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Graduate Student's Guide to Necessary Skills for Nonacademic Conservation Careers

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Abstract: *Graduate education programs in conservation science generally focus on disciplinary training and discipline-specific research skills. However, nonacademic conservation professionals often require an additional suite of skills. This discrepancy between academic training and professional needs can make it difficult for graduate students to identify the skills and experiences that will best prepare them for the conservation job market. We analyzed job advertisements for conservation-science positions and interviewed conservation professionals with experience hiring early-career conservation scientists to determine what skills employers of conservation professionals seek; whether the relative importance of skills varies by job sector (government, nonprofit, and private); and how graduate students interested in careers in conservation science might signal competency in key skills to potential employers. In job advertisements, disciplinary, interpersonal, and project-management skills were in the top 5 skills mentioned across all job sectors. Employers' needs for additional skills, like program leadership, conflict resolution and negotiation, and technical and information technology skills, varied across sectors. Our interview results demonstrated that some skills are best signaled to employers via experiences obtained outside thesis or dissertation work. Our findings suggest that graduate students who wish to be competitive in the conservation job market can benefit by gaining skills identified as important to the job sector in which they hope to work and should not necessarily expect to be competent in these skills simply by completing their chosen degree path.*

Keywords: disciplinary, government, higher education, nonprofit, practitioner, private, workplace skills

Guía para el Estudiante de Grado de las Habilidades Necesarias para Carreras de Conservación Académicas

Resumen: *Los programas educativos de grado en ciencia de la conservación generalmente se concentran en la capacitación disciplinar y obtención de habilidades para la investigación específicas a la disciplina. Sin embargo, profesionales no académicos a menudo requieren un conjunto adicional de habilidades. Esta discrepancia entre el entrenamiento académico y las necesidades profesionales puede dificultar que los estudiantes de grado identifiquen las habilidades y experiencias que los prepararán mejor para el mercado de trabajo en conservación. Analizamos anuncios de trabajo para posiciones en ciencia de la conservación y entrevistamos a profesionales de la conservación con experiencia en la contratación de científicos de la conservación que inician su carrera para determinar las habilidades que buscan los empleadores de profesionales de la conservación; si la importancia relativa de las habilidades varía con el sector de empleo (gobierno, sin fines de lucro y privado); y la forma que estudiantes de grado interesados en carreras en ciencia de la conservación pueden mostrar competencia en habilidades clave para los empleadores potenciales. En los anuncios analizados, las habilidades disciplinares, interpersonales y de manejo de proyectos estuvieron entre las 5 habilidades más importantes mencionadas en todos los sectores de empleo. La necesidad de habilidades adicionales reconocidas por empleadores, como el liderazgo, la resolución y negociación de*

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conflictos, el manejo de tecnología de la información (TI), varió entre sectores. Los resultados de nuestras entrevistas demostraron que algunas habilidades son mejor mostradas a los empleadores mediante experiencias obtenidas fuera de trabajos de tesis o disertación. Nuestros resultados sugieren que los estudiantes de grado que desean ser competitivos en el mercado de trabajo en conservación se pueden beneficiar mediante la obtención de habilidades identificadas como importantes para el sector en que esperan trabajar y no deben necesariamente esperar ser competentes en estas habilidades simplemente con la conclusión del grado elegido.

Palabras Clave: Disciplinar, educación superior, gobierno, habilidades de trabajo, privado, profesional, sin fines de lucro

Introduction

Conservation science is a multidisciplinary field, and the list of the skills relevant for nonacademic careers in conservation science is extensive (Muir & Schwartz 2009). Nonacademic conservation scientists need a firm grounding in a core discipline (e.g., ecology or population biology), broad scientific knowledge, and other nonscientific skills (Jacobson 1990; Cannon et al. 1996; Muir & Schwartz 2009). This diverse skill set allows conservation scientists to be more effective conservation leaders, furthering the goals and effect of the entire field (Manolis et al. 2009). Although it is possible to obtain skills from on-the-job training (Bonine et al. 2003), recent graduates are more likely to be hired for a particular job if they can signal competency in the skills essential to the position prior to hiring. We defined a *skill* as competency in a particular subject, topic, or field (e.g., communication skills, interpersonal skills) (Table 1) and a *signal* as information obtainable from a curriculum vitae or job interview that indicates a person has competency in a skill required for a particular job.

Graduate students may be able to obtain appropriate training for nonacademic positions in conservation science, but only if they are armed with a clear understanding of employers' needs (Touval 1994). Many new graduate students, particularly those with limited job experience, are unaware of the breadth and type of skills required to work in nonacademic conservation-science jobs. Previous critiques of conservation training have evaluated graduate programs (Shaw 2000; van Heezik & Seddon 2005; Kainer et al. 2006), obtained students' perspectives (Lopez 2001; Campbell et al. 2005; Fisher et al. 2009), and queried conservation professionals (Bonine et al. 2003; Dietz et al. 2004; Muir & Schwartz 2009). These studies identified a wide range of skills important for jobs in conservation, including disciplinary knowledge (Bonine et al. 2003), interpersonal skills (Cannon et al. 1996), leadership capacity (Dietz et al. 2004; Manolis et al. 2009), fundraising and project-management experience (Bonine et al. 2003), public-speaking and technical-writing expertise (Adelman et al. 1994), policy analysis and negotiation training (Clark 2001), field experience, and multilingual proficiency (Jacobson 1990).

