# FOLLOW-UP STUDY OF THE IMPORTANCE OF MAPPING TECHNOLOGY KNOWLEDGE AND SKILLS FOR ENTRY-LEVEL FORESTRY JOB POSITIONS, AS DEDUCED FROM RECENT JOB ADVERTISEMENTS

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ABSTRACT. The purpose of this follow-up investigation is to further assess the importance of mapping technology knowledge and skills for entry-level forestry job candidates, based on relevant job advertisements available on the Internet. The study assumes that an expectation of the relevant details regarding educational background and desired work experience of an entry-level forestry position would be evident in the job advertisements. One hundred and seventy-two (172) job advertisements were analyzed from 91 employment and recruitment Internet sites over a six-month period of time between March 30, 2017 and September 30, 2017. Using a summative content analysis approach, we analyzed the word/phrase frequency of use of mapping technology requirements in these job advertisements. The results indicate that over half of the entry-level forestry job advertisements required candidates to possess knowledge (24.4%) or skill (26.2%) related to geographic information systems (GIS). Over one-quarter of the advertisements suggested knowledge (10.5%) or skill (16.9%) of global positioning systems (GPS) was important. Only one GIS system was specifically mentioned in the job advertisements. Knowledge and skill related to the use of a compass, aerial images, and in a broader sense, remote sensing were mentioned in much lower frequencies (6 to 13% of the time). We observed some variation with respect to the type of forestry organization seeking job applicants (public vs. private), and the region in which the jobs being offered were situated.

**Keywords:** Content analysis; GIS; GPS; Mapping technology; Forestry employment.

## 1 INTRODUCTION

Forestry involves the art and science of professional land management, and a forester may have a wide range of duties, some of which may require the utilization of mapping technology. Within the United States, it is estimated that there are over 12,000 of such jobs, and the potential growth of opportunities in this occupation has recently been estimated to be around 5% per year (U.S. Bureau of Labor Statistics 2018). Educational programs focusing on forestry are often designed as professional schools, imparting science, technology, and wisdom to students in an effort to ensure they are capable of beginning a career in natural resource management. However, the relative importance of these types of ideals may vary among academics (Gibson-Sweet et al. 2010). The identification of knowledge and skill requirements to be developed in college graduates is therefore important for the creation of educational programs that develop work-ready graduates (Messum et al. 2017). The

knowledge and skills deemed important for any type of job can be influenced by academic programs, potential employers, and professional accreditation organizations (Dunbar et al. 2016). The success of education programs can partly be reflected in the employment opportunities its students obtain (Kaba 2017). Thus skill gaps between those embodied within job applicants and those desired by employers can become evident when educational programs are not informed by workplace requirements (Jackson and Chapman 2012). These issues are becoming more important with rapid advances in technology (Yadav and Bankar 2016). Continuous assessments of academic curricula with regard to skill gaps can be as valuable as continuous assessments of other aspects of a professional education program (McArthur et al. 2017), such as those focused on understanding recent advances in science.

Knowledge and skill related to GIS, GPS, and other mapping technologies are some of the most important

features employers' desire in entry-level forestry positions (Sample et al. 2015), making it essential that forestry academic programs emphasize these types of technical skills (Bullard 2015). Graduate placement rates are an important metric of success for academic programs (Chen and Zhang 2017); therefore, forestry graduates should possess the knowledge and skills desired of perspective employers (Connaughton 2015). Merry et al. (2016) noted that about 79% of foresters in a survey conducted in the southern United States used GIS at least once per week in their regular job activities. Job advertisements can be consulted to help understand the scope of knowledge and skills required by different levels of positions within many professions (Gold and Grotti 2013), as job advertisements would ideally provide an indication of core competencies, although the amount of detail provided can vary considerably from one employer to another (Dunbar et al. 2016).

Many job advertisements are available via the Internet today, as this form of delivery can be less costly, may be more accessible, and content can be continuously updated (Kaba 2017). Job advertisements, as a collection, can illustrate the knowledge and skills desired by employers, and from a forestry perspective, a synthesis of the detail may inform both students and educators of the importance of mapping technology in their programs of study (Bettinger et al. 2016). Through an analysis of job advertisements, one may be able to envision gaps between what is offered in academic programs and what employers desire (Hong 2016).

