Skills for Employment in the Environment Profession: Insights from Australia

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KEY WORDS

Environment/sustainability professionals; electronic survey; professional skills

ABBREVIATIONS

OECD - Organisation for Economic Co-operation and Development
PISA - Programme for International Student Assessment
DeSeCo - Definition and Selection of Competencies
UNESCO - United Nations Educational, Scientific and Cultural Organization
ESD - Education Sustainable Development
CEO - Chief Executive Officer
NRM – Natural Resources Management
EIA - Environment Impact Assessment
GIS – Geographic Information System
GHG – green-house gases

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What this paper adds:

Professional skills are often identified by academics and / or from small scale surveys of employers. The paper adds data and understanding about the critical skills for working in the environment / sustainability sector as identified by environment professionals themselves. The generic skills identified are similar to those noted for professionals generally.

Abstract: Like other professionals, the skills expected to be exercised by those working in the professional environment and sustainability sector cover a wide range. There has been considerable discussion given to what this range embraces, and which are the more important of the skills. Also discussed has been the terminology associated with skills; i.e. core skills, generic skills, transferable skills, competencies, capabilities, and more. An electronic survey of environment professionals based in Australia provided the opportunity to explore the skills that a sample of these professionals considered to be important in their professional work. The results indicated that the critical generic skills for being an environmental professional are: communication (written); project management; interpersonal skills; judgment and decision making; scientific approach and application; team work (coordination); initiative and enterprise; and computer skills. Considering others' work regarding other professions, it appears that many of the skills in this list are also relevant to a range of professions. Further, the broad relevance of these skills is indicated as the survey participants considered them to be important for specific (current) jobs and for working in the sector generally. Surprisingly critical thinking, which is often noted in the literature as a high priority, was considered important for current positions, but not so for working in the sector generally. Also, the participants indicated little appreciation of aspects of 'normative skills'; suggesting that practitioners are focused on skills needed for 'getting the job done', but show little recognition of what the 'job is and its implications'. The results provide a snap-shot of the profession, and point to areas of research regarding the skills that future environment, and other, professionals will need, and how educational institutions will have to respond; given fast moving climate change, alongside the continuing roll-out of automation in work-places.

Introduction: For some time there has been discussion of the range of skills that environmental professionals need to operate successfully in their workplaces. As an example, based on their survey of Australian sustainability professionals, Turning Green Pty Ltd (2011) noted that "35% flagged a skills shortage as the biggest factor that will make it difficult to recruit staff in the area of sustainability, climate change and/or environmental disciplines in the future." (p. 4). Similarly from a survey of international business leaders, results indicated that education institutions were expected to develop employees, and future business leaders, "with the knowledge, skills, attitudes and behaviours to manage sustainability issues as an integral part of the way they think about business." (Lacy et al. 2010, p. 49).

This discussion may be embedded in the broader issue of the skills associated with employment, where there is growing recognition of the range of views regarding the most valuable skills for the workplace. With some focus on vocational positions, SkillsIQ (2017) note that "Australian employers are expecting job candidates to be increasingly qualified" (p. 12), concern is expressed regarding the relevance of the skills of new employees:

> "For example, soft or employability skills are the bedrock of success for workers in the people-facing sectors, but may be less valuable elsewhere. Employers often express concern that these skills are missing in graduates, suggesting that either they are not being sufficiently embedded within qualifications or the training for these qualifications is not being delivered well by providers" (p. 9).

With similar concerns about the skills of employees, the (Australian) Productivity Commission (2017) concluded that "technology adoption, use and diffusion — the long-run drivers of productivity — require people with the right skills. " (p85) Elaborating on this theme, the Commission's report notes "for many future jobs, new skills and knowledge will be needed as part of the core competencies. … A range of 'soft' skills (such as communication, empathy, creativity and adaptability) complement other 'harder' skills and are useful to navigate changes in job requirements." (p. 87). Being more specific, Deloitte Access Economics (2017, p, 1) note that "soft skill intensive occupations will account for two-thirds of all jobs by 2030, compared to half of all jobs in 2000." [1] Across Australia, they identify a strong soft-skills base, however "a quarter of entry-level employers report having difficulty filling vacancies because applicants lack employability skills" (p. 1) and "despite the value that businesses place on soft skills, data from LinkedIn profiles reveals that less than 1% of Australians report having any soft skills on their profiles" (p. 1). The importance of employability skills (specifically communication and teamwork, caring and empathy, organisation) is also emphasised by (Australian) Department of Employment (2017).

For Department of Education, Employment and Workplace Relations (2010a), general employability skills (similar to Deloitte's soft skills) are non-technical or generic skills; such as communication, team work and problem solving, which contribute to a person's ability to be an effective and successful participant in the workplace. Such skills may be referred to as key, core, life, essential, or soft skills. Importantly, unlike most technical skills, employability skills are considered to be transferable between employment positions. To provide a framework for categorising skills, the OECD built on the Programme for International Student Assessment (PISA) with their Definition and Selection of Competencies (DeSeCo) Project. The DeSeCo Project identified three main groups of competencies (OECD, 2005):

- interactive use of tools - language, symbols and text; knowledge and information; knowledge and information;
- interacting in heterogeneous groups – relating to others; co-operating; managing and resolving conflict;
- acting autonomously - act within the big picture; develop and implement life and personal projects; defend and assert rights.

Associated with these groups, OECD (2005) outlined a rationale for having key competencies; considered to be broad, and being more than knowledge and skills.

In parallel universities had begun to consider the generic attributes that could be expected of graduates entering the work-force (e.g. Barrie, 2006), and academics contributed arguments relating to the important, or key, competencies associated with particular professions (e.g. Barth et al., 2007; Hadgraft & Muir 2003). Likewise Association of American Colleges and Universities (2007) were identifying learning outcomes so that, "beginning in school, and continuing at successively higher levels across their college studies, students should prepare for twenty-first-century challenge" (p. 12) A range of outcomes was proposed, covering the categories of: knowledge of human cultures and the physical and natural world, intellectual and practical skills, personal and social responsibility, and integrative learning.

[1] Deloitte Access Economics (2017, p. 1) comment that "Soft skills are also referred to as employability skills, enterprise skills and they are transferable between industries and occupations."