Developing competency in all these skills during graduate school is not feasible (Muir & Schwartz 2009). Thus, students need to know which skill sets and experiences are essential. We sought to provide insight into which skill sets and experiences are important across nonacademic job sectors (e.g., government, nonprofit, private) and within each sector. We expected the need for particular skills to vary among sectors because government agencies, nonprofit organizations, and private companies have different missions, cultures, and organizational structures. Armed with information about key skills and self-knowledge of their strengths and weaknesses, graduate students should be able to proactively (with support from graduate programs) seek the training they need to achieve their professional goals.

This study builds on a workshop on Graduate Education for Conservation Professionals (GECP) held at the University of California, Davis in 2010 (http://gecp.ucdavis.edu). The workshop, in which conservation professionals, graduate students, and faculty participated, centered on how students in science-based programs can gain graduate-level training appropriate for a range of nonacademic conservation jobs. Workshop participants identified 3 core questions: What skills do employers seek when hiring conservation professionals? Does the relative importance of certain skills vary by job sector? And, how can graduate students signal competency in key skills to potential employers?

To address these questions, we analyzed job advertisements in the nonacademic conservation-science job market. We quantified the relative importance of different skills in job advertisements in government, nonprofit, and private job sectors of conservation science. In addition, we interviewed conservation professionals and compared their descriptions of needed skills with the results of our job-advertisement analyses. We focused on jobs that required a research-based advanced degree (MS or PhD). Primarily, this article is intended to inform early-career graduate students about professional expectations so they can obtain targeted and relevant professional development while in graduate school. Secondarily, we sought to identify critical skills common to all job sectors to inform graduate programs of their opportunities to improve professional training.

Table 1. Definitions, example keywords, and average importance value (i.e., normalized frequency) of skill categories in 60 advertisements for conservation jobs from government, nonprofit, and private sectors.

Skill	*Percent of job advertisement (SE)*	*Skill definition*	*Example keywords*
Specific and analytical disciplinary	21 (2)	knowledge of specific ecosystems, conservation issues or analytical tools	regulation, fauna, analy*, statistic
Project management*	11 (0.9)	process of managing projects that fall within a mission of an organization	manage*, implement
General disciplinary	9.8 (1)	knowledge of general scientific and conservation principles	principles, science
Interpersonal*	8.0 (0.7)	ability to engage in cooperative learning and produce products with a team of people	work with, cooperat*
Field experience	6.4 (1)	ability to conduct research in the field; specific field skills	field, outdoor
Written communication*	6.0 (0.5)	ability to write effectively in any forum relevant to the job title	writ*, report
Program leadership*	5.9 (0.7)	the process of leading and developing projects that fall within a mission of an organization	organize, design
Networking*	5.9 (0.6)	ability to identify and bring together many individuals on the basis of common ideas or goals	partner*, collaborat*
Personnel leadership	4.3(0.7)	process of managing personnel or cooperators in an organization	supervise, oversee
Technical, information technology	4.2 (0.6)	competency in using basic and specific software and technical tools	computer, software, GIS
Oral communication	3.1 (0.4)	ability to speak effectively in any forum relevant to the job title	present*, verbal*
Outreach communication	2.6 (0.4)	ability to connect ideas or practices to the efforts of other organizations, groups, specific audiences or the general public	outreach*, public
Independent, self-starter	2.5 (0.4)	attribute of a person who is motivated to accomplish new endeavors on his or her own	independent, initiat*
Fundraising, monetary	2.1 (0.4)	experience raising money or managing budgets to support a research goal or a mission of an organization	budget*, grant*
Other communication	2.0 (0.3)	ability to communicate in unspecified manner	humor, relations
Ability to complete tasks	1.7 (0.3)	ability to complete projects in a timely and efficient manner	complet*, execut*
Inter-, multidisciplinary	1.1 (0.3)	training that crosses traditional boundaries between academic disciplines or schools of thought	discip*, divers*
Cultural, international experience	1.1 (0.3)	training that promotes understanding among cultures and countries	language, international
Conflict resolution, negotiation	0.7 (0.2)	ability to negotiate and resolve conflict with diverse stakeholders to advance the mission of an organization	negotiat*, conflict
Multitasking, prioritization	0.6 (0.2)	ability to balance multiple activities simultaneously	multitask, prioritize, balance

**Top 5 nondisciplinary skills.*

Methods

Job-Advertisement Analyses

We analyzed 60 job advertisements related to conservation to determine the relative importance of various skill sets for nonacademic positions. Between January and April 2011, we selected for analyses advertisements from nonacademic institutions for jobs that required a masters or PhD. We searched public databases, such as Ecolog and USAjobs, and several state-government job boards (Supporting Information).