Content analysis is a process that can be employed to analyze job advertisements and to understand the knowledge and skills desired by employers (Chen and Zhang 2017, Dunbar et al. 2016, Messum et al. 2017). Hong (2016) reported a specific study using content analysis to examine the job requirements of GIS analysts. A number of other authors have used content analysis in a similar manner, which included recent studies focusing on librarians (Detmering and Sproles 2012, Triumph and Beile 2015, Yadav and Bankar 2016, Kaba 2017), brand managers (Zuzana 2016), logisticians (Kovács et al. 2012), operations research professionals (Sodhi and Son 2010), project managers (Ahsan et al. 2013), marketing professionals (McArthur et al. 2017), data management professionals (Chen and Zhang 2017), and non-profit business managers (de Cooman and Pepermans 2012).

This study was a follow-up on our previous study of similar subject matter (Bettinger et al. 2016), and its primary objective was to determine the importance of a mapping technology background of a job applicant with respect to initial screening for entry-level forestry positions. Through this study, we were able to describe the number of jobs advertised, the potential employer group,

the type and title of the employment opportunities, and the requested mapping technology knowledge and skills to be demonstrated by a potential applicant. This study entailed a summative content analysis of the occurrence of responsibility and qualification descriptors that focused on mapping technologies. Specific questions we posed were:

1. What mapping knowledge and skills are desired of entry-level foresters?

2. Which sets of knowledge and skills are more important to the employability of forestry graduates?

Our content analysis process involved job advertisements for entry-level foresters, and was both unobtrusive and empirically grounded. The process involved a systematic examination of communicative matter (Krippendorff 2013), specifically job advertisements posted through the Internet. In general, we attempted to ascertain whether mapping technologies were important enough to potential employers that they needed to be declared in job advertisements. Observances of these instances were categorized and coded, and a summative analysis was subsequently performed.

## 2 METHODS

This study is the second of its kind assessing the information contained in job advertisements targeting entry-level foresters, and follows the same protocols employed during the first study conducted two years ago (Bettinger et al. 2016). Five general steps were followed in the process. As with the previous study, we defined the job category associated with the analysis and the variables to be assessed (entry-level foresters). We then identified the Internet sites where associated job advertisements (the samples) might be located. We collected sample data, and then we categorized and coded the content of the samples. Finally, we performed a summative assessment of the use of the coded descriptors frequency within the job advertisements. As in the previous study, the sample frame included job advertisements targeting only entry-level forestry positions within the United States. The sampling frame was further confined to those job advertisements that were posted on one of the Internet sites monitored between March 30 and September 30, 2017. Also as in the previous study, we were only concerned with entry-level forestry positions where anyone with the appropriate minimum amount of training (a bachelor's degree in forestry) could apply, therefore we excluded from the sample those job advertisements where professional registration was required, and those where more than one year of prior relevant job experience was required.

Titles of advertised positions (Table 1) were fairly descriptive of entry-level forestry positions in the field of

forestry and land management. For example, the titles of area forester, assistant and associate forester, service forester, resource forester, and lands forester all are reflective of basic forestry jobs where a wide scope of land management practices are employed. Inventory foresters are those who collect information on forest condition in order to quantitatively assess the current character of a forest. One difference between the current study and the previous study (Bettinger et al. 2016) is the exclusion of consulting utility foresters (transmission foresters, distribution foresters, etc.) in the current study. While this area of work is of great value to society, we found it difficult to track the unique advertisements available through some Internet sites, and thus our level of confidence for avoiding duplicate job advertisements was low. For example, one method we employed to monitor unique job advertisements was to record the position number, which some organizations employ to track positions. Yet in monitoring job advertisements, we found some cases where an employer may use the same position number to represent more than one position located in more than one location (perhaps in two different regions), and to represent different job opportunities at different times during the study period. In addition to the exclusion of consulting utility foresters, we also focused on actual calls for job applicants rather than outreach efforts where employers sought interest in a position rather than explicitly seeking a person to fill a position. We further focused on job advertisements that did not demonstrate an obvious preference for specific demographic groups. We focused on jobs assumed to be representative of full-time work (rather than part-time) and work assignments that were not limited to a short duration of time. Finally, excluded from the study were duplicated job advertisements located on more than one Internet site and any identifiable re-advertisements posted within an individual Internet site. In accordance with these constraints, the sampling units for this study consisted of individual job advertisements for entry-level foresters in the United States.