At this point we need to acknowledge that the terminology associated with skills is confused. Weinert (2001, p. 45) points out that:

> "In general, we know what the terms "competence", "competencies", "competent behaviour" or "competent person" mean, without being able to precisely differentiate them. The same can be said of terms such as "ability", qualification", "skill" or "effectiveness."

He also notes that terms like fitness, ability, capability, capacity, efficiency, proficiency and skill are used as synonyms for competencies. Across the literature we see this range of terms used, with Méhaut and Winch (2012) providing a discussion of use of the terms in the European context. Expanding this discussion, Pegg et al (2012, p. 20) suggest that:

> "In recent years there has been a shift in terminology away from skills;… (since) "underpinning all these attributes, the key foundation, must be a positive attitude". The continued foregrounding of 'skills', 'attributes' or 'capabilities' to access and describe employability endures, as it is a quick and relatively easy way to engage employers, curricula and students with employability and with career management."

The inter-relationships between these terms underlie the complexities of the concepts and the range of factors that affect their development. In their discussion of the range of components that lead to the employment of a graduate, Dacre Pool and Sewell (2007) have illustrated stages, and the process, that contribute to employability skill development (see Figure 1). Summarising these relations these researchers say that "employability is having a set of skills, knowledge, understanding and personal attributes that make a person more likely to choose and secure occupations in which they can be satisfied and successful." (p. 280)

For convenience, unless another term is relevant to the specific discussion point, in this paper the term 'skills' will be used, since this is common in much of the broad discussion of employability, especially in Australia.

Skills associated with the environment / sustainability profession: Drawing on the principles of Education Sustainable Development (ESD), Sterling and Thomas (2006) discuss a broad framework to identify types of skills relevant to ESD, and thence the learning outcomes that would be expected to enable graduates to enter the environment profession. Similarly taking a broad view, and building on discussions related to competences dating from the 1980s, the UNESCO Report 'Learning: the Treasure Within' identified four competence groups: domain competences; methodological competences; personal competences; and social competences (Mochizuki and Fadeeva, 2010). From this report Mochizuki and Fadeeva (2010) see that the essential characteristics of ESD provide a base for development of 'dispositions for sustainability' and subsequent groupings of sustainability related competencies. Going further, to the basis of sustainability discussions, specifically the concepts of Sustainable Development, Svanström et al. (2008) had undertaken an analysis of learning outcomes that had been proposed in the Tbilisi and Barcelona declarations. They found commonalities include systemic or holistic thinking, the integration of different perspectives, skills such as critical thinking, change agent abilities and communication, and finally different attitudes and values" (p. 339). A similar list was identified by Sandri (2014) as part of her review of the developments within ESD.

To guide ESD, and hence the education of environmental professionals, organisations with an interest and/or responsibility for guiding the curricula of higher education have developed guidelines for the development of environment/sustainability curricula. The complexity of such a task is summarised by the comment that "a wide range of skills, knowledge and attributes are required to create an action-orientated, sustainability-literate graduate" (Higher Education Academy 2006, p. 6). Similarly, Rees et al. (2006) compiled student employability profiles to guide Higher Education practitioners in the UK. Specifically for the area of environmental science they commented that: "Like all graduates, Environmental scientists should possess the following skills and qualities: communication, organisation, critical thinking, research skills, critical analysis, presentation, ability to work under pressure, self-management, interpersonal skills, confidence and a willingness to learn." (p. 78)
In addition, these authors considered that environmental professionals should have:

- knowledge (including of monitoring and management, interdisciplinary approach, global awareness);
- thinking skills (to make decisions in an integrated and holistic way, and develop arguments from many points of view);
- practical skills (including working in teams, project management, problem solving and analysis, literacy, numeracy and graphicacy skills, be flexible and adaptable, and have the confidence to deal with the unexpected).

A degree of similarity was found through a Delphi study of selected experts from a small sample of European and Latin American countries. The experts identified 12 key competencies, but the ”most relevant ones are those for systemic thinking, anticipatory thinking and critical thinking” Rieckmann (2012, p. 127).

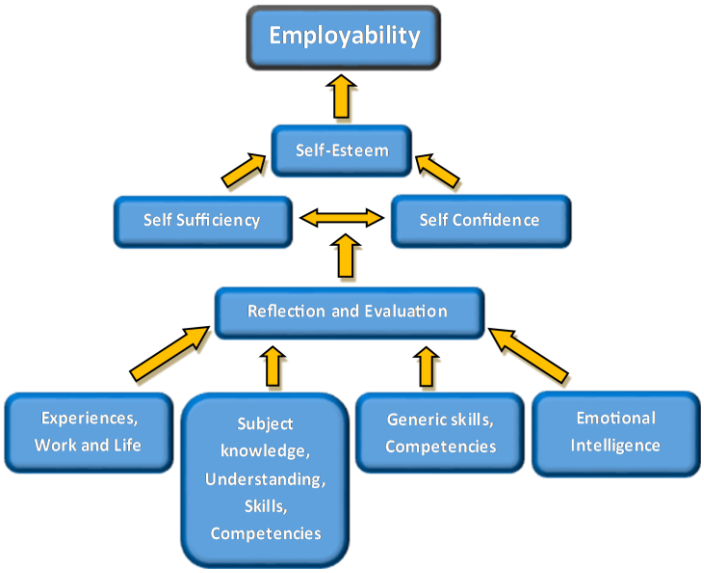

Figure 1 – Factors associated with development of employability skills
(After Dacre Pool and Sewell 2007)

Employers have sometimes contributed to the development of these guides. Equally the views of employers have also been sought to help understand the needs of the sector. In the Australian context for example, Department of Education, Employment and Workplace Relations (2010b) surveyed a range of employers, asking if they had been affected, or thought they would be affected in the future, by environmental and sustainability issues. In relation to these issues, respondents were asked to identify any additional skills needed by their workforce. Responses primarily noted a need for knowledge of environmental issues and/or processes (e.g. knowledge of the relevant legislation; environmental awareness; environmental management; green products; occupational health and safety issues).