We conducted a power analysis to determine whether our sample size was adequate and found that a minimum of 19 job advertisements per sector were needed to achieve 90% confidence that our counts of job skills would reflect the full pool of job advertisements

during the study period (assuming a coefficient of variation of 25%). We included 20 advertisements from each of the 3 major sectors: government; nonprofit; and private (Supporting Information). We used job sector as an aggregating variable because, in our experience, graduate students often have strong preferences for careers with governments, with nonprofit organizations, or in the private sector. Professionals participating in the GECP workshop also identified job sector as an important differentiating factor for job applicants. The total sample included 17 international jobs (8 nonprofit, 9 private) and 43 jobs in the United States (12 nonprofit, 11 private, and 20 government). We pooled international and U.S. advertisements for all analyses. Our sample included a wide variety of jobs within each sector (Supporting Information). Job titles included fish and wildlife biologist (government), environmental project manager—Superfund (government), ecosystem services scientist (nonprofit), project manager, Bangalore (nonprofit), avian ecologist (private), and habitat restoration project manager (private).

We analyzed each job advertisement to determine the presence and frequency of mentions for 20 major skills identified at the GECP workshop as important for a successful career in conservation. We developed a list of keywords that are often used to indicate those 20 skills (Table 1). For example, we searched for interpersonal skills with words or phrases such as "cooperat*" and "work with," and for project management with "manage*" and "implement." In each case, the asterisk (*) indicates multiple words with the same root (e.g., management, managing). For each job advertisement, we tallied the number of mentions of each skill. We normalized the counts for each skill by dividing the number of mentions for each skill by the total number of mentions for skills in that advertisement (to account for variation in job-advertisement word count and detail). Each advertisement was reviewed by 3 individuals, all of whom were trained on standardized review practices (e.g., applying the protocol for assessing different verbiage, applying protocol to a training set of jobs not included in the final analysis). To control for intercoder variation, we used the average of our 3 normalized counts (1/reader) for our analyses of individual skills. These normalized average frequencies are hereafter referred to as "importance values."

Raw or square-root-transformed data met the assumptions of analysis of variance (ANOVA) for 11 out of the 20 skills (see Supporting Information for transformation information). We compared means of normalized scores both with and without disciplinary skills (e.g., principles of conservation science or statistical analyses) because our interests extended beyond disciplinary training.

To test whether job advertisements tended to require certain groups of skills (skill sets), we performed a principal components analysis (PCA) on the 11 skills that met assumptions of normality and equal variances (Supporting Information). We then tested whether principal component values differed significantly across job sectors with an ANOVA and post hoc Tukey's (honestly significant difference [HSD]) means comparisons tests.

To determine whether the importance value of a given skill varied across job sectors, we used multivariate analysis of variance (MANOVA) followed by individual ANOVA analyses and post hoc Tukey's HSD means comparisons tests for the 11 skills mentioned earlier. Data met normality and homoskedasticity assumptions for MANOVA and subsequent ANOVA analyses. For the 9 skills that did not meet ANOVA assumptions, we tested for differences across sectors with nonparametric Wilcoxon analyses and post hoc Steel–Dwass means comparisons tests. All analyses were conducted in JMP 9.0 (SAS Institute 2011).

We further investigated the differences among job sectors through a classification and regression tree (CART) analysis (rpart package, R Developer Core Team 2011). The CART analysis explained differences among job sectors (i.e., response variable) by one or more skills (i.e., explanatory variables) by splitting the data into homogeneous groups (De'ath & Fabricius 2000) on the basis of differences in required skills. Thus, we determined distinctness among job sectors by calculating the proportion of time an advertisement from a particular job sector was included in the split for another job sector (misclassification error rate). A CART analysis does not require assumptions of normality or homogeneity of variances, so we used the entire data set in our analysis. By minimizing the error in the complexity parameter, we pruned the tree to minimize cross-validation error and avoid overfitting the data.

Interviews with Conservation Professionals

We conducted targeted phone interviews with 14 professionals from the government ($n = 4$), nonprofit ($n = 6$), and private ($n = 4$) sectors to collect personal comments regarding signals of required skills in the 3 conservation-science sectors. Interviewees were senior conservation scientists, selected on the basis of both convenience and snowball sampling, who had extensive experience hiring project managers and program scientists within their organizations (range: 4–30 years hiring experience). Interviews were conducted under the approval of the Institutional Review Board at University of California, Davis (protocol 253146-2).

Our structured interview had 19 questions (Supporting Information) that focused on nondisciplinary skills required of conservation professionals, advice on how job applicants can signal proficiency in skills, and opinions about whether typical experiences of graduate students qualify as a signal of proficiency. We then conducted a qualitative comparison of the responses interviewees provided and the results of our job-advertisement

Table 2. Average importance of different skills required within conservation job sectors.