Throughout the study period, on a weekly basis, we consulted 91 Internet sites. The sites chosen needed to be freely accessible (no charges required), and further would not require a job seeker to either register with the employment organization nor develop an online profile. In making these assumptions, we precluded the use of some Internet sites hosted by state or university organizations. Some of the state-sponsored Internet sites were also inaccessible during the period of study, and a few others were not consulted due to the low likelihood of locating job advertisements meeting the needs of our study. Several of the Internet sites were managed by private organizations (e.g., Weyerhaeuser, Sierra Pacific Industries) and only provided jobs pertaining to their

Table 1: Position titles for entry-level forestry job advertisements in the United States, from March 30, 2017 to September 30, 2017.

| No. | Position Title |
|-----|----------------|
| 1. | Area forester |
| 2. | Assistant forester |
| 3. | Associate forester |
| 4. | Entry level forester |
| 5. | Forest inventory and analysis (FIA) forester |
| 6. | Forester |
| 7. | Inventory forester |
| 8. | Land resource specialist |
| 9. | Natural resource manager |
| 10. | Procurement forester |
| 11. | Resource forester |
| 12. | Resource land manager |
| 13. | Service forester |
| 14. | Silviculture forester |
| 15. | Staff forester |
| 16. | State lands forester |
| 17. | Timber buyer |
| 18. | Timber management forester |
| 19. | Urban forester |

business structure. Other Internet sites were managed by university forestry programs (Michigan State University, Oregon State University, Pennsylvania State University, Purdue University, University of Georgia, University of Minnesota), that were freely available to the general public. Some Internet sites became inaccessible for different reasons (e.g., changes in employment listing system) during our period of study, and required periodic browser searches to locate the changed, or updated, employment system URLs. Two Internet sites that required cookies, and were persistently inaccessible, were discarded from the potential set of monitored sites. Some of the Internet sites visited contained forestry-specific job advertisements (e.g., Forestry Careers USA, Society of American Foresters Career Center). Other Internet sites contained job advertisements from a broad scope of fields (e.g., Monster.com, USAJOBS.gov, state-sponsored employment agencies, university websites). When a job advertisement was located on Internet intermediaries such as Monster.com, the website of the specific organization that offered the job was consulted for verification. When necessary, we employed two keywords: "forester" or "forestry."

Each job advertisement we located was carefully examined. In this process, we recorded the organization name, the job title, the position number or code (when provided), the location of the position (state and region), the type of hiring organization (public, private,

non-governmental organization), and the verbatim relevant content that related to mapping technology. We assumed northeastern states to be West Virginia, Maryland, Pennsylvania, New York and all others located in the northeast. Midwestern states were assumed to be Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. The southern states were assumed to be Oklahoma and Texas and all others situated toward the east coast. All other states were assumed to be western states.

The statements from the job advertisements were coded with respect to six main categories: GIS, GPS, maps, compass, aerial images, remote sensing. Categories were created through the expert opinion of the researchers during the first study two years ago (Bettinger et al. 2016), yet as in the previous study, the sample material we collected was evaluated to ensure compatibility with the six categories and to assess whether additional categories were necessary. Each category contained associated sub-categories (knowledge and skill) and specific descriptors of these. As in the previous study we conducted, our guiding research question, which helped us to determine the characteristics (category, sub-category, descriptor) of the statements from the samples was:

*How important are mapping technology knowledge and skills for entry-level forestry positions?*

The descriptors we collected from the job advertisements related to mapping knowledge and skills students could have obtained while pursuing an undergraduate degree in forestry. A synthesis of the information into required and preferred qualifications (as in Hartnett 2014) was not possible because many advertisements did not specifically note required and preferred aspects of job candidates. In these cases, all relevant content with respect to mapping technology knowledge and skill was considered important for our analysis. Our summative content analysis process was performed using a spreadsheet, as in Triumph and Beile (2015); formal content analysis software was not employed as it was in Chen and Zhang (2017), Hong (2016), and other works. Within our process, we carefully cross-checked each categorization of job requirement to ensure consistency in our coding process. These processing steps represent the qualitative aspect of the summative analysis (Mayring 2000, Ahsan et al. 2013). Results were then developed based on the frequency with which the coded classes or categories were present in the job advertisements. Our results reflect univariate quantitative analysis, which is consistent with recent research using content analysis to evaluated job advertisements (Chen and Zhang 2017). Our results also reflect a closer examination of regional and employer differences, as portrayed by cross-

tabulations of the frequency of use, or a bivariate quantitative analysis process (Sodhi and Son 2010).