These data were used to provide information related to future employment directions. In a related report Department of Education, Employment and Workplace Relations (2010a) emphasised the role of employability skills (noted above), and specifically considered the types of ‘green skills’:

“Green skills, or skills for sustainability, are the professional and vocational skills, as well as the generic skills (such as sustainable approaches, innovation and problem solving) required for new green jobs and the greening of existing jobs across all industry sectors as a response to climate change and sustainability imperatives” (p. 27)

Also noted was that “workers across a range of occupations will need new skills to … implement new technologies and practices for a more sustainable world. … Green skills will be important to all industries and sectors, not just to the trades.” (p. 27). This position was supported by the survey of business leaders reported by Lacy et al. (2010, p. 44), where the CEOs thought that “… exposure to the field of “systems thinking” will help employees understand the interrelations and multiple causalities within a complex adaptive system.’

Those directly involved in the environment/sustainability workplace have also contributed to discussion of essential skills. From a survey across the UK environment sector including business, government and the research base, Environment Research Funders’ Forum (2007) identified a list of 15 most wanted skills; of these, slightly over half focused on specific skill of knowledge areas. Subsequently, respondents to an international survey (with a North American context) of environmental professionals, reported by Willard et al. (2010), that the “top skills needed for success as a sustainability professional, (were) good communication skills.”(p. 2) These authors also found that generally “more “soft” skills were deemed of extremely high importance than “hard” skills. … (of) soft skills examined… most critical were communication with internal and external stakeholders, problem solving, and inspiring and motivating others.” (p. 2) Likewise, recognising the breadth of the environment field, Quality Assurance Agency for Higher Education (2014) revised their statement for earth sciences, environmental sciences and environmental studies. Importantly the revision identified distinctive features of these subject areas and clarified the generic skills across the subject areas. Specifically greater emphasis has been given to:

- sustainability and sustainable development
- employability and professionalism (including links to PSRBs [professional, statutory and regulatory bodies])
- multidisciplinarity and interdisciplinarity
- the importance of practical skill development, especially in field situations.” (p5)

Environmental professionals have increasingly come through the environment and sustainability programmes offered by Higher Education Institutions. The graduates of

some programmes have been surveyed for their opinions of the skills needed in their employment. For example, Hansmann et al. (2010) reported results of a survey of Swiss graduated environmental scientists, listing a range of types of expertise and knowledge, along with social-communicative competencies. In the Dutch context, Bootsma and Vermeulen (2011) surveyed environmental science graduates University and their employers, identifying several generic academic skills plus discipline specific knowledge and skills.

These generic skills are among those that are also called 'transferable', as discussed by Department of Education, Employment and Workplace Relations (2010a). However, Lum (2009) points out that a person's application of any generic 'skill' (not the term he chooses) is context dependent, and associated with the precise situation where the skill will be applied, so that the concept of 'transferability' of skills is questionable. Yet, for those in the environmental professional this may not be too much of an issue, since the wide range of employment areas that are related to the environment and sustainability fields (see Thomas and Day 2012) could, conceivably, mean that there are multiple job situations that would be similar.

Interest in sustainability skills has not been confined to only those who have completed academic programmes, as university students have also contributed to the discussion of relevant skills. For example, a survey of a sample of first and second-year university students in the UK, found that the majority believed that sustainability should be covered by their university (Drayson et al., 2012). Specifically they considered that "skills in adaptability and communication are valued more highly than those towards the environment and ethics in relation to employment " (p23) and highlighted planning for the long term as well as the short term, adapting to new situations, and problem solving using many perspectives.

It is apparent that there are differences of opinion about the naming and thinking about skills for environmental professionals. Also, clearly there is no single set of agreed skills for environmental professionals. However, some researchers have sought to draw out common themes. For instance, Mochizuki and Fadeeva (2010) reviewed competence approaches and examined the adequacy of a competence-based model as the means of achieving educational and societal transformation towards sustainability; although Lum (2009) considers a focus on competence to be limiting. Going further, and accepting the concept of competencies, Wiek et al. (2011) undertook a literature review of publications related to competencies associated with sustainability education and practice. They categorised the range they reviewed into the key areas of: systems thinking competence, anticipatory competence, normative competence, strategic competence, and interpersonal competence. Appreciation of the need for a professional to integrate these five competencies led to Wiek et al. (2016) including the additional competency of 'integrated problem-solving competence'.

The importance of an integrating or overview competency has been recognised following a review of the literature relevant to skills/capabilities/competences for sustainability, by Perez Salgado et al. (2017), leading to an understanding of what professional competences for 'interventions towards sustainability' may be. To test this, the authors engaged practicing Dutch professionals in workshop discussions to determine that intervention competency is a key for leading to change for sustainable outcomes. Specifically:

"… 'intervention competence', ... comprises an interlocking set of knowledge, skills, attitudes and behaviours that include: … reaching decisions or interventions; … learn from lived experience of practice and to connect such learning …; … political-strategic thinking…; …goal-oriented, adequate action; adopting … ethical practices during the intervention process; … cope with the degree of complexity, and … translate stakeholder diversity into collectively produced interventions (actions) towards sustainability." (p. 163)

Given the above, this paper focuses on the skills that professionals, employed in the environment/sustainability fields in Australia, see as being relevant in every-day work, and careers. Over the years there have been reports about the type of skills expected for these professionals, often based on small sample discussions with employers, but information from the professionals themselves has been lacking. Drawing on results from a survey environment/sustainability professionals, the purpose of this paper is to report the main skills that these environment/sustainability professionals use in their work.

The preceding material provides a brief overview of skills that have been broadly attributed to the fields by researchers, governments and businesses. Drawing on this discussion, the following section presents the overview the electronic survey developed to collect data from people who have been working in environment/sustainability fields across Australia, and the skill specific questions which were included. An outline of the results related to skills, is presented subsequently. The paper concludes with discussion of the results and consideration of their implication for the future of the environment/sustainability profession; for simplicity from this point the term environmental profession will be used.

Method for surveying environmental professionals skills: In 2016 an Australia-wide electronic survey was undertaken, based on two earlier surveys to update their results. As with the previous surveys the aim was to determine:

- what jobs are currently included in the broad category of 'green collar' jobs; skills, education and experience required to secure these roles
- key tasks undertaken in the range of roles that now exist
- perceptions of future employment within the environment industry.

Specifically, the data were to be used to:

- develop a career guide on the environment industry
- help inform secondary students, graduates and career changers about environment careers
- provide information on potential career options and paths for potential entrants to the environment sector
- provide insight into future personnel issues associated with the sector.

