	language, internation*
1	conflict resolution, negotiation	ability to negotiate and resolve conflict with diverse stakeholders to advance the mission of an organization	conflict, negotiat*
1	multitasking	ability to managing multiple projects simultaneously	multiple
2	passion for mission, work	demonstrates passion or deep interest in mission of company or project	passion, commitment

<sup>a</sup>Sources: 1, Blickey et al. 2013; 2, originated by authors.

<sup>b</sup>An asterisk (\*) represents the root of common keywords.

and developing countries. We located the conservation professionals we spoke with via online searches of publicly available information (e.g., organization websites). We searched sites for the term *conservation* during the spring of 2016. Interview protocols were approved by the University of Oklahoma's Institutional Review Board (approval number 6652).

Interviews consisted of 12 questions (Supporting Information) that pertained to the current position the individuals were and to their graduate school training and previous experience in conservation positions. We

recorded interviewee responses in writing. We classified skills mentioned by respondents into the same categories used for analyzing job postings (see above). We characterized the frequencies that skills were mentioned with descriptive statistics (i.e., percentages, Microsoft Excel).

## Results

In the first 4 months of 2016, we identified 200 conservation-focused job advertisements: 26 academic



**Table 2.** The average (SE) percentage of skills mentioned in each conservation job posting ( $n = 20$ ).<sup>a</sup>

Skill category	Developing countries		Economically developed countries			
	<i>all sectors</i>	<i>all sectors</i>	<i>academic</i>	<i>government</i>	<i>nonprofit</i>	<i>private</i>
Specific disciplinary	6.8 <sup>x</sup> (0.7)	12.3 <sup>y</sup> (1.1)	7.4 <sup>ac</sup> (2.0)	19.6 <sup>b</sup> (2.2)	7.3 <sup>a</sup> (1.0)	17.8 <sup>bc</sup> (3.4)
General disciplinary	18.4 (1)	19.3 (1.1)	29.3 <sup>a</sup> (4.7)	20.8 <sup>ab</sup> (2.9)	15.6 <sup>b</sup> (0.9)	18.4 <sup>ab</sup> (2)
Project management	7.8 (0.6)	7.0 (0.6)	1.8 <sup>a</sup> (1.3)	6.9 <sup>b</sup> (1.2)	7.2 <sup>b</sup> (0.8)	10.6 <sup>b</sup> (1.7)
Interpersonal skills	7.1 (0.6)	5.2 (0.4)	3.7 (1.2)	4.2 (0.8)	6.1 (0.6)	5.8 (1.2)
Field experience	1.3 (0.4)	1.1 (0.3)	0.5 (0.5)	1.1 (0.5)	1.1 (0.4)	1.4 (0.7)
Written communication	5.8 (0.4)	6.8 (0.4)	3.2 <sup>a</sup> (1.2)	6.8 <sup>ab</sup> (0.8)	7.6 <sup>b</sup> (0.5)	7.6 <sup>b</sup> (0.9)
Program leadership	2.4 (0.3)	2.1 (0.3)	2.5 <sup>ab</sup> (1.1)	1.3 <sup>ab</sup> (0.5)	3.2 <sup>a</sup> (0.6)	0.2 <sup>b</sup> (0.2)
Networking	4 (0.4)	4.6 (0.4)	2.5 (1.1)	4.5 (0.9)	5.6 (0.7)	4.1 (0.9)
Personnel leadership	3.2 (0.3)	3.2 (0.4)	3.2 <sup>ab</sup> (1.1)	2.2 <sup>a</sup> (0.6)	4.5 <sup>b</sup> (0.6)	1.5 <sup>a</sup> (0.5)
Analytical, technical skills	5.3 <sup>x</sup> (0.6)	8.9 <sup>y</sup> (0.8)	3.5 <sup>a</sup> (1.8)	13.3 <sup>b</sup> (2)	7.4 <sup>ab</sup> (1.1)	10.1 <sup>b</sup> (1.5)
Oral communication	4.1 (0.3)	5.5 (0.4)	3.4 <sup>a</sup> (1.2)	5.5 <sup>ab</sup> (0.7)	6.5 <sup>b</sup> (0.6)	4.7 <sup>ab</sup> (0.8)