## 3 Results

Over the six-month study period, we collected and analyzed 172 unique entry-level employment-related forestry advertisements that were posted on the employment-related Internet sites (Table 2). This sample size is similar to other studies (Wellman 2010). The largest share (45.7%) of the job advertisements were related to positions located in the southern states. Of the others, 34.1% were located in the western states, 12.7% were located in the Midwestern states, and 6.9% were located in northeastern states. These distributions were similar to those we observed two years earlier (Bettinger et al. 2016).

Private organizations offered 45.3% of the job advertisements, while governmental agencies offered 53.5%. The remaining two job advertisements were offered by a non-governmental organization and a Native American Indian organization. Of the public organization job advertisements, the majority (85.9%) were from state agencies. The federal government (8.7%), counties (3.3%) and cities (2.2%) advertised for far fewer entry-level forestry jobs during our study period. Of the state agency opportunities, nearly half (49.4%) were situated in southern states, about 30.4% were situated in western states, very similar to the previous study. Of the public employment opportunities, most (82.6%) were related to general forestry or land management job responsibilities, while 12% were related to conducting inventories or administrating geographic information systems. The remaining positions focused on wildlife, forest health, and recreation. Of the private organization job advertisements, most (46.2%) were offered with respect to locations in the southern states. This distribution, along with job advertisements for positions located in western states (34.6%), Midwestern states (14.1%), and northeastern states (5.1%) was also similar to the previous study. Of the private organization job advertisements, two-thirds (66.7%) were related to general forestry or land management positions, and 14.1% were wood procurement positions. The remaining job advertisements were related to inventory, silviculture, harvesting, and GIS.

Within the 172 job advertisements, we found 128 unique statements regarding mapping technologies. Interestingly, about one-third of the job advertisements contained no statements related to knowledge or skill of mapping technology. Sixty-seven percent of the job advertisements offered at least one statement regarding mapping technologies, while 48% contained only one statement. Based on the presence of statements re-

Table 2: Six-month view of the employment opportunities for entry-level foresters, by region and by employer type, in the United States, from March 30, 2017 to September 30, 2017.

| Region | Private | Public | | | | Total |
|---|---|---|---|---|---|---|
| | | Federal | State | Sub-state | NGOa | |
| Midwest | 11 | – | 10 | 1 | – | 22 |
| Northeast | 4 | – | 6 | 2 | – | 12 |
| South | 36 | 3 | 39 | 1 | – | 79 |
| West | 27 | 5 | 24 | 1 | 2 | 59 |
| | | | | | | |
| Total | 78 | 8 | 79 | 5 | 2 | 172 |

a Native American Indian organization, non-governmental organization

garding various categories of mapping technologies, GIS knowledge and skill ranked the highest, as it was mentioned in 51.2% of the job advertisements (Table 3). GPS knowledge and skill ranked second, as statements to this regard were found in 25.6% of the job advertisements. Statements referring to the maps and aerial image knowledge and skill were located in 13.4% of the job advertisements, while statements related to compass knowledge and skill were located in 6.4% of the advertisements. The broader area of remote sensing knowledge and skill was noted in 5.8% of the job advertisements.

Table 3: Percentage of job advertisements that had keywords associated with the categories and sub-categories of the content analysis conducted of entry-level forestry positions in the United States, from March 30, 2017 to September 30, 2017.

| Category and *sub-category* | Percent of advertisements |
|---|---|
| Geographic Information Systems | 51.2 |
| *General knowledge* | 24.4 |
| *General skills* | 26.2 |
| Global Positioning Systems | 25.6 |
| *General knowledge* | 10.5 |
| *General skills* | 16.9 |
| Compass | 6.4 |
| *General knowledge* | 1.7 |
| *General skills* | 4.7 |
| Maps | 13.4 |
| *General knowledge* | 8.1 |
| *General skills* | 8.7 |
| Aerial photogrammetry | 13.4 |
| *General knowledge* | 9.9 |
| *General skills* | 5.2 |
| Remote sensing | 5.8 |
| *General knowledge* | 4.7 |
| *General skills* | 1.2 |

