ECOLOGICAL SKILLS
SHAPING THE PROFESSION FOR THE 21ST CENTURY

Phase 1 Research Report
prepared by
The Management Standards Consultancy Ltd

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PREFACE

The Cambridge Advanced Learner's Dictionary describes a professional as a person having the type of job that requires a high level of education and training. Certainly professional ecologists and environmental managers will have undertaken specific programmes of higher education study and sought opportunities to extend and update their knowledge and skills through ongoing training and professional development throughout their careers. Indeed IEEM members are required to undertake continuing professional development as a condition of membership in recognition of their professional responsibility to ensure that they are equipped with the most up-to-date knowledge and skills to discharge their roles effectively.

But what if those higher education programmes and the training and professional development opportunities available are not fully aligned to the needs of employers working to deliver effective biodiversity management and enhancement? Ecological and environmental management techniques do not stand still. They are based on ongoing scientific research and are delivered within a continually developing policy and legislative framework. It is the responsibility of leaders within a profession as a whole to ensure that the education, training and professional development that underpins practitioners’ expertise is up to date, relevant and meeting the needs both of the profession and of society as a whole.

Increasing anecdotal evidence has suggested that there was an emerging skills gap as well as the prospect of skills shortages within our profession. IEEM undertook to seek evidence of the validity of the skills gap, its scope and scale and, if appropriate, identify action to be taken to address the gaps and prospective skills shortages. This research project was commissioned by IEEM but engaged with key stakeholders who provide ecological services and those who play an active role in supporting and/or delivering education, training and professional development in our field. As the results show, there is real reason for concern but also belief that concerted and appropriate action can be taken to address the issues that have been identified.

Any profession must ensure that the necessary training, guidance and support are available to its members throughout their careers in order that they are able to do their jobs properly. But also those practitioners must be able to demonstrate that they are fully competent to undertake the work required of them. These challenges are substantial in a profession that is currently largely unregulated and with practitioners entering it through diverse routes. A brief look at the structures and support for some other professions that ecologists and environmental managers commonly work with, e.g. landscape architects, civil engineers and surveyors, suggests that they have sought to be more prescriptive with respect to both career paths and the expectations along the way of higher education, the professional institute, other training providers, and the individual professional. Such a route may offer the ecological and environmental management profession part of the solution to address the skills gap.

Why does this matter? The natural environment is under increasing pressure. The Countdown 2010 targets to halt biodiversity loss have been missed. Climate change is impacting on species distribution and survival, as well as the availability of natural resources. The drive for economic recovery is seen by many as being at odds with biodiversity protection and the prospect of
planning reform is viewed as a potential threat to our cause. Yet post-Nagoya\(^1\) there is a renewed determination by many governments to perform better in protecting the natural environment. In the UK and Ireland there is the very recent development of new policy frameworks, a recognition of the need to better understand and value the services that ecosystems provide and to put the protection and enhancement of these services at the heart of decision-making. There are opportunities for our profession to lead, influence and implement changes to the way we manage our environment. But in order to do so we must make sure that we have the necessary knowledge and skills, that we recognise and promote competent practice and that we set and maintain the highest standards for our profession.

In commissioning this research IEEM has sought not only to establish whether a skills gap and/or skills shortages exist but also, should their existence be supported by the available evidence, to raise awareness of the risks to our natural capital if not addressed. The report provides a basis for discussion and decision making as to how the Institute and other stakeholders respond to the challenges that lie ahead.

*Prof Max Wade CEnv, FIEEM*
*Chair, Ecological Skills Project Board*

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\(^1\) The United Nations Environment Programme Convention on Biodiversity Conference of the Parties (COP 10) held in Nagoya, October 2010
SUMMARY

The Ecological Skills Project arose out of concern amongst IEEM members and stakeholders regarding a potential skills gap in the profession. Anecdotal evidence implied a gap in the availability and competence of qualified ecologists and environmental managers able to undertake a wide range of relevant employment roles both now and in the future. (The term ‘skills’ is used in the broad sense of education, training and continuing professional development.)