Government		*Nonprofit*		*Private*	
skill	*percent of job advertisement (SE)*	*skill*	*percent of job advertisement (SE)*	*skill*	*percent of job advertisement (SE)*
Specific and analytical disciplinary	21 (2)	Project management*	14 (2)	Specific and analytical disciplinary	31 (4)
General disciplinary	14 (2)	Interpersonal*	11 (1)	Field experience	11 (2)
Project management*	11 (1)	Specific and analytical disciplinary	10 (2)	Project management*	8.1 (1)
Interpersonal*	7.7 (1)	Networking*	8.5 (1)	General disciplinary	8.1 (2)
Program leadership*	6.2 (1)	Program leadership*	8.1 (1)	Written communication*	7.5 (1)
Networking*	5.9 (0.8)	General disciplinary	6.8 (0.9)	Technical, information technology *	6.3 (1)
Field experience	5.9 (2)	Personnel leadership*	4.6 (1)	Interpersonal*	5.9 (1)
Written communication*	5.8 (0.7)	Written communication	4.6 (0.8)	Personnel leadership*	4.9 (1)
Oral communication	3.7 (0.7)	Fundraising, monetary	4.2 (0.9)	Program leadership	3.5 (0.9)
Personnel leadership	3.3 (0.9)	Outreach communication	4.1 (0.8)	Networking	3.3 (0.9)
Outreach communication	3.2 (0.7)	Technical, information technology	4.0 (0.9)	Independent, self-starter	2.5 (0.7)
Technical, information technology	2.3 (0.7)	Oral communication	3.6 (0.6)	Oral communication	2.0 (0.7)
Ability to complete tasks	1.9 (0.5)	Other communication	3.2 (0.6)	Other communication	1.6 (0.5)
Independent, self-starter	1.9 (0.5)	Independent, self-starter	3.1 (0.9)	Complete tasks	1.2 (0.5)
Conflict resolution, negotiation	1.6 (0.5)	Field experience	2.8 (1)	Fundraising, monetary	1.0 (0.5)
Other communication	1.3 (0.5)	Cultural/international experience	2.2 (0.8)	Inter-, multidisciplinary	0.8 (0.4)
Fundraising, monetary	1.1 (0.4)	Ability to complete tasks	1.9 (0.6)	Cultural/international experience	0.6 (0.6)
Inter-, multidisciplinary	1.0 (0.5)	Inter-, multidisciplinary	1.6 (0.4)	Outreach communication	0.5 (0.2)
Multitasking, prioritization	0.5 (0.3)	Multitasking, prioritization	0.9 (0.4)	Multitasking, prioritization	0.5 (0.3)
Cultural, international experience	0.3 (0.2)	Conflict resolution, negotiation	0.4 (0.2)	Conflict resolution, negotiation	0.1 (0.1)

**Top 5 nondisciplinary skills for each sector.*

analyses to see whether there was strong agreement between our analyses and the opinions of our interviewees.

Results

Job Advertisements

Top Skills Sought within Sectors

On the basis of relative number of total tallies across all job advertisements, 74% of the average job advertisement was devoted to disciplinary skills and 5 nondisciplinary skills: project management, interpersonal skills, written communication, program leadership, and networking (Table 1). Within the individual sectors (government, nonprofit, and private), project management was uniformly the top desired skill. All sectors valued interpersonal skills and leadership but varied substantially in the importance they placed on disciplinary skills (Table 2).

Skill Sets within Different Job Sectors

The PCA explained 60% of overall variation in the importance value of skills with the first 3 axes

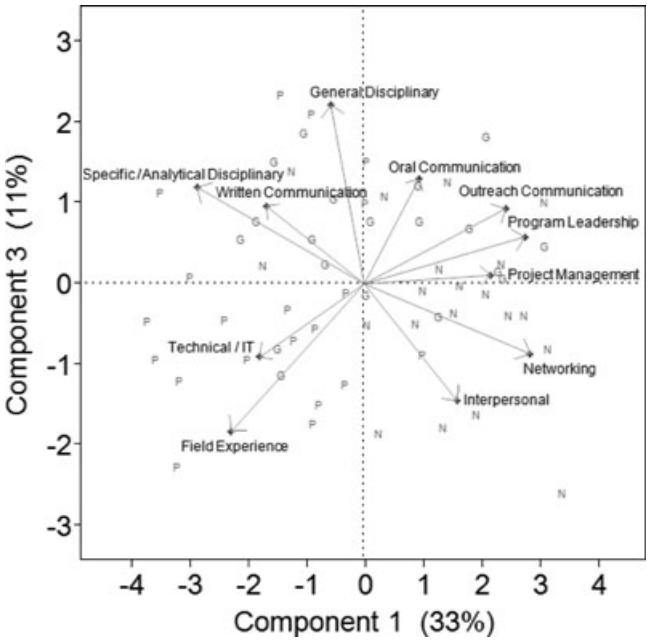

Figure 1. Conservation skill loadings in principal components analyses for government (G), nonprofit (N), and private (P) job sectors.

(component 1, component 2, and component 3). Component 1 explained 33% of overall variance and separated interpersonal, networking, oral communication, outreach communication, program leadership, and project-management skills (all of which had loadings >0.2) from technical and information technology (IT) skills, written communication skills, specific disciplinary skills, and field experience (all of which had loadings <−0.2) (Fig. 1). This axis indicated that some jobs emphasized conservation as a social process, whereas other jobs focused on the production of technical information in support of conservation. The values of component 1 differed significantly across sectors ($F_{2,57} = 20.82$, $p < 0.001$). Nonprofit jobs had significantly higher values on component 1 than government or private jobs, and government jobs had significantly higher values than private jobs (government: 0.17 [SE 0.36]; nonprofit: 1.4 [0.31]; private: −1.57 [0.31]) (Supporting Information).