### 1. GIS knowledge and skill

As we noted, with respect to the category GIS, 51.2% of the job advertisements referenced this subject. The sub-categories of knowledge (24.4%) and skill (26.2%) were referenced through the keywords or descriptors we chose. Evidence of GIS knowledge was expected of job candidates through *experience* (13.4% of the job advertisements) and general *aptitude* or *knowledge* (8.1%) regarding the technology. With regard to GIS skill, the main keywords employed in the job advertisements were *skill* or *skills* (9.9%), *use* (7.6%), and *proficiency* or *proficient* (7.5%). Regionally, GIS knowledge and skill was referenced in 66.7% of the job advertisements from the northeast, 64.4% of the advertisements from the west, and 50% of the advertisements from the Midwest. The south had the lowest proportion of job advertisements that referenced GIS knowledge or skill (38.8%), which was consistent with the previous survey (Bettinger et al. 2016). With respect to the hiring organization, 43.5% of the public organization job advertisements and 59.0% of the private organization job advertisements referenced GIS knowledge and skill. While an equal amount of the public organization and private organization job advertisements referenced *experience* (25.0% and 26.1%, respectively) and *aptitude* or *knowledge* (17.5% and 13.0%, respectively) with respect to GIS as important in job candidates, *use* and *skill* were more often noted in public organization job advertisements, while *proficient* or *proficiency* were more often noted in private organization job advertisements. In the entire set of 172 job advertisements, specific reference to GIS software was made in 17.4% of the job advertisements, and only one GIS software company and product was noted (ESRI, ArcGIS).

### 2. GPS knowledge and skill

Of the job advertisements we located, 25.6% mentioned GPS knowledge and skill requirements; 10.5% of the advertisements suggest knowledge of the technology was important, while 16.9% suggested skill in using GPS was important. The sum of these exceeds 25.6% as some

advertisements suggested both knowledge and skill were important. Of the job advertisements associated with western states, 23.7% mentioned GPS technology, compared to 40.9% of the job advertisements associated with the Midwestern states, and 41.7% associated with northeastern states. As with the previous study (Bettinger et al. 2016), the lowest rate (20.5%) was observed in job advertisements associated with southern states. Job advertisements associated with private organizations had a higher frequency (36.4%) of mentioning knowledge or skill with respect to GPS technology than job advertisements associated with public organizations (28.3%). *Knowledge* (4.0%) and *experience* (4.6%) were the most frequently used keywords with respect to general knowledge of GPS. *Use* (8.1%) and *skill* (5.2%) in the context of GPS data collection were the most frequently used keywords with respect to GPS skills.

### 3. Compass knowledge and skill

Compass skills were very infrequently mentioned in job advertisements; only eleven (6.4% of the total) mentioned knowledge of how to use one, or skill in using one was important. The use of a compass may be considered a basic skill every forester should possess. Nonetheless, the ability to use a compass, often specifically for navigational purposes, was noted mainly in western job advertisements (nine of the eleven) with a nearly even distribution among public and private organization jobs. The remaining two were for public (state) agency jobs located in the south. No job advertisements from the Midwestern or northeastern states referred to desired knowledge or skill in this area. With regard to the full sample, 6.5% of the public organization job advertisements and 6.4% of the private organization job advertisements referred to compass knowledge or skill requirements. Keywords associated with statements contained in the advertisements included *knowledge*, *skill*, *ability*, *use* (experience), and *proficiency* with compasses for mapping and navigational purposes.

### 4. Map knowledge and skill

From the full sample, 13.4% of job advertisements referenced knowledge or skill with respect to maps, representing about a 50% drop from the level reported in the 2015 study (Bettinger et al. 2016). Most of the job advertisements mentioning *maps* were related to jobs located in the west (73.9%), and of these, 58.8% were associated with public organization job opportunities, while 35.3% were related to private organization job opportunities. Four job advertisements (2.3% of the total sample) mentioning knowledge or skill in using a map were associated with job opportunities in the south, and one each were related to job opportunities in the Midwest and northeastern states. The most frequently used keywords associated with this category were *use* (4.1% of the full sample) and *interpret* (2.3%); *read*, *prepare*,

*create*, and *review* were offered to a lesser extent. A desire for *experience* (1.7%) for communication, navigation, and locational purposes was infrequently stated. Finally, reference was made more frequently to topographic maps (5.8% of all job advertisements) and ownership maps (1.7%). No other specific type of map was mentioned in the job advertisements.