Employers such as the statutory government agencies (e.g. Natural England, Countryside Council for Wales, Environment Agency, Environmental Protection Agency (Ireland)), ecological consultancies, NGOs and local authorities had all expressed concerns. Indeed, there were indications to suggest that the core skills required for competent ecological or environmental management practice were being lost from undergraduate and postgraduate degree courses in the UK and Ireland. If validated, such skills’ erosion could seriously affect the profession’s ability to meet the challenges of biodiversity loss, a changing climate and other environmental pressures.

Phase One of the Ecological Skills Project set out to:

- evaluate the evidence for a skills gap;
- if present, analyse its nature, scale, significance and causes;
- engage with stakeholders in identifying a strategy for closing any skills gap; and
- build partnerships amongst stakeholders in order to implement an agreed strategy.

In September 2010 the Institute commissioned The Management Standards Consultancy, to undertake a research project to address these points. The attached report outlines the findings of the research and signifies completion of Phase One of the Ecological Skills Project.

Research Methods

A wide range of research methods – literature review, analysis of data on IEEM members’ initial education and training and continuing professional development, online surveys of professionals and their employers, interviews with key stakeholders and a technical workshop – has been used to paint a reliable picture of current levels of knowledge and skills and to determine options for addressing existing or potential deficits.

Knowledge, Skills and Applications Framework

To facilitate the gathering and classification of data, a high-level Knowledge, Skills and Applications Framework (KSA Framework) for Ecology and Environmental Management has been developed, listing the key requirements for ecologists and environmental managers under four sections:

- knowledge;
- specialist skills;
- transferable skills;
- applications.
This KSA Framework has been refined through consultation with stakeholders and consensus has been reached that it covers all the requirements at a high level. The development of additional levels of detail will enable its use as a tool for the strategic development of professional competence.

**Knowledge and Skills Gaps**

The research has identified that, whilst many core areas of knowledge and skill are adequately covered by existing higher education courses and continuing professional development provision, there are a number of gaps that need to be addressed.

<table>
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<th>Knowledge Gaps</th>
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<tr>
<td>• Environmental economics, including understanding of ecosystem goods and services</td>
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<td>• Freshwater, coastal and, especially, marine systems and processes</td>
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<td>• Environmental legislation and policy</td>
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<td>• Microbiology, including microbes in marine biotopes(^1), micro aquatics, micro invertebrates, plant pathology and biosecurity</td>
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<td>• Spatial planning systems</td>
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<tr>
<td>• Construction techniques to mitigate threats to habitats</td>
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\(^1\) = an area that is uniform in environmental conditions and in its distribution of animal and plant life

<table>
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<th>Specialist Skills Gaps</th>
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<tr>
<td>• Taxonomy and systematics</td>
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<tr>
<td>• Species identification skills, particularly in respect of: invertebrates, fish, lower plants, lichens, algae and fungi</td>
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<tr>
<td>• Ecological survey, sampling, analysis, assessment, evaluation and monitoring skills in respect of: invertebrates, fish and bird communities</td>
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<tr>
<td>• Undertaking Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA)</td>
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<tr>
<td>• Habitat creation, restoration and management in marine, coastal and upland environments</td>
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<td>• New technologies, particularly IT, mobile technology and genetics</td>
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<td>• Tackling invasive species and the spread of diseases</td>
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<td>• Landscape-scale Approach, recognising the importance of ecological networks and connectivity</td>
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<th>Transferable Skills Gaps</th>
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<td>• Written communication, particularly writing reports that address the key questions and show the evidence that support the findings</td>
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<tr>
<td>• Project management and contract management</td>
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<tr>
<td>• Management and accessibility of data</td>
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<td>• Influencing and stakeholder engagement</td>
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<td>• Financial management</td>
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<td>• Risk analysis and management</td>
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Gaps in knowledge and skills are not evenly spread across the profession. The high volume of responses to the online surveys, particularly the professionals’ questionnaire, has allowed more
sensitive analysis to identify the priority gaps by organisational context, biotope\(^2\) and length of experience. For instance, as in many professions, the demand for specialist knowledge and skills increases over the first ten years of practice but then decreases as some senior professionals take on more strategic roles and spend more of their time supervising others carrying out professional and technical activities.