Component 2 explained 16% of overall differences and separated interpersonal, communication (written, oral, outreach), and technical and IT skills (loadings > 0.2) from project-management skills and general disciplinary skills (loadings < −0.2). This axis indicated a split between management positions and jobs focused on producing and reporting technical information. The value of component 2 did not differ significantly across sectors ($F_{2,57} = 0.63$, $p = 0.5$) (Supporting Information).

Component 3 explained 11% of overall variance and separated communication skills (written, oral, outreach), specific and analytical disciplinary skills, and general disciplinary skills (loadings > 0.2) from interpersonal, networking, field, and technical and IT skills (loadings < −0.2) (Fig. 1). This axis indicated that conservation jobs were split between those requiring a broad knowledge of conservation science and research (disciplinary skills) and those requiring more specific skills (field and technical skills). The value of component 3 differed significantly across sectors ($F_{2,57} = 4.05$, $p = 0.02$). Government jobs had significantly higher component-3 values compared with nonprofit or private jobs (government: 0.55 [SE 0.18]; nonprofit: –0.29 [0.24]; private: –0.27 [0.28]) (Supporting Information).

Skills Required in Different Job Sectors

Job sectors differed significantly in the proportion of different skills indicated for each of the 11 skills analyzed parametrically (Wilk's $\lambda = 0.266$, approximate $F_{22,94} = 4.02$, $p < 0.0001$). Government and private job advertisements emphasized disciplinary skills more than nonprofit advertisements (Fig. 2 & Supporting Information), especially for specific and analytical disciplinary skills. Nonprofit job advertisements mentioned project management, program leadership, interpersonal, networking, and oral communication skills significantly more than private-sector advertisements. Government and nonprofit advertisements mentioned outreach communication skills significantly more than private-sector advertisements. Finally, private-sector advertisements highlighted technical and IT skills more than government advertisements.

For the less commonly mentioned skills, nonprofit advertisements emphasized fundraising and monetary skills more than government or private-sector advertisements (Fig. 2 & Supporting Information). Similarly, nonprofit advertisements sought cultural and international experience more than private-sector advertisements. Government advertisements featured conflict resolution and negotiation skills more than private-sector advertisements.

Results of the CART analyses further supported that the requirement for disciplinary skills was a defining difference among job sectors. Government jobs frequently emphasized general disciplinary skills, and private jobs more commonly emphasized specific and analytical disciplinary skills and field experience. Government and nonprofits jobs mentioned skills relating to networking, outreach communication, and fundraising and monetary skills more frequently than private jobs (Table 3). The CART misclassification error rate was 0.4 for government jobs and 0.15 for nonprofit and private-sector jobs; this result indicates the job-sector groupings were highly distinct, although government job advertisements were

generally less distinct from both nonprofit and private job advertisements.

Interviews with Conservation Professionals

Top Nondisciplinary Skills

The top skills identified by professionals were similar to those identified in job advertisements. The top nondisciplinary skills in advertisements were project management, interpersonal, networking, written communication, and technical and IT skills. The last 2 skills were top skills only for private-sector jobs (Table 2). Twelve out of the 14 interviewees agreed that the top 3 skills identified for their sector by our analysis were important to the jobs for which they hire (Table 2). When asked to identify the top skills critical for incoming job applicants (apart from or in addition to our top 3 skills), interviewees from all sectors also prioritized written and oral communication. Interviewees from government and nonprofit sectors also prioritized disciplinary skills (specific and analytical as well as general), which mirrored job-advertisement findings. When asked to pick the most important nondisciplinary skill, 11 out of 14 interviewees chose either interpersonal skills or project management.

We further explored the importance of the top 3 skills in job advertisements by asking interviewees about the absolute necessity of having those skills when applying. Most interviewees said they would be willing to provide on-the-job training for at least one of the top skills. One interviewee explained that candidates who did not have one or more of the top 3 skills but were otherwise highly qualified would immediately begin informal and formal training. However, interviewees did indicate that competitive candidates needed to have one or more top skills. Interviewees from different sectors had different opinions about which skills were essential. Most professionals in government and nonprofit jobs said interpersonal skills were required. One interviewee said, " . . . there are a lot of things you can learn, but [interpersonal skills are]