### 5. Remote sensing knowledge and skill

Remote sensing is a broad concept, and involves the collection of information about a subject (in this case, land and forest resources) without physically coming in contact with the subject. Technically, the collection of aerial images (next section) is a subset of remote sensing options available to society. However, in forestry, the two ideas are often conceptually separate, where aerial images relate to large format products derived from cameras mounted in airplanes or drones (and perhaps presented as a composite image), and remote sensing relates to products derived from satellite sensors. Overall, 5.8% of entry-level forester job advertisements required knowledge or skill related to remote sensing. Of the 10 job advertisements, seven were associated with job opportunities in the west, and three were associated with job opportunities in the south. Nine of ten job advertisements were from public organizations, and seven of ten were specifically related to federal government agencies (U.S. Forest Service, U.S. Army Corps of Engineers, U.S. Bureau of Land Management). Statements found in the job advertisements that referred to remote sensing suggested general knowledge of the subject was desired.

### 6. Aerial imagery knowledge and skill

Overall, 13.4% of job advertisements required knowledge or skill related to aerial imagery. Of these, 73.9% desired general knowledge of aerial imagery, while 39.1% desired skill using the technology. Most (69.6%) of the twenty-three job advertisements were associated with job opportunities in the west, three were associated with job opportunities in the south, and four were associated with job opportunities in the Midwest. Twenty of the twenty-three job advertisements (87%) were those of public organizations, while nearly an equal amount from state and federal government organizations. With respect to skills desired, *interpret* (2.9% of the full sample) and *use* (1.2%) were two keywords provided.

## 4 DISCUSSION

As expected, given the diverse set of independent forestry organizations that may be seeking entry-level foresters, the stated need for mapping knowledge and skill requirements was inconsistently presented in job advertisements. Further, the job advertisements lacked uniformity, which has been demonstrated in other similar studies (Kaba 2017). However, aspects of mapping

technology contained within job advertisements might differ based on the employer type (public and private) and the region where a job might be situated. As we noted above, an emphasis on compass knowledge and skill was mainly found in western job advertisements, and GIS knowledge and skill were more likely mentioned in western and northeastern job advertisements. Further investigation into the determining factors causing these differences might reveal that they may be related to the topography in which forests are managed (with greater relief found in the west), the remoteness of the forested areas (which is greater in the west), the land ownership pattern and proportion (greater amounts of public land in the west), and other factors (professional culture, organizational convention) that were proposed previously (Bettinger et al. 2016).

In general, it should be reasonable to expect that a profession associated with managing vast areas of natural resources, such as forestry, would rely and be dependent upon on mapping technologies. However, the goals and objectives of each organization with respect to the administration and management of land can vary considerably (Siry et al. 2015). One may expect disparities between the needs of different forestry organizations and the academic preparation for a career centered on these types of positions. While the frequency with which mapping technology knowledge and skills that were noted in job advertisements may have been lower than one might expect, GIS, GPS, and mapping technology knowledge and skills should be assumed inherent in a forestry education degree program today. Technology is also changing so rapidly that academic programs may struggle to keep up with progress, as the teaching philosophy in this area may more focused on developing bases of understanding and learning ability, rather than the state of current knowledge. Within forestry schools, one or two classes may have emphasized these areas, yet upon graduation a job applicant needs to be both competent and confident with regard to their ability in these areas. This suggests that when mapping technology knowledge and skills are important, persons seeking entry-level forestry positions may need to pursue self-improvement to enhance/update their qualifications rather than rely solely on content provided through likely outdated university coursework. Self-improvement in the areas of mapping technologies can be acquired relatively quickly for a motivated person through resources available over the Internet. Given the relatively low appearance of mapping technology knowledge and skills in job advertisements, our findings might also suggest that mapping technology knowledge and skills may not seem to be as important as other sets of skills. For example, some forestry positions place greater emphasis on business and negotiation skills. It is also possible that in the presence of the rel-

atively short half-life of the mapping technology knowledge, the employers might deliberately plan on-the-job training programs in recognition that whatever knowledge and skill a new employee might possess would likely be outdated at the time of hiring for their positions. One limitation of the study is that we did not examine soft, or general skills required of job applicants, yet general skills (involving communication, interpersonal, problem-solving, project management) have been noted as being critically important, or of greater importance, for certain technical fields closely associated with forestry (Hong 2016).