**Implications for the Future Education, Training and Professional Development of Ecologists and Environmental Managers**

The findings of this research have important implications for the education, training and ongoing professional development of ecologists and environmental managers, which need to be addressed. A failure to do so could significantly undermine the UK and Ireland’s capacity to meet their post-Nagoya 2020 and 2050 biodiversity targets. At a time when the UK and Irish Government and devolved administrations are revising their natural environment policy frameworks and creating new mechanisms to achieve these targets, a continuing skills gap and skills shortage must not be allowed to compromise effective delivery.

**Recommendations**

The five key recommendations are summarised in the boxes below.

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<tr>
<td>A strategy for the education, training, career and professional development of ecologists and environmental managers should be developed, including:</td>
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<tr>
<td>• the definition of a set of core competences;</td>
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<td>• the definition of role profiles;</td>
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<td>• a system of accreditation of first degrees and postgraduate courses based on a detailed Knowledge, Skills and Application Framework (see below);</td>
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<td>• the definition of competence requirements linked to recognised professional standards;</td>
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<td>• the production of materials and activities for secondary school and post-16 students to promote the career opportunities for ecologists and environmental managers;</td>
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<td>• planning tools to help ecologists and environmental managers develop their careers and the competences required to take the next step;</td>
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<td>• a system of accreditation for short courses;</td>
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<td>• the accreditation of professionals’ specialist areas of competence;</td>
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<td>• a structured approach to continuing professional development (CPD);</td>
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<td>• support to employers in providing structured professional development programmes.</td>
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\(^2\) The term ‘biotope’ as used in this report refers to geographical sub-unit of the biosphere that can be delimited by convenient boundaries and characterised by its fauna and flora (e.g. marine, freshwater, terrestrial and coastal areas).
Further Development of the Knowledge, Skills and Applications Framework

The Knowledge, Skills and Application Framework should be developed further, in particular:

- expanding each of the knowledge, skills and applications to finer levels of detail;
- developing levels that describe the various depths of knowledge or skill required by professionals at different stages in their careers.

Addressing Priority Knowledge and Skills Gaps and Shortages

A strategy for addressing the priority knowledge and skills gaps and shortages identified in this research should be produced to stimulate the development of a range of accessible, flexible and affordable learning opportunities.

The identified priority knowledge and skills requirements should be published.

Members of the profession should be encouraged and supported to address their individual CPD needs in the priority areas, either through self-study or through a range of accredited courses and other learning opportunities within their CPD.

Assuring the Quality of Professional Work

To ensure that ecologists and environmental managers deliver work to the highest standards (for example in survey work) a needs-based programme of training, tools and good practice guidance should be provided.

Processes should be identified to support the development and maintenance of individual standards of practice.

Self-regulation of the profession should be promoted through membership of an appropriate professional body, with mechanisms in place to take action against those who practice outwith their level and area of competency.

Communicating the Importance of the Natural Environment, Biodiversity and the Value of Ecosystem Goods and Services

Communicating to and influencing politicians, policy makers, other professionals and the public of the importance and value of the natural environment and biodiversity and the ecosystem goods and services they provide is fundamental to meeting biodiversity targets and hence human welfare requirements.