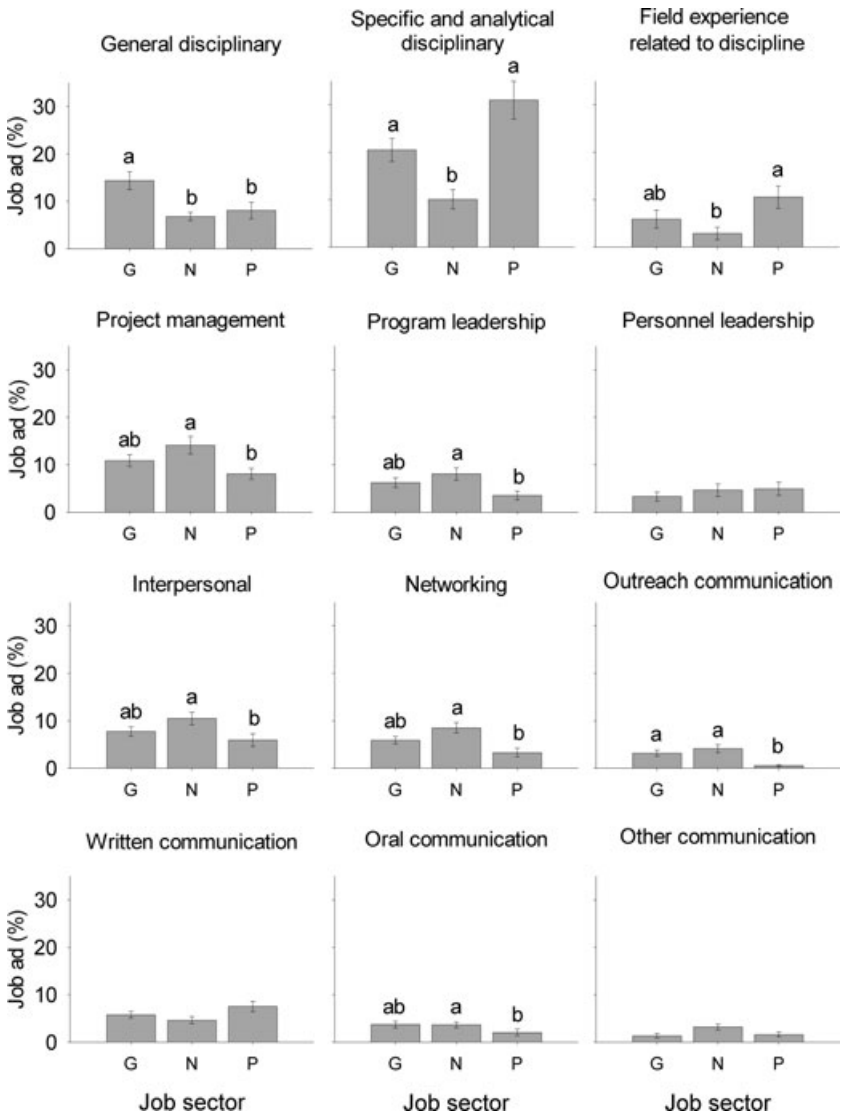

Figure 2. Differences among job sectors in the mean (1 SE) percentage of job-advertisement text allocated to each skill. Sectors sharing the same letter are not significantly different (Tukey's honestly significant difference means comparisons for parametric tests and Steel–Dwass means comparisons for nonparametric tests [Supporting Information]). Original data are displayed, although some analyses were conducted on data transformed to the square root (G, government; N, nonprofit; P, private sector).

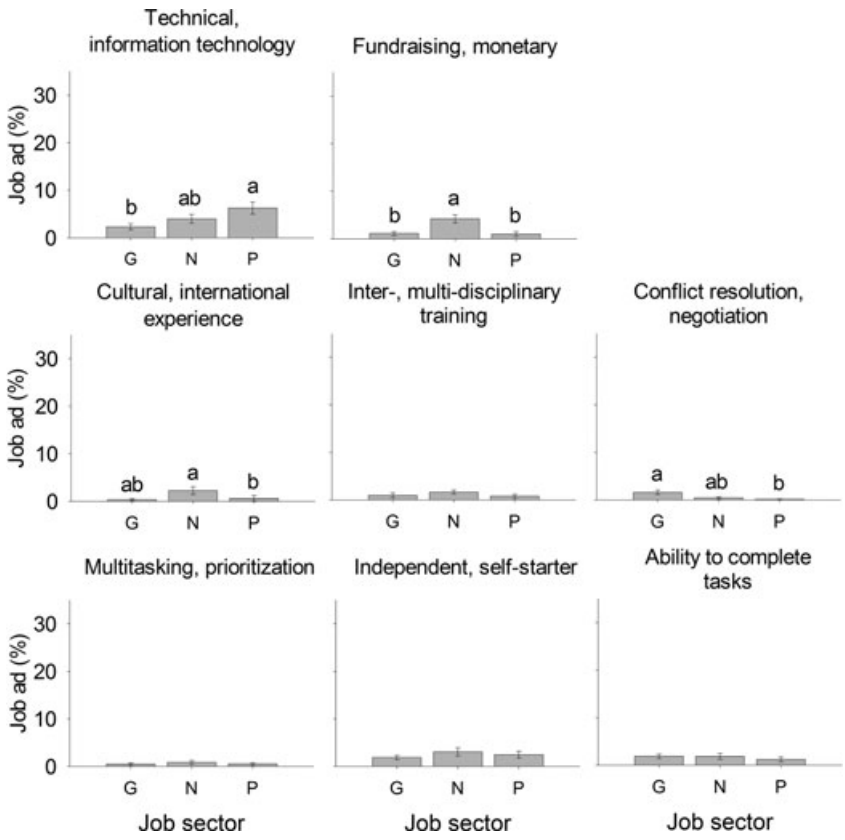

Figure 2. Continued

Table 3. Conservation skill categories and importance value cutoffs that determined classification and regression tree (CART) splits of job advertisements into government, nonprofit, and private job sectors