As we noted, the presentation of content within job advertisements was quite inconsistent from one potential employer to the next. Our study did not examine the motivations behind an employer's depth (or lack thereof) in the descriptions of required or preferred characteristics of a job candidate. We therefore assumed that the inconsistencies were likely due to time constraints or organizational practices and protocols (Bettinger et al. 2016). Offering job advertisements via the Internet is an affordable and relatively fast endeavor that can provide the news of a job vacancy to anyone who is afforded access (Kaba 2017), as a result, it may not be necessary to minimize the content within job advertisements that are available in this manner. We also noted some issues related to access of Internet sites, and the potential for duplication of postings, yet we failed to mention earlier that some job advertisements may likely be re-posted on Internet intermediaries (and other sites) simply because they were found (pulled from) elsewhere on the Internet, and not pushed to those Internet sites by the potential employer. This can potentially cause a job seeker to apply for a position that has already been filled. One suggestion to job seekers would be frequently check multiple Internet sites, and trace an advertisement back to the original employer. This was one aspect of our methodology, however some advertisements could not be successfully traced from an Internet intermediary to the human resources section of an employer's Internet site. In these cases, a judgment call was made based on whether it seemed that the job advertisement had been viewed on a previous date during the study period. Although our attempts to minimize these problems seemed successful, they do pose a potential issue for content analyses that are based on freely available content available through the Internet.

Aside from potential problems such as these, conducting a content analysis of job advertisements can be considered a useful course of action for assessing the desired knowledge and skills of entry-level foresters by potential employers. Content analysis has been criticized due to its summative nature in reporting the frequency of statements provided (Sodhi and Son 2010), and because the

meaning of these statements is left for the researcher to surmise. As others have shown, multivariate statistical analyses, where appropriate, might be employed to conduct a hierarchical clustering of groups of knowledge and skill requirements within job advertisements (as in Dunbar et al. 2016). This would allow one to examine the homogeneity (or lack thereof) among the groups and assess relationships between knowledge or skill areas that were (or were not) mentioned in the same advertisement (Hong 2016). As this was not the purpose of our study, we chose not to pursue this course of action, yet it demonstrates that content analysis can be subject to the more robust statistical processes desired by academics. On a positive note, an analysis of job advertisements does provide a perspective on the importance of mapping technology knowledge and skills for those persons pursuing entry-level forestry positions.

## 5 Conclusions

The goal of this study was to identify the knowledge and skill requirements of entry-level forestry positions in the United States, as suggested through job advertisements. Content analysis was used to examine the areas of importance to potential employers. The most important were knowledge of and skill in the use of GIS and GPS. This study contributes to the ongoing review of evidence regarding the knowledge and skill sets desired by employers of entry-level foresters in the United States. Forestry program accreditation teams may find the results we provided beneficial as well. While some minor differences were noted when the current study was compared to a similar study conducted two years ago, general agreement persists in the relative importance of mapping technology knowledge and skill areas for entry-level foresters. Further, while the development and use of technology in natural resource management continues to evolve, the analysis we provided may help graduating forestry students understand the importance of mapping technology from the view of potential employers. Hopefully, any skill gaps recognized by those seeking entry-level forestry positions can be addressed prior to graduation to raise the employability skills desired by public and private forestry organizations. Our results also noted some differences in the importance of knowledge or skill areas by employer type and by region. An examination of these differences may assist job applicants in preparing their case for potential employment. Academic programs may also benefit from the analysis we provided through an evaluation and assessment of curricula with respect to mapping technology knowledge or skill desires of potential employers, while also benchmarking these desires against criteria for forestry program accreditation.

## References

Ahsan, K., M. Ho, and S. Khan. 2013. Recruiting project managers: A comparative analysis of competencies and recruitment signals from job advertisements. Project Management Journal. 44(5): 36-54.

Bettinger, P., K. Merry, and C. Cieszewski. 2016. The importance of mapping technology knowledge and skills for students seeking entry-level forestry positions: Evidence from job advertisements. Mathematical and Computational Forestry & Natural-Resource Sciences. 8(1): 14-24.

Bullard, S.H. 2015. Forestry curricula for the 21st Century - maintaining rigor, communicating relevance, building relationships. Journal of Forestry. 113(6): 552-556.

Chen, H.-L., and Y. Zhang. 2017. Educating data management professionals: A content analysis of job descriptions. The Journal of Academic Librarianship. 43(1): 18-24.

Connaughton, K. 2015. Forestry employment trends. Journal of Forestry. 113(6): 571-573.

de Cooman, R., and R. Pepermans. 2012. Portraying fitting values in job advertisements. Personnel Review. 41(2): 216-232.