Formulating a communications strategy to:

- develop greater understanding and valuing of the role of ecologists and environmental managers in protecting and enhancing our natural assets; and
- distinguish and promote career opportunities to attract individuals into the profession.
1. INTRODUCTION

1.1 Until now, anecdotal evidence has provided the only basis to support claims of skills shortages and/or gaps in the ecological and environmental management professions. Such was the importance to the profession to verify the evidence, that IEEM initiated the Ecological Skills Project (ESP) in 2008; its remit to establish the validity, magnitude, nature and causes of any skills shortages and gaps, recognising that there are differences according to the professional context in which individuals are working.

![Fig 1. Variables in the Professional Context of Ecology and Environmental Management](image)

1.2 The ESP began and concluded its work through direct stakeholder engagement by holding workshops with a wide range of interested parties. These included: Government, statutory agencies (nature conservation and environment), NGO, Lantra, academia and consultants across the UK and Ireland, many of whom are IEEM Members.
1.3 In September 2010 The Management Standards Consultancy Ltd was appointed to support IEEM in identifying the future skills\(^3\) needs in ecology and environmental management and highlight any actual or potential skills gaps\(^4\) or shortages\(^5\). The consultants’ brief was to help the Ecological Skills Project Board to:

- appraise the magnitude of any skills gap within the profession of ecology and environmental management relative to the needs of employers
- appraise its nature and causes
- raise awareness and understanding of the scale and significance of the skills gap
- engage with stakeholders in identifying a strategy for closing the skills gap
- build partnerships amongst stakeholders to implement an agreed strategy.

1.4 Chapter 2 describes the methodology adopted by the consultants and the initial findings.

1.5 Chapter 3 reports the initial findings from each strand of the research.

1.6 Chapter 4 describes the underpinning drivers and challenges, drawing both on the Environment Research Funders Forum (ERFF) research and the primary research undertaken during the current project.

1.7 Chapter 5 explains the Knowledge, Skills and Applications Framework for ecologists and environmental managers, its development and how it may be developed and applied.

1.8 Chapter 6 summarises the priority skills gaps and shortages emerging from the quantitative and qualitative research.

1.9 Chapter 7 considers the implications of the findings for future policy and practice in the education, training and continuing professional development of ecologists and environmental managers.

1.10 Chapter 8 sets out recommendations to ensure a sufficient supply of ecologists and environmental managers with the necessary knowledge, skills and competence to meet future challenges.

1.11 Annexes A, B and C look in detail at the particular skills requirements, gaps and shortages for different populations of ecologists and environmental managers.

- Annex A covers the different contexts in which ecologists and environmental managers work – consultancy, industry, land/sea management, research, statutory, teaching.
- Annex B looks at the differences in requirements according to the in which professionals are working, and how well their skills meet these requirements.
- Annex C investigates the differences in skills requirements and levels of confidence at various stages in professionals’ careers.

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\(^3\) The project has taken a broad definition of skills to include the concepts of knowledge (what the professional needs to know), skills (what the professional needs to be able to do) and applications (the ability of the professional to apply their knowledge and skills to achieve the outcomes required in their work context).

\(^4\) Skills gaps refers to deficiencies in the current levels of skills of individual professionals (ie where they need to develop new knowledge, skills or applications).

\(^5\) Skills shortages refers to deficiencies of skills in the labour market (ie where employers have difficulty in finding applicants with the necessary knowledge, skills and competence).
2. METHODOLOGY

2.1 The research into the skills requirements, gaps and shortages of the ecology and environmental management profession comprised: a literature review; desk analysis of existing data; field research and analysis.

![Ecological Skills Project Research Structure](image)

**Literature Review**

2.2 IEEM supplied a wide range of documents (listed in Annex 1) for review to answer the following research questions:

- What are the future priorities and/or directions in the fields of ecology and environmental management in the next 5 – 10 years?
- What skills will be needed by ecologists and environmental managers to support the future priorities and direction of the profession?
- What are the current key trends, developments, challenges and policy drivers affecting ecologists and environmental managers?
- What are the current skills (specific and generic) of ecologists and