Main splits	*Government (%)*	*Nonprofit (%)*	*Private (%)*
General disciplinary	>16	<16	<16
Specific and analytical disciplinary	<16	<16	>16
Field experience	-[a]	<7	>7
Outreach communication	>1.5	>1.5	<1.5
Networking	>0.5	>0.5	<0.5
Fundraising, monetary	>4.5	>4.5	<4.5
No. categorized (G/N/P)[b]	12/0/1	4/17/2	4/3/17

[a] *Not diagnostic for distinguishing this job sector.*
[b] *Number of job advertisements from each job sector included in the final split.*

the hardest to teach." Private-sector interviewees sought written communication skills, and most would not consider a candidate that did not already have these. Most nonprofit professionals considered a candidate competitive only if she or he had already demonstrated project-management experience, whereas the majority of government and private-sector interviewees stated they would consider less-experienced candidates. Both government and nonprofit interviewees indicated that they would consider candidates that did not already have experience in program leadership.

Signaling Skill Proficiency

Responses of interviewees to questions on how early-career conservation scientists can signal proficiency varied. Signals for project management included evidence that a student had either managed volunteers or technicians or organized an event or project. Interviewees indicated that interpersonal skills are often signaled directly in their interactions with job applicants (e.g., in an interview). Examples of program leadership were considered "the most intangible," but interviewees thought evidence of taking the lead on a project or motivating coworkers can show proficiency in this skill. Professionals identified the interview and the curriculum vitae or resume as the most important places to find signals of competency for most skills. A few interviewees also mentioned instances of looking for certain skills in cover letters or by talking to references. Interviewees considered the interview and curriculum vitae or resume to be the most important ways to signal competence.

Experience

There was no consensus on whether managing a graduate research project is a sufficient signal for project

management. Most interviewees said it depends on the level of graduate student involvement in project organization and implementation. However, 10 respondents said project management experience outside of core graduate schoolwork (e.g., extracurricular activities such as organizing a conference or fundraising) provided a good signal of project-management skills. One interviewee thought having broad experiences is good because it shows flexibility. Seven respondents said evidence of collaboration, such as a team project or being a coauthor on a paper, provides a good signal that a person has interpersonal skills. One interviewee thought having a project with real-world application is advantageous. For 7 respondents, taking a class in a subject was not a sufficient signal to show evidence of technical and IT skills. Six respondents said coursework may be adequate but that it is better to have experience applying these skills. Eight respondents said that writing a dissertation or thesis was not a sufficient signal for written communication skills because theses tend to be heavily edited. One interviewee indicated proposal and grant writing are important examples of written communication, "especially if there is a record of success."

Discussion

Our results suggest that to be competitive in the conservation job market, graduate students need to take control of their graduate experience and ensure they develop skills important for their intended career. Traditional research-based graduate programs in conservation science tend to emphasize disciplinary training and to have limited training in critical nondisciplinary skills important for nonacademic careers (Jacobson 1990; Cannon et al. 1996; Muir & Schwartz 2009). We found that project management, interpersonal, networking, program leadership, and written communication skills are crucial nondisciplinary skills for all job sectors. Manolis et al. (2009) identified similar skills as necessary for effective leadership and translation of science into policy and management. We believe students interested in conservation careers should focus on these skills, which can help them become successful leaders whatever their career path.

Our results also indicate students will benefit from focusing on developing the skills specifically associated with their job sector of interest. In our experience, as students move through graduate school, they make decisions about what sector to target for future employment. For government and nonprofit sectors, interpersonal, networking, oral and outreach communication, program leadership, and project-management skills composed the core skills in the desired set. In contrast, private-sector jobs emphasized technical and IT, written communication skills, specific and analytical disciplinary skills, and field skills. There are many other skills that were not emphasized in job advertisements within sectors or within skill sets (e.g., ability to complete tasks) (Table 2). However, we think all graduate students interested in careers in conservation will benefit from reviewing the entire list to be aware of the breadth of desired skills. One caveat related to our study is that the government job advertisements we evaluated were all for jobs in the United States and therefore may not reflect other countries' skill requirements for employment in government.

Obtaining necessary skills while in graduate school requires strategic thinking. Our interviewees had mixed responses on whether attainment of an advanced degree is a sufficient signal of skill competency. Experiences beyond graduate-school activities may be necessary. In some instances, a graduate program may provide training outside disciplinary skills (Inouye & Dietz 2000; Kainer et al. 2006). Engaging nonacademic professionals in the education process and developing project-based learning programs supplies students with skills not normally obtained in an academic setting (Martinich et al. 2006). The university may provide learning opportunities, like internships or the Interdisciplinary Graduate Education and Research Training (IGERT) program, that provide project management, leadership, and written communication experiences (Graybill et al. 2006). Students may also organize special seminars that focus on specific professional skills (Perez 2005).