Detmering, R., and C. Sproles. 2012. Forget the desk job: Current roles and responsibilities in entry-level reference job advertisements. College & Research Libraries. 73(6): 543-555.

Dunbar, K., G. Laing, and M. Wynder. 2016. A content analysis of accounting job advertisements: Skill requirements for graduates. e-Journal of Business Education & Scholarship of Teaching. 10(1): 58-72.

Gibson-Sweet, M., R. Brennan, A. Foy, J. Lynch, and P. Rudolph. 2010. Key issues in marketing education: the marketing educators' view. Marketing Intelligence & Planning. 28(7): 931-943.

Gold, M.L., and M.G. Grotti. 2013. Do job advertisements reflect ACRL's *Standards for Proficiencies for Instruction Librarians and Coordinators*?: A content analysis. The Journal of Academic Librarianship. 39(6): 558-565.

Hartnett, E. 2014. *NASIG's Core Competencies for Electronic Resources Librarians* revisited: An analysis of job advertisement trends, 2000–2012. The Journal of Academic Librarianship. 40(3-4): 247-258.

Hong, J.E. 2016. Identifying skill requirements for GIS positions: A content analysis of job advertisements. Journal of Geography. 115(4): 147-158.

Jackson, D., and E. Chapman. 2012. Non-technical skill gaps in Australian business graduates. Education + Training. 54(2/3): 95-113.

Kaba, A. 2017. Online library job advertisement in United Arab Emirates: a content analysis of online sources. Library Management. 38(2/3): 131-141.

Kovács, G., P. Tatham, and P.D. Larson. 2012. What skills are needed to be a humanitarian logistician? Journal of Business Logistics. 33(3): 245-258.

Krippendorff, K. 2013. Content analysis, An introduction to its methodology. Third edition. Sage Publications, Inc., Thousand Oaks, CA.

Mayring, P. 2000. Qualitative content analysis. Forum: Qualitative Social Research. 1(2): Article 20.

McArthur, E., K. Kubacki, B. Pang, and C. Alcaraz. 2017. The employers' view of "work-ready" graduates: A study of advertisements for marketing jobs in Australia. Journal of Marketing Education. 39(2): 82-93.

Merry, K., P. Bettinger, D.L. Grebner, K. Boston, and J. Siry. 2016. Assessment of geographic information system (GIS) skills employed by graduates from three forestry programs in the United States. Forests. 7(12): Article ID 304. 12 p.

Messum, D., L. Wilkes, C. Peters, and D. Jackson. 2017. Senior managers' and recent graduates' perceptions of employability skills for health services management. Asia-Pacific Journal of Cooperative Education. 18(2): 115-128.

Sample, V.A., R.P. Bixler, M.H. McDonough, S.H. Bullard, and M.M. Snieckus. 2015. The promise and performance of forestry education in the United States: Results of a survey of forestry employers, graduates, and educators. Journal of Forestry. 113(6): 528-537.

Siry, J.P., P. Bettinger, K. Merry, D.L. Grebner, K. Boston, and C. Cieszewski (eds.). 2015. *Forest Plans of North America.* Academic Press, New York. 458 p.

Sodhi, M.S., and B.-G. Son. 2010. Content analysis of OR job advertisements to infer required skills. Journal of the Operational Research Society. 61: 1315-1327.

Triumph, T.F., and P.M. Beile. 2015. The trending academic library job market: An analysis of library position announcements from 2011 with comparisons to 1996 and 1988. College & Research Libraries. 76(6): 713-739.

U.S. Bureau of Labor Statistics. 2018. Conservation scientists and foresters, Job outlook. In Occupational Outlook Handbook. U.S. Department of Labor, Bureau of Labor Statistics, Washington, D.C. https://www.bls.gov/ooh/life-physical-and-social-science/conservation-scientists.htm#tab-6 (Accessed February 22, 2018).

Wellman, N. 2010. The employability attributes required of new marketing graduates. Marketing Intelligence & Planning. 28(7): 908-930.

Yadav, A.K.S., and P.D. Bankar. 2016. Employment opportunities in LIS field in India: A content analysis of positions advertised. Annals of Library and Information Studies. 63(1): 53-58.

Zuzana, W. 2016. Requirements for brand managers and product managers responsible for competitiveness of product and brands. Journal of Competitiveness. 8(3): 5-21.