(Thomas & Day 2012, p. 8)

The web-based Australia-wide survey was made available, following ethics clearance, through email and electronic newsletters inviting a non-random sample of environmental professionals to participate. The invitation was distributed through three Australian networks that support environment professionals; i.e. Centre for Sustainability Leadership, Environmental Jobs Network and NRM Jobs. Because of the very broad approach to issuing invitations the number who may have received the invitation is unknown, as is the number who viewed or opened the invitation. Ultimately, 585 responses were received. With the difficulty in defining the profession, and the range of associated disciplines and sectors, there is no information about total employment within the profession; data reported by (Australian) Department of Employment (2017) indicated that in 2016 for the category 'environmental scientist', the only category that clearly associated with environmental roles, some 22,800 people were employed.

Survey questions, which were based on those of the earlier surveys and recent literature relating to skills (discussed above), sought information regarding:

- categories of professional environment employment
- characteristics of environment professionals
- position titles by which the respondents' positions were designated
- typical activities with which respondents are engaged
- education levels and skills considered to be most important in their work
- duration of careers, and job movements within it
- generic and specific skills considered important to their employment.

For data collection the web-based survey application Qualtrics was used, enabling participants' responses to be anonymous. However, email addresses were provided by some who offered to provide a profile of their work and careers for publication, and/or were interested in a summary of the survey results.

Reported skills of the environmental professionals: Overall results coming from the survey are reported elsewhere (see Thomas in press), and a summary has been made available on the web sites of the three organisations noted above. Respondents were identified as female 56%, male 43% and not disclosed 0.01%. Categories of employment ranged across the spectrum of employment possibilities. Full-timers represented 62% of the sample and part-timers 12%, 6% were casual, 5% were on contracts, 5% identified themselves as consultants, and 5% were self-employed. In addition 1% identified as volunteers, and 2% were unemployed. A range of ages was apparent, see Figure 2, with the median age being 36-40 years.

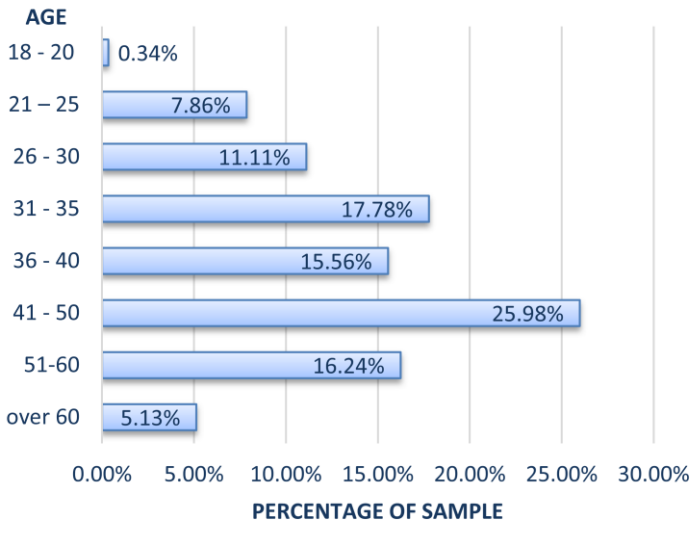

Figure 2 – Participants' ages

The following will focus on the results related to skills. Specifically, survey participants were asked, in separate

questions, to nominate up to three skills that relate to each of the quadrants in Figure 3:

Generic skills – for current job	**Generic skills – for work in the environmental / sustainability sector to date**
Environmental / sustainability specific skills, knowledge or experience – for current job	**Environmental / sustainability specific skills, knowledge or experience – For work in the environmental / sustainability sector to date**

Figure 3 – Quadrants of skills types

Based on the previous surveys a range of generic skills had been listed for the convenience of participants, while an option of 'other' was provided. Table 1 presents the 10 *most frequently* nominated skills for the respondents' current position, and generally from their experience working in the sector (Table 2).

Generic skills that are important for Current job (listed in rank order, from most to less frequent)	***n***	***%***
Critical Thinking	156	9.9
Communication - Written	149	9.5
Project Management	140	8.9
Communication - Spoken/Verbal	125	7.9
Interpersonal Skills	112	7.1
Judgment and Decision Making	95	6
Scientific Approach and Application	94	6
Team work - Coordination	73	4.6
Initiative and enterprise	56	3.6
Computer Skills	55	3.5

Table 1 – Ten most frequently noted generic skills – for current job sector to date

These data are combined in Table 3 together with the remaining results for the questions. This table illustrates the range of skills participants identified and provides the opportunity to identify any differences in the perceived importance[2] of skills between respondents' current jobs, and their overall experiences in the sector. Information in the far right column suggest that, with their positive values, both 'critical thinking' and 'communication (spoken/verbal)' are more important for participants' current jobs than generally across environment sector jobs; whereas 'equipment maintenance',' communication - customer service', and 'computer skills' were needed more across the sector.

[2] A high frequency of reporting is assumed to indicate that the skill is important for professional practice.

Refiguring the overall data, in Figure 4, a comparison is presented of the relative importance of the generic skills identified for respondents' current jobs, and their experiences in the sector. Here only the *most frequently* noted skills for both groupings are listed.

Generic skills that are important for Sector skills (listed in rank order, from most to less frequent)	***n***	***%***
Interpersonal Skills	113	9
Project Management	103	8
Communication - Customer Service	99	8
Computer Skills	98	8
Communication - Written	95	8
Equipment maintenance	90	7
Scientific Approach and Application	61	5
Initiative and enterprise	52	4
Judgment and Decision Making	52	4
Team work - Coordination	44	4

Table 2 – Ten most frequently noted generic skills – for work in the environmental / sustainability sector to date

Here the absence of 'critical thinking' and '(spoken) communication' from the 'top ten' skills for sector wide jobs is noticeable, while '(customer service) communication', and 'equipment maintenance' are absent from the current job group. However, '(written) communication', interpersonal skills' and 'project management' are important in both job groups.