Within the framework of their dissertation research, graduate students can also gain valuable experience in project management, personnel management, and program leadership by incorporating undergraduate interns into their research program. Undergraduate students are often looking to gain research experience. Graduate students who seek opportunities to advise undergraduate volunteers will gain valuable mentoring experience in addition to helping hands for their research. In addition, there are often undergraduate science clubs that seek graduate student mentors. Undergraduate advisors may be able to point to opportunities for graduate students to gain experience with managing and mentoring.

Students may also develop partnerships with organizations outside the university to answer research questions of interest to the organization. These efforts provide practical experience with the institutional structure, culture, and work processes. Concrete examples of this approach include having a committee member who is employed in the job sector of interest or engaging in a formal career-training program (e.g., Student Career Experience Program offered through the U.S. federal government).

In our experience, time management is critical when considering taking on activities to increase the breadth of one's skills. Students, faculty, and departments all share an interest in limiting time to degree completion. Embarking on extra tasks that improve and demonstrate nondisciplinary skills must relate to career goals and time commitments must be carefully managed. Open dialogue

between students and faculty mentors about goals and expectations for graduate training as well as the contractual obligations of research support during this period is essential to finding the right balance between depth and breadth of training. Faculty should work with students to balance research goals with other training needs.

Once students enter the job market, they should consider how to best signal their relevant skills. Every interaction with a potential employer sends a signal. Students should highlight relevant skills in their job application materials using vocabulary from the job advertisement. Applicants should also provide specific examples that signal competency in core skills required for that job but remember to think broadly about signals. For example, interviewees mentioned signals for project management could include experience such as managing volunteers during graduate research or organizing an event outside of the university.

The job market of the professional conservation scientist is highly variable and continues to evolve as new conservation challenges emerge. Job advertisements included in our study represented a limited sample in both time and space. In addition, our 14 interviews represented a modest number of opinions, despite the substantial collective experience of the senior conservation leaders we queried. Given these limitations, graduate students should be aware that as the challenges facing conservation evolve, so might the skills required to meet those challenges. Similarly, skills required in one geographic region may differ from skills required elsewhere. Graduate students should make a practice of scanning job advertisements to assure they are garnering skill sets that will prepare them for their targeted career objectives. Students should also consider doing informational interviews with potential employers to find out which specific signals are recognized as indicators of skill competency.

Students can use our results to evaluate their suitability for jobs in different sectors but should recognize our findings are intended as a guide, not as the definitive resource for planning one's graduate career. Nonacademic conservation jobs vary in skills required, and employers vary in how they evaluate skill signals. A career-planning process requires self-awareness and self-evaluation. Graduate programs and university faculty can help guide entering graduate students through this process of career planning by providing structure for self-reflection and learning about career options. Graduate programs can provide opportunities for students to gain nondisciplinary skills important for nonacademic jobs and appropriate reward systems that further incentivize students to gain additional skills (Jacobson 1990; Jacobson & Robinson 1990). Although we focused on nonacademic jobs, the skills identified herein are not exclusive to positions outside academia. Providing opportunities for graduate students to gain these skills will also benefit students who want an academic career, especially those who will collaborate with conservation scientists in nonacademic positions (Jacobson & McDuff 1998). Ensuring that students develop the skills they need to excel professionally is beneficial for graduate students and advances conservation because early-career conservation practitioners will be better prepared to immediately address conservation challenges.

Recommendations

On the basis of the GECP workshop, our results, and our collective personal experiences as graduate students, we make the following recommendations to graduate students.

(1) Focus on key skills. Gain competency in transferable skills. Broaden your potential for future opportunities by focusing on areas of overlap.
(2) Decide on a career track early in graduate training and tailor your graduate work accordingly.
(3) Be creative and go beyond minimum requirements. View it as insufficient to graduate with only coursework and dissertation research.
(4) Start collecting job information early. Develop a process to scan and evaluate job advertisements long before you are ready to apply so you develop the skills needed for the positions you find appealing.
(5) Be strategic. Identify the job skills that make you stand out, match these to positions that require these skills, and then augment your profile with complementary skills. For example, if you are a better field biologist than a people person, build your resume to that strength by gaining quantitative analytical skills.
(6) Be proactive. If your program does not offer what you need, make your own opportunities. Contact potential future employers and volunteer.
(7) Do not undervalue your experiences. Potential employers may value your experiences in group leadership, event planning, or volunteer positions even if they are not directly linked to, or gained during, your graduate degree.
(8) Talk to conservation professionals. Strategic planning for a career outside academia will be difficult if you only interact with academics.
(9) Recognize time constraints. Budget time between the conflicting interests of finishing your degree, fulfilling work obligations, and gaining a breadth of skills.

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Supporting Information

Specific details of job advertisements evaluated (Appendix S1), results of statistical tests and PCA analyses (Appendix S2), and interview questions (Appendix S3) 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.

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