Outreach	1.3 (0.2)	2.4 (0.3)	2.6 <sup>ab</sup> (1.3)	2 <sup>ab</sup> (0.6)	3.3 <sup>a</sup> (0.5)	0.5 <sup>b</sup> (0.3)
Independent	3.2 (0.4)	2.3 (0.3)	2.2 <sup>ab</sup> (1.3)	1.1 <sup>a</sup> (0.4)	3 <sup>b</sup> (0.5)	2.5 <sup>ab</sup> (0.8)
Fundraising	5.1 (0.6)	3.7 (0.4)	6.2 <sup>a</sup> (1.7)	1.6 <sup>b</sup> (0.6)	4.8 <sup>a</sup> (0.7)	1.9 <sup>ab</sup> (0.7)
Complete tasks	1.6 (0.2)	1.7 (0.3)	0 <sup>a</sup> (0)	1.6 <sup>ab</sup> (0.5)	2.4 <sup>b</sup> (0.4)	1.8 <sup>ab</sup> (0.7)
Multidisciplinary	1.1 (0.3)	1.2 (0.3)	3.8 (1.5)	0.6 (0.3)	1 (0.3)	0.6 (0.3)
International experience	9.7 <sup>x</sup> (0.6)	1.7 <sup>y</sup> (0.3)	0.7 <sup>ab</sup> (0.5)	0.8 <sup>a</sup> (0.6)	2.9 <sup>b</sup> (0.6)	0.8 <sup>ab</sup> (0.5)
Flexibility	2.9 (0.4)	2.5 (0.4)	1.5* (1.1)	1.8* (0.8)	2.9* (0.5)	3.5* (1.1)
Conflict resolution, negotiation	0.4 (0.1)	0.6 (0.1)	0 (0)	1 (0.4)	0.7 (0.2)	0.2 (0.2)
Multitasking	1.1 (0.2)	0.7 (0.1)	0 <sup>a</sup> (0)	0.2 <sup>a</sup> (0.1)	1.2 <sup>b</sup> (0.3)	0.8 <sup>ab</sup> (0.4)
Teaching experience	3.2 (0.7)	2.6 (0.6)	16 <sup>a</sup> (3.2)	0.2 <sup>b</sup> (0.2)	0.7 <sup>b</sup> (0.3)	0.5 <sup>b</sup> (0.4)
Passion for conservation	3.5 (0.5)	1.8 (0.3)	0.6 <sup>a</sup> (0.6)	0.4 <sup>a</sup> (0.3)	2.6 <sup>b</sup> (0.5)	2.9 <sup>ab</sup> (0.9)
Publications	0.2 <sup>x</sup> (0.1)	1.4 <sup>y</sup> (0.3)	4.1 (1.4)	1.4 (0.6)	0.7 (0.3)	1.1 (0.6)
Physical	0.7 (0.2)	1.4 (0.3)	1.4 (1.1)	0.9 (0.4)	2 (0.6)	0.6 (0.4)

<sup>a</sup>Letters denote similarity among sectors, and an asterisk (\*) indicates differences existed among sectors, but we lacked the statistical power to identify specific differences among sectors.

<sup>b</sup>Skills among the top 5 most mentioned skills within a sector are italicized.

(21<sub>developed</sub>, 5<sub>developing</sub>), 42 governmental (40<sub>developed</sub>, 2<sub>developing</sub>), 101 nonprofit (67<sub>developed</sub>, 34<sub>developing</sub>), and 31 private-industry (27<sub>developed</sub>, 4<sub>developing</sub>) positions. Nonprofit jobs were more than twice as common as other positions, whereas all other sectors were similar. This pattern was more apparent for developing countries (76% nonprofit) than for developed nations (43% nonprofit).

### Key Skills in Position Announcements

The skills required for conservation positions differed between developed and developing countries (PERMANOVA:  $F_{1,192} = 2.73$ ,  $p = 0.007$ ) (Table 2). Job postings in economically developed countries emphasized analytical and technical skills ( $W = 4166$ ,  $p = 0.041$ ), a background in the specific science discipline ( $W = 4316$ ,  $p = 0.014$ ), and publications ( $W = 3904$ ,  $p = 0.041$ ) more than job postings in developing countries. Job postings from developed economies also included written communication 1 of the 5 most desirable skills, whereas written communication was relatively less important in developing countries. By contrast, international experience was the only skill that was more important for jobs in developing countries ( $W = 1129$ ,  $p < 0.001$ ). Job postings in developing nations also emphasized interpersonal skills

relatively more than job postings in developed nations (Table 2).