Generic skills that are important for … (skills are listed in alphabetical order)	**Current job** ***Count***	**Current job %**	**Sector skills** ***Count***	**Sector skills %**	***Difference*** **Current job % - Sector skills %**
Communication - Customer Service	50	3.2	99	8	**-4.8**
Communication - Spoken/Verbal	125	7.9	29	3	**4.9**
Communication - Written	149	9.5	95	8	1.5
Computer Skills	55	3.5	98	8	**-4.5**
Critical Thinking	156	9.9	28	3	**6.9**
Equipment maintenance	7	0.4	90	7	**-6.6**
Honesty	31	2	5	0.4	1.6
Identifying complex problems	42	2.7	29	3	-0.3
Initiative and enterprise	56	3.6	52	4	-0.4
Interpersonal Skills	112	7.1	113	9	-1.9
Judgment and Decision Making	95	6	52	4	2
Learning Skills	26	1.7	42	3	-1.3
Mathematical literacy and abilities	19	1.2	9	1	0.2
Negotiation / Persuasion / Build Argument	47	3	35	3	0
Operation and control of equipment / systems	7	0.4	6	0.5	-0.1
Operation monitoring and analysis	16	1	14	1	0
Practical skills (e.g. installation of equipment / systems)	26	1.7	33	3	-1.3
Project Management	140	8.9	103	8	0.9
Resource Management Skills - Financial Resources	6	0.4	5	0.4	0
Resource Management Skills - Long term planning and organising	38	2.4	12	1	1.4
Resource Management Skills - Management of self	38	2.4	14	1	1.4
Resource Management Skills - Material Resources	7	0.4	6	0.5	-0.1
Resource Management Skills – Personnel	10	0.6	7	1	-0.4
Scientific Approach and Application	94	6	61	5	1
Solution Development	22	1.4	24	2	-0.6
Team work - Coordination	73	4.6	44	4	0.6
Team work - Instructing	15	1	7	1	0
Technology Design	6	0.4	2	0.2	0.2
Timeliness	23	1.5	10	1	0.5
Troubleshooting	18	1.1	10	1	0.1
As for current career / position			99	8	
Other, total	*29*	*1.8*	20	2	
**Other – experience, practical approach*	*4*				

Other – specific area or knowledge (eg ecology, GIS)	7				
Other – personal attributes (eg work ethic)			7		
Other – broad capabilities (strategic approach, problem solving, political literacy			3		
Other – technical or administrative skills			3		
Other experience related (field work, remote locations, volunteering)			3		
Other knowledge related (business/corporate, legislation, risk management, teaching)			4		
Total	**1573**		**1238**		

Notes –
- in the right-hand column, differences between current job and sector experience are presented; differences in **bold** are noticeably greater than the bulk of the results.
- a positive.% indicates the skill was noted more frequently, and considered important, in relation to current jobs; a negative number indicates the opposite case.

Table 3 – Combined data regarding generic skills

For the questions related to 'environmental/sustainability specific skills, knowledge or experience', a wide range of topic related skills was expected. Rather than constraining respondents to a finite list the survey participants were encouraged to use their own descriptors so that information would be available regarding categories of specific skills. The data in Tables 4 and 5 come from a manual review of the responses to determine the 'sentiment' of each specific response. Combining the results for the three skills that respondents were asked to identify, some 13 categories, or sentiments, were identified, and given a code. Individual responses provided by the participants were then assigned the relevant code, and the total for each code was calculated. The data in Tables 4 and 5 present the categories of skills and the numbers of responses for each (whether as given for skill 1, 2 or 3) along with the total for each category. These results are listed in descending rank order, relative to the total of the three skills, for the 'sentiment' categories.

Discussion: Respondents have indicated there is a high degree of consistency in opinion about the skills that are important for current jobs and generally across the sector. Considering Figure 4 and Table 3, 80% of the 10 most important skills ('top band') are common to both current job and sector categories. Of those 20% that are not common, 'critical thinking' and 'communication - spoken/verbal' which are high on the current job list are just below the top sector skills. Likewise for skills high on the sector list, 'communication - customer service' is just out of the current job list, however, 'equipment maintenance' has a much lower importance; possibly suggesting that as the participants have gained professional experience, they have been less involved in the details of monitoring and other technical tasks.

Looking at the other skills, presented in Table 3, the 'middle band' of generic skills for 'current' jobs (less than 3.5% to 2%) and 'sector' skills (less than 4% to 3%) show little commonality. Only 'identifying complex problems' features in the band for both sets of skills. Others, such as 'resource management skills' (both long-term, and self) feature in the current job set, while both 'learning skills' and 'practical skills' appear in the sector set, suggesting, as above, that with increasing time in the profession there may be less involvement with technical tasks.

The same interpretation comes from consideration of the far right column of Table 3, where the percentage difference for each skill is indicated. The five items in bold type show substantially larger differences between the current job and sector skills sets than indicated for all other skills. Where the differences are positive (communication - spoken/verbal, and critical thinking) participants have indicated that the skill is more important for their current jobs, while the negative items indicate the skills to be more important across their time in the sector (i.e. communication - customer service, computer skills, and equipment maintenance). Again the suggestion is that the more technical and specific skills are important to be developed in the early years of the professional experience.

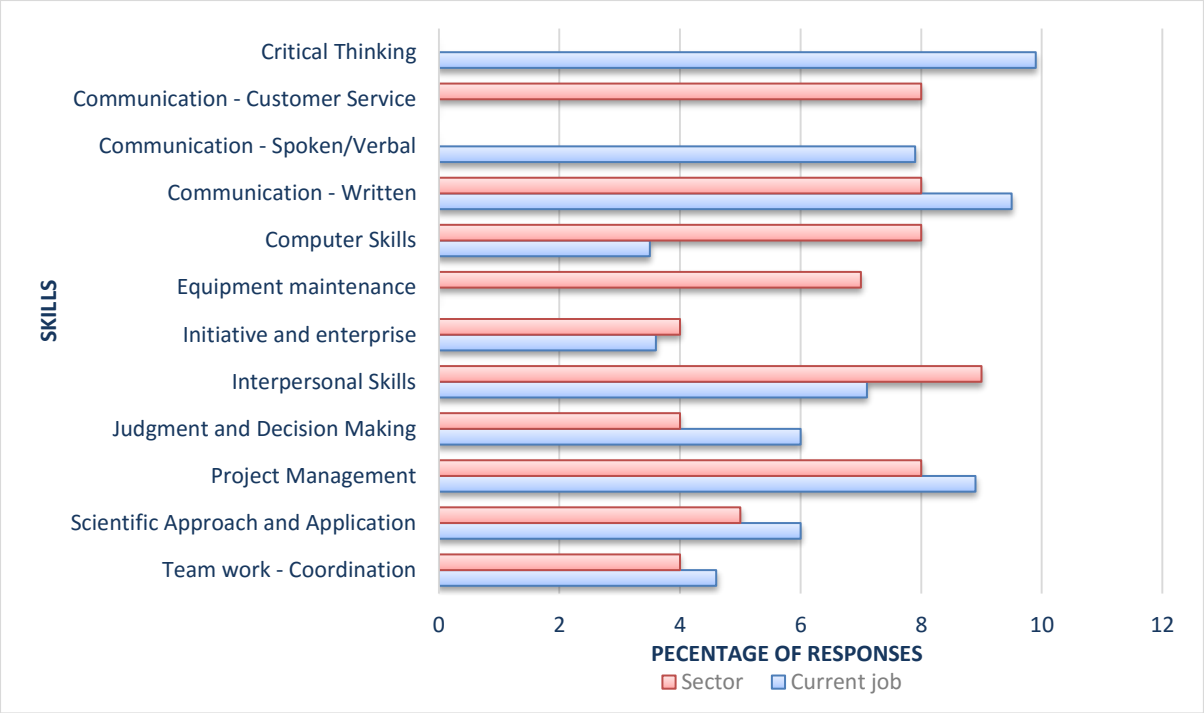

Figure 4 - Comparison of generic skills for current job and experience in the sector

Skill (listed in Total rank order, from most to less frequent)	**Skill 1 Count**	**Skill 2 Count**	**Skill 3 Count**	**Total Count**	**Total %**
Knowledge, of specific environmental aspects (e.g. sustainability, ecology, recycling)	140	84	56	280	26.0
Knowledge and/or expertise with broad concepts (e.g. systems thinking, ecological systems, strategic thinking, environmental management)	102	64	60	226	21
Knowledge and/or expertise with environmental tools/techniques (eg GIS, IT applications, auditing, sustainability reporting, education, policy/legislation, EIA)	69	76	55	200	18.6
Broad/general capabilities e.g. oral and/or written communication, critical thinking, interpretation of information, judgement, decision-making	24	52	67	143	13.3
Research ability (including development, analysis, reporting)		29	18	47	4.4
Field experience (e.g. fauna)	21	13	11	45	4.2
Management, of projects (development of plans and/or implementation), people		18	17	35	3.2
Business and/or economic understanding	3	8	14	25	2.3
Scientific approach (e.g. assessing data)		12	8	20	1.9
Broad experience and/or of specific sector/business (e.g. management)	6	7	5	18	1.7
Technical ability/skill	3	8	7	18	1.7
Ability to collect, analyse and/or interpret data	13			13	1.2
Modelling abilities (e.g. for water, air, systems)	5		2	7	0.6
Total				**1117**	**100**

Table 4 - Environmental/sustainability specific skills, knowledge or experience for current job

Skill (listed in Total rank order, from most to less frequent)	**Skill 1 Count**	**Skill 2 Count**	**Skill 3 Count**	**Total count**	**Total %**
Knowledge and/or understanding of environment management tools (e.g. GIS, EIA, environmental planning, policy/legislation, environmental reporting, environmental education)	18	29	22	69	23.2
Knowledge, of specific environment aspects (e.g. water, air, ecosystems, biology/zoology)	37	20	10	67	22.6
Broad capabilities e.g. oral and/or written communication, critical thinking, interpretation of information written communication, critical thinking, multi-disciplinary approach, interpretation of information	16	12	21	49	16.5
Management, and understanding of environment aspects (e.g. water, waste, air, ecosystems, sustainability)	8	8	10	26	8.8
Field experience	6	3	7	16	5.4
Business and economic understanding		13	3	16	5.4
Personal capabilities (e.g. passion, empathy)	5	6	2	13	4.4
Research ability (including development, analysis, reporting)	4	4	5	13	4.4
Management, of projects, people	3	5	2	10	3.4
Technical skills, including IT, modelling	4	2	2	8	2.7
Management, of energy, GHG	4			4	1.3
Practical approach to management			3	3	1.0
Project development/co-ordination		1	1	2	0.7
Goal setting and strategy development	1			1	0.4
Total				**297**	**100**

Table 5 - Environmental / sustainability specific skills, knowledge or experience – for work in the environmental / sustainability sector to date

The importance of types of generic skills can also be inferred by the more diagrammatic representation of the 'top band' data in Figure 4. Here skills that can be thought of as more associated with management have a higher 'ranking' for 'current' jobs than for 'sector' wide; i.e. communication – written, judgment and decision making, and team work – coordination. By contrast interpersonal skills and computer skills are both ranked much higher as sector skills. An emphasis on computer (i.e. technical) skills could be anticipated for the early years of a career, but it is surprising that the data also suggest that interpersonal skills are also more relevant in the early years. Perhaps, like computer skills, the participants have largely assumed that these skills are developed in first stages of a career and, while still important, are skills that become 'part of the professional'. Whereas, the more management related generic skills have greater utilisation as people advance in their profession. Overall it appears that while Lum (2009) relates the application of generic skills to specific contexts, the variety of participants and their jobs suggest that many of the generic skills identified have wide currency across the environment profession.

For specific skills the overall results for current jobs and sector wide work, presented in Table 6, show both similarities and differences. A clear indication was given that knowledge of specific topics was most important for current jobs[3]; while being a close second for sector wide positions. Knowledge and/or expertise with broad concepts, associated with physical systems (e.g. ecology, systems) and with social and political systems (e.g. auditing, reporting, policy) were also of notable importance for current jobs, while knowledge and/or expertise associated with social and political systems was identified

[3] Identification of 'knowledge' is the key descriptor of the skill, whereas the identification of a specific topic can be interpreted to demonstrate the particular interest area of the participant