Although there were general differences between job posting in developed and developing countries, most postings emphasized the same 5 skills. First and foremost, a general disciplinary background in science was the most sought-after skill (Table 2). Similarly, 66% of all postings required a background in a specific scientific field, and this skill was particularly important to governmental and private-industry jobs ( $H_3 = 25.94$ ,  $p < 0.001$ ). With the exception of academia in countries with advanced economies ( $H_3 > 19.43$ ,  $p < 0.001$ ), the same 3 other skills rounded out the top-5 required skills for conservation-based jobs: excellent written communication, project management experience, and analytical or technical skills (Table 2).

Requirements for academic positions in developed countries were distinct from other sectors. Apart from a background in both the general and specific discipline of interest, academic postings emphasized teaching experience ( $H_3 = 66.18$ ,  $p < 0.001$ ), fundraising (6.2% of skills mentioned per announcement;  $H_3 = 14.54$ ,  $p = 0.002$ ), and publications (4%;  $H_3 = 7.11$ ,  $p = 0.068$ ) among the top-5 required skills (Table 2). Teaching experience differed the most from other sectors; it comprised 16% of all academic skill requirements but was <1% for all

other sectors. Three skills were missing from all academic postings: the ability to complete tasks, conflict-resolution skills, and multitasking. These omissions are notable because the other 3 sectors omitted no skills.

Among the other 3 sectors in developed countries, nonprofit organizations required a greater variety of skills relative to other sectors. In particular, nonprofit organization postings emphasized a suite of different communication and leadership skills. Nonprofit postings emphasized oral communication more than academic postings ( $H_3 = 8.90$ ,  $p = 0.031$ ) and a passion for conservation more often than both academic and governmental postings ( $H_3 = 14.38$ ,  $p = 0.002$ ). They also listed program ( $H_3 = 14.02$ ,  $p = 0.002$ ) and personnel leadership ( $H_3 = 13.47$ ,  $p = 0.004$ ) more than private positions and outreach experience ( $H_3 = 9.99$ ,  $p = 0.019$ ) more than both private and governmental jobs. Finally, international experience ( $H_3 = 13.77$ ,  $p = 0.003$ ) and the ability to work independently ( $H_3 = 11.31$ ,  $p = 0.01$ ) were emphasized more by nonprofit organizations than by governmental positions.

Private and governmental position requirements were similar in economically developed countries. These 2 sectors mentioned the same 8 skills the most in their job postings, and, in total, these skills composed 79% and 82% of all skills mentioned in private and governmental postings, respectively. Specifically, these sectors emphasized general and specific disciplinary scientific knowledge, written and oral communication skills, networking experience, interpersonal skills, project management experience, and analytical or technical skills (primarily experience with geographic information systems [GIS]). No minor skills were mentioned more often in these postings than in postings for other sectors.

### Interview Results

All professionals had master's degrees or Ph.D.s and had been in their current positions from <1 year to almost 20 years. Roughly half of the individuals (9 out of 20) found their current position through online postings like the ones we examined. The other half found their positions through networking or within-organization promotions.

Eighty-five percent of our interviewees began graduate school knowing they were interested in pursuing conservation-based work. However, just less than half of the professionals we spoke with took conservation-focused classes while in graduate school, generally because the classes were not offered. Some of the individuals gained experience by collaborating with conservation organizations while in school; however, the majority (17 of 20) did not receive conservation-based training until after graduation. When asked which courses they wish they would have taken more of while in school, the top responses were business or project management (40%) and statistics (20%).

In accordance with our job-posting results, the most recommended skill from conservation professionals was a strong general discipline in science. The top nondisciplinary skills recommended by professionals were interpersonal skills (60% frequency) and strategic thinking or problem solving abilities (50% frequency). Professionals frequently emphasized (45%) the need for individuals to keep long-term goals in mind and to have positive mindsets in the face of adversity. Although only 1 individual specifically emphasized, the importance of previous experience working in the biome or country of interest, 50% of our interviewees identified experience with a language or culture as an important component of them gaining their current position. In contrast to our job-announcements results, only 1 conservation professional explicitly mentioned project management as 1 of the top 3 skills required for successfully conducting work in conservation.

### Discussion

Our results provide the first description of the global conservation job market and highlight the wide range of available positions (Supporting Information). Our finding that only 10% of the available positions in conservation are in academia supports previous work and suggests that traditional tenure-track positions are limited (Kolata 2016; McDowell 2016). Therefore, it is critical that students be aware of alternative career routes early on so they can tailor their training to be successful in the labor market. Making students aware of the current job market can be a collaborative experience among academic advisors, nonacademic professionals, and students communicating early on about future career goals and how to maximize their experiences during graduate training.

In general, the most mentioned skills across all sectors were similar and are attainable in graduate school. Furthermore, most of the top skills required across sectors were consistent with those mentioned in previous studies (Blickley et al. 2013). Mastering both general and specific skills related to scientific practice is the primary goal of graduate school. Similarly, mastering an analytical tool, such as GIS, is one way to make oneself marketable across sectors. The importance of analytical skills has increased from 2011 to 2016 (Blickley et al. 2013), demonstrating a potential shift in what is expected of conservation professionals.

Despite some similarities, we found differences in skill sets across sectors. For students interested in continuing in academia, teaching experience is one of the top skills to develop throughout their education, along with publishing in peer-reviewed journals and acquiring funding (Table 2, Muir & Schwartz 2009). However, if students plan to work outside academia, we

**Table 3. Nondefinitive list of programs highlighted as effective in training for today's conservation job market needs.**

<i>Graduate school programs</i>		
Cornell University	Zoology and Wildlife Conservation	<a href="http://www.vet.cornell.edu/bbs/Research/ZoologyWildlifeConservation.cfm">http://www.vet.cornell.edu/bbs/Research/ZoologyWildlifeConservation.cfm</a>
Cornell University	Department of Natural Resource	<a href="https://dnr.cals.cornell.edu/">https://dnr.cals.cornell.edu/</a>
Duke University	Nicholas School of the Environment	<a href="https://nicholas.duke.edu/about">https://nicholas.duke.edu/about</a>
Imperial College	Department of Life Sciences	<a href="http://www.imperial.ac.uk/life-sciences/postgraduate/masters-courses/msc-in-conservation-science/">www.imperial.ac.uk/life-sciences/postgraduate/masters-courses/msc-in-conservation-science/</a>
James Cook University	Conservation Biology	<a href="http://www.jcu.edu.au/courses-and-study/courses/master-of-science-in-tropical-biology-and-conservation">www.jcu.edu.au/courses-and-study/courses/master-of-science-in-tropical-biology-and-conservation</a>
University of California, Davis	Wildlife, Fish and Conservation Biology Department	<a href="http://wfcf.ucdavis.edu/">http://wfcf.ucdavis.edu/</a>
University of Georgia	Integrative Conservation Ph.D. Program	<a href="http://icon.uga.edu/">http://icon.uga.edu/</a>
University of Maryland	Sustainable Development and Conservation Biology	<a href="http://www.cons.umd.edu/">http://www.cons.umd.edu/</a>
University of Texas A&M	Applied Biodiversity Science	<a href="http://biodiversity.tamu.edu/">http://biodiversity.tamu.edu/</a>
University of Washington	Center for Conservation Biology	<a href="http://conservationbiology.uw.edu/">http://conservationbiology.uw.edu/</a>
University of Wisconsin	Nelson Institute for Environmental Studies	<a href="http://nelson.wisc.edu/">http://nelson.wisc.edu/</a>
Yale University	School of Forestry and Environmental Studies	<a href="https://environment.yale.edu/">https://environment.yale.edu/</a>
<i>Postdoctoral programs</i>		
AAAS	Science and Policy Fellowship	<a href="http://.aaas.org/page/fellowships">http://.aaas.org/page/fellowships</a>
Smithsonian	James Smithson Fellowship	<a href="http://smithsonianofi.com/fellowship-opportunities/james-smithson-fellowship-program/">http://smithsonianofi.com/fellowship-opportunities/james-smithson-fellowship-program/</a>
San Diego Zoo Institute for Conservation Research	Conservation Research Postdoctoral Fellowship	<a href="http://institute.sandiegozoo.org/opportunities/postdoctoral-fellowships">http://institute.sandiegozoo.org/opportunities/postdoctoral-fellowships</a>
United Nations University	Smith Fellowship Postdoctoral Program	<a href="http://conbio.org/mini-sites/smith-fellows">http://conbio.org/mini-sites/smith-fellows</a> <a href="http://ias.unu.edu/en/about/fellowships">http://ias.unu.edu/en/about/fellowships</a>
<i>External training</i>		
Conservation Leadership Programme	Conservation Leadership Program	<a href="http://www.conservationleadershipprogramme.org/">http://www.conservationleadershipprogramme.org/</a>
Conservation Training	Conservation Training Online Programs	<a href="https://www.conservationtraining.org/">https://www.conservationtraining.org/</a>
Emerging Wildlife Conservation Leaders	Emerging Wildlife Conservation Leaders	<a href="http://wildlifeleaders.org/">http://wildlifeleaders.org/</a>
National Science Foundation	Integrate Graduate Education and Research Traineeship	<a href="https://www.nsf.gov/crssprgm/igert/intro.jsp">https://www.nsf.gov/crssprgm/igert/intro.jsp</a>
University of London	Short Course Conservation and Society	<a href="http://www.soas.ac.uk/courseunits/">http://www.soas.ac.uk/courseunits/</a>
Smithsonian-Mason School for Conservation	Professional Training Programs	<a href="http://smconservation.gmu.edu/">http://smconservation.gmu.edu/</a>
Wildlife Conservation Society	Biodiversity Conservation Professional Certificate Program	<a href="http://wildlife.org/learn/professional-development-certification/certification-programs/">http://wildlife.org/learn/professional-development-certification/certification-programs/</a>

recommend they focus on gaining experience in business and project management and developing interdisciplinary skills. We acknowledge that teaching is often an important source of income for graduate students but emphasize there may be alternative ways to support students. Some schools in the United States are beginning to incorporate paid internships with external organiza-

tions as a way to supplement student income (e.g., University of Pittsburgh; NSF Graduate Research Internship Program; University of Missouri, St. Louis, MO, U.S.A.). These programs provide meaningful conservation-based training that can lead to important networking benefits. Although some schools provide this training, our results indicate more universities should include nontraditional



programs such as these to prepare students for conservation positions.

One of the more striking differences between the job markets of developed and developing economies was how important international, cultural, and language-based experience was for working in countries with developing economies (Table 2). For students interested in working in a specific country long term, it would be beneficial for them to conduct their dissertation research in their country of interest. This suggestion is supported by how frequently conservation professionals attributed experience working in the country of application as a key factor in them gaining their position. We also found that interpersonal skills were more frequently required in jobs in developing countries (Table 2). Therefore, encouraging international collaborations early on in an individual's career may be one of the best ways to prepare her or him for the future international job market. Developed nations frequently emphasized skills that are accessible in most graduate programs (e.g., technical and analytical skills, publication history, and written communication). However, depending on the sector of interest, supplemental training will likely maximize an individual's chance in obtaining a position in conservation.

To be successful in today's job market, students must take command of their education early on in their program. This may require looking outside of their departments and institution to diversify their training. We recommend students speak with conservation professionals early in their education to identify the sector that best fits their goals. Although we focused on students pursuing postgraduate degrees, our suggestions are applicable to undergraduates through early-career scientists. Furthermore, instructors and mentors can use our results to better prepare their students. By teaching skills tailored to the future goals of their students, graduate programs can maximize postgraduate job placement. Similarly, by providing avenues for students to conduct internships and collaborate with professionals in a range of sectors, graduate programs will increase their production of well-prepared conservation scientists. Ultimately, the skill sets defined here will enable students and programs to adjust their training to meet the needs of the current job market and have the greatest long-term success.

## Examples of Programs

In Table 3, we provide a sample list of programs for individuals interested in conservation at various points in their career. Each program specializes in conservation science and was recommended by conservation professionals. We stress that this list is not exhaustive; rather, it provides a starting point for individuals looking for conservation-based training.

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## Supporting Information

A list of the job announcements examined (Appendix S1) and the oral consent script used for interviews (Appendix S2) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

## Literature Cited

- Blickley JL, Deiner K, Garbach K, Lacher I, Meek MH, Porensky LM, Wilkerson ML, Winford EM, Schwartz MW. 2013. Graduate student's guide to necessary skills for nonacademic conservation careers. *Conservation Biology* 27:24–34.
- Brewer C. 2002. Outreach and partnership programs for conservation education where endangered species conservation and research occur. *Conservation Biology* 16:4–6.
- Caro T, Darwin J, Forrester T, Ledoux-Bloom C, Wells C. 2011. Conservation in the anthropocene. *Conservation Biology* 26:185–188.
- Convention on Biological Diversity (CBD). 2011. Conference of the Parties decision X/2: strategic plan for biodiversity 2011–2020. CBD Secretariat, Montreal.
- Corlett RT. 2015. The anthropocene concept in ecology and conservation. *Trends in Ecology & Evolution* 30:36–41.
- Crutzen PJ, Stoermer EF. 2000. The 'anthropocene'. *IGBP Newsletter* 41:17–18.
- Czech B. 2008. Prospects for reconciling the conflict between economic growth and biodiversity conservation with technological progress. *Conservation Biology* 22:1389–1398.
- Edmonds D. 2015. More than half of college faculty are adjuncts: Should you care? *Forbes*, 28 May. Available from <https://www.forbes.com/sites/noodleeducation/2015/05/28/more-than-half-of-college-faculty-are-adjuncts-should-you-care/#59386c681600> (accessed August 2017).
- Graybill JK, Dooling S, Shandas V, Withey J, Greve A, Simon GL. 2006. A rough guide to interdisciplinarity: graduate student perspectives. *BioScience* 56:757–763.
- Hale R. 1962. Broadening graduate conservation training. *Transactions of the North American Wildlife and Natural Resources Conference* 27:459–470.
- Hunter ML, Lindenmayer DB, Calhoun AJK. 2016. Saving the Earth as a career: advice on becoming a conservation professional. Blackwell Publishing, Oxford, United Kingdom.

- International Monetary Fund (IMF). 2016. World economic outlook: too slow for too long. IMF, Washington, D.C.
- Jacobson SK, Robinson JG. 1990. Training the new conservationist: cross-disciplinary education in the 1990s. *Environmental Conservation* **17**:319–327.
- Jacobson SK. 1990. Graduate-education in conservation biology. *Conservation Biology* **4**:431–440.
- Jacobson SK, McDuff MD. 1998. Training idiot savants: the lack of human dimensions in conservation biology. *Conservation Biology* **12**:263–267.
- Kolata G. 2016. So many research scientists, so few openings as professors. *The New York Times* 16 June 2016.
- Martinich JA, Solarz SL, Lyons JR. 2006. Preparing students for conservation careers through project-based learning. *Conservation Biology* **20**:1579–1583.
- Mcdowell G. 2016. The fool's gold of Ph.D. employment data. Science Available from <http://www.sciencemag.org/careers/2016/06/fool-s-gold-phd-employment-data> (accessed 26 July 2017).
- Meffe GK, Viederman S. 1995. Combining science and policy in conservation biology. *Wildlife Society Bulletin* **23**:327–332.
- Muir MJ, Schwartz MW. 2009. Academic research training for a nonacademic workplace: a case study of graduate student alumni who work in conservation. *Conservation Biology* **23**:1357–1368.
- Pietri DM, Gurney GG, Benitez-Vina N, Kuklok A, Maxwell SM, Whiting L, Vina MA, Jenkins LD. 2013. Practical recommendations to help students bridge the research–implementation gap and promote conservation. *Conservation Biology* **27**:958–967.
- R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna.
- Robinson JG. 2012. Common and conflicting interests in the engagements between conservation organizations and corporations. *Conservation Biology* **26**:967–977.
- Shaw WW. 2000. Graduate education in wildlife management: major trends and opportunities to serve international students. *Wildlife Society Bulletin* **28**:514–517.
- Touval JL. 1994. The problem of teaching conservation problem solving. *Conservation Biology* **8**:902–904.