Skill 1, 2 and 3 (listed in Total rank order, from most to less frequent)	**Current job Total Count**	**Current job Total %**	**Sector Total Count**	**Sector Total %**
Knowledge, of specific environmental aspects (e.g. sustainability, ecology, recycling)	280	26.0	67	22.6
Knowledge and/or expertise with broad concepts (e.g. systems thinking, ecological systems, strategic thinking, environmental management)	226	21	na	na
Knowledge and/or expertise with environmental tools/techniques (e.g. GIS, IT applications, auditing, sustainability reporting, education, policy/legislation, EIA)	200	18.6	69	23.2
Broad/general capabilities e.g. oral and/or written communication, critical thinking, interpretation of information, judgement, decision-making	143	13.3	49	16.5
Research ability (including development, analysis, reporting)	47	4.4	13	4.4
Field experience (e.g. fauna)	45	4.2	16	5.4
Management, of projects (development of plans and/or implementation), people	35	3.2	10	3.4
Business and/or economic understanding	25	2.3	16	5.4
Scientific approach (e.g. assessing data)	20	1.9		
Broad experience and/or of specific sector/business (e.g. management)	18	1.7	na	na
Technical ability/skill	18	1.7	8	2.7
Ability to collect, analyse and/or interpret data	13	1.2	na	na
Modelling abilities (e.g. for water, air, systems)	7	0.6	na	na
Management, and understanding of environment aspects (e.g. water, waste, air, ecosystems, sustainability)	na	na	26	8.8
Personal capabilities (eg passion, empathy)	na	na	13	4.4
Management, of energy, GHG	na	na	4	1.3
Practical approach to management	na	na	3	1.0
Project development/co-ordination	na	na	2	0.7
Goal setting and strategy development	na	na	1	0.4
Total	1117	100	297	100

Note: na indicates the category did not appear in the responses for the indicated job category.

Table 6 – Combined specific skills 1, 2 and 3: environmental/sustainability specific skills, knowledge or experience for current job and work in the environmental / sustainability sector to date

for work in the sector. For both current jobs and sector work, broad/general capabilities (e.g. communication, judgement) were the next important skills. Other skills were substantially less frequently noted.

With the range of responses, and interpretation needed to develop the categories of skills, it is inferring too much from the data to be confident about any clear trend; such as whether, compared with sector work, current jobs prioritise broad concepts. To determine such trends additional research and more detailed interrogation of participants would be required. However, that 'management, and understanding of environment aspects' has a degree of importance for sector wide work is noticeable, and again suggests that those in the early years of their career had a focus on the technical aspects of their profession.

These results could be assumed to reflect the experiences of environmental professionals within Australia, and possibly in other countries. To assess the likelihood of this we can determine the extent to which the results align with the findings of other studies. Unfortunately, as indicated previously, there is a range of skills that have been identified by reference to theory, and by surveys of students, professionals and employers. These sources have their own list of skills, and while there is considerable overlap across these lists, at least in terms of the concepts underlying the skills, there is no single list of skills that stands out. In light of this complexity, the overview and integration of concepts from much of the earlier work, and development of a concise list of broad/generic skills by Wiek et al. (2010 and 2016) allows some comparison with others' experience. This comparison is presented in Table 7, in regard to the generic skills reported in Tables 1 and 2. All the reported skills can be seen to be associated with the concepts underlying the theoretical skills. While only in the case of 'interpersonal skills' does the terminology of the two lists of skills align exactly, the results of the survey of Australian professionals indicates a close association with the lists of skills that have been derived as sustainability skills, based on international research.

Further, the reported generic skills have much in common with the employability, or soft, skills discussed by Deloitte Access Economics (2017) and Department of Education, and Employment and Workplace Relations (2010a), as skills needed in the Australia workforce. Specifically the skills of communication, team work and problem solving, which had all been noted, are all among the frequently

Skill identified by Wiek et al, (2010 and 2016) Survey reported generic skill	Systems thinking	Anticipatory	Normative	Strategic	Interpersonal	Integrated problem-solving
Critical Thinking	associated		associated	associated		
Communication - Written					related	
Project Management	associated	associated		associated		associated
Communication - Spoken/Verbal					related	
Interpersonal Skills					related	
Judgment and Decision Making		associated		associated		
Scientific Approach and Application	associated			associated		
Team work - Coordination					related	associated
Initiative and enterprise		associated	associated			associated
Computer Skills		associated	associated		associated	

Notes
associated = reported skill would be *associated (a component)* of the identified skill
related = reported skill would be *very closely related* to the identified skill
. *Systems thinking* – the ability to understand and analyse the interplay between systems (environmental, social, economic) (Wiek et al. 2010, 207).
. *Anticipatory* - the ability to craft 'pictures' of the future based on effective analysis and evaluation of sustainability issues and problem-solving frameworks (Wiek et al. 2010, 207-209)
. *Normative* – an ability to assess the current sustainability of social-ecological systems using normative sustainability knowledge as well as the ability to craft more sustainable visions for these systems (Wiek et al. 2010, 209)
. *Strategic* - the skill includes an understanding of concepts such as path dependencies, and barriers; but more importantly an understanding of how to get things done (Wiek et al. 2010, 210).
. *Interpersonal* – broadly the skill set for advanced stakeholder engagement including negotiating, deliberating, collaboration and leadership skills (Wiek et al. 2010, 211).
. *Integrated problem-solving* – the ability to apply different problem-solving frameworks to complex sustainability problems and develop viable solution options. (Wiek et al. 2016, 251)

Table 7 – Comparison of reported generic skills with literature derived skills

reported skills. In addition, there is an alignment with the skills that have been identified as goals for university level teaching programmes; i.e. those that educate the future professionals. As noted earlier, at the international level the OECD (2005) had proposed three broad categories of skills (their competencies) to be developed by graduates. Again, the generic skills reported in this research show considerable complementarity, particularly regarding the categories of 'using tools' and 'interacting in heterogeneous groups'. However, the reported skills indicate that the category of 'acting autonomously', especially in relation to the survey participants being reflective and acting within an ethical framework, is not evident. Further research, in both the broad Australian and international contexts, is needed to examine the veracity of these observations.

Looking at which skills would be relevant to graduates of the environment/sustainability discipline, the broad generic skills noted earlier by Higher Education Academy (2006) and Rees et al. (2006) have overlap with the reported generic skills. There is also commonality to be seen in the specific skills these researchers outlined, with the specific skills reported in Tables 5 and 6; particularly regarding their 'knowledge' and 'practical' skills lists. In the Australian context, a set of learning outcomes has been established, in 2015, for graduates of environment and sustainability bachelors programmes (Phelan et al. 2015). These outcomes are grouped under four broad groups and can be summarised as:

- Transdisciplinary knowledge - a broad and coherent knowledge of: environments and their social interdependencies; environment and sustainability challenges; holistic systems thinking.
- Systemic understanding – approaches for conceptualising environmental and sustainability challenges; different frameworks for knowing;

individual and others' values; values of indigenous peoples globally.
- Skills for environment and sustainability - well-developed cognitive, technical and communication skills through a range of issues (covering research, envisioning, applying tools, collaborative work, communicating, engaging).
- Ethical practice - ethical professional, public and personal conduct by having capacity to: reflect on learning and practice; participate in decision-making consistent with principles of sustainable development.

Comparing these with the survey results there is a reasonable degree of similarity in the ten highest ranked generic skills (Tables 1 and 2) with the grouping 'skills for environment and sustainability'; particularly regarding application of tools, collaborative work, communication. Likewise for the reported specific skills (Tables 4 and 5), there are clear similarities with specifics of both 'transdisciplinary knowledge' and 'skills for environment and sustainability'. Again, though, there was little indication from the participants that aspects of 'systemic understanding' or 'ethical practice' were important; e.g. regarding different frameworks for knowing, individual and others' values, ethical conduct, or reflect on learning and practice.

However, the learning outcomes were released in 2015, only a year before the survey was undertaken, While prior to this academic staff of some programmes may have been thinking about curriculum change to meet these outcomes, it would be very unlikely that any students would graduate, with the full set of outcomes, before 2020; given the time to implement curriculum change, and for students to progress through a 3-4 year program. Further, over 80% of the participants were over 30 years of age, and almost 80% had been working in the environmental sector for more than 5 years, Hence, it may be that a small proportion of participants had been exposed to recent curriculum that contained some aspects of reflection, diversity and ethics (e.g. since 2005), it would not be possible for any participants to experience the full set of learning outcomes.

In this situation it would not be reasonable to suggest that the participants were deficient in terms of some of the recent learning outcomes, but it suggests that some 'in-service' or 'professional development' may be valuable, to cover different frameworks for knowing, individual and others' values, ethical conduct, and reflection on learning and practice. Yet, since the survey did not specifically ask related questions, further research would be appropriate to determine if a gap actually exists, or whether the survey participants felt that these aspects were inherent in the professional ethics of the environmental profession, and/or in their work practice.

Conclusions: While the survey did not attempt to be comprehensive and include all environmental professionals, it achieved responses from professionals, from all jurisdictions across Australia, in numbers that can be taken to be representative of situation in Australia; if not further afield. In line with the aim of the survey these professionals indicated the critical generic skills for being an environmental professional, being:

- communication (written)
- project management
- interpersonal skills
- judgment and decision making
- scientific approach and application; team work (coordination)
- initiative and enterprise
- computer skills

These are considered to be important skills for specific (current) jobs and for working in the sector generally. Both 'critical thinking' and 'communication (spoken/verbal)' were considered to be among the highly ranked skills for their current jobs, but were much less highly ranked for respondents' sector-wide professional experience. Contra-wise, neither 'communication (customer service)' nor 'equipment maintenance' were of high importance for current jobs, but were so in the sector-wide context.

Arising from these findings are observations that generate thoughts relating to the profession. Firstly, given that 'critical thinking' and 'communication' are frequently identified by researchers as being among the most important skills (e.g. Rees et al. 2006), that they are not highlighted for sector-wide jobs is surprising. Remembering that the respondents' age profile and time working in the profession both indicated that most would have middle or senior positions, the implication is that the results for the 'current job' skills relate to these level positions, which are likely to entail a high component of management related activities. In parallel, it appears that skills more closely associated with 'technical' activities, such as 'equipment maintenance', have been considered to be associated with the more junior positions, and sector-wide experiences.

However, it would be concerning if skills like 'critical thinking' and (non-written) 'communication' were not promoted in junior positions, given that graduates entering the profession will have been given to understand, by research about the profession and the likes of graduate learning outcomes (e.g. Higher Education Academy, 2006;

Wiek et al. 2011), that these skills are very important. If the entering graduates are not encouraged, or able, to use these skills, then they could become disgruntled professionals.

Secondly, results from this research demonstrate that, to date, the skills identified by practitioners are closely aligned with those that have been promoted in the relevant literature. That this is the case could be expected, since frequently information in the literature has been derived from similar practitioners, and it has not been unusual for practitioners to be involved in the development of the educational experiences for professional; i.e. through advice to environment/sustainability programmes, and/or contributions to processes to guide educational outcomes, such as the learning outcomes developed for Australia (Phelan et al., 2015).
The results suggest, fourthly, that practitioners are focused on skills needed for 'getting the job done' (e.g. project management and team work), but show little recognition of what the 'job is and its implications'. Specifically there was little indication of importance of aspects of 'normative skills' (discussed by Wiek et al., 2011), which are similar to the 'systemic understanding' and 'ethical practice' learning outcomes identified by Phelan et al. (2015). Nor was there any indication of a role for 'intervention competence', identified by Perez Salgado et al. (2017). This suggests little recognition of frameworks for knowing, values, ethical conduct, and acting/intervening, or reflection on learning and practice. These aspects may be understood, and practiced, but it is not indicated by the results. So, further research is warranted to see if these aspects are evident in any of the thinking, and practice, of current environmental professionals. If it is lacking, then a case could be made for professional development activities to redress any deficiency.

Finally, irrespective of the outcome, the implication of such research will be a need for the environment profession to consider the role of 'normative skills'. With these types of skills being highlighted to students undertaking environmental programmes, through learning outcomes, it would be reasonable for the graduates of these programmes to expect to apply their skills in the workplace. If it is found that 'normative' skills are not being applied by practicing environmental professionals, then work needs to be done to determine why this would be the case. Should normative skills be found to be irrelevant there are implications for the Australian learning outcomes, programmes' curricula, and perhaps the ethical base of the profession. If these skills are relevant, then there is a pressing need to investigate why normative skills are not operating in the workplace, and what is needed to ensure they are practiced.

The survey results provide a snap-shot of the skills base of the environmental profession. By no means does this snap-shot provide universal nor unchanging understanding of the profession. Rather it points to areas of research to seek understanding of the skills that future entering professionals will need, and how educational institutions will develop the skills in graduates; given fast moving climate change, alongside the continuing roll-out of artificial intelligence and automation in work-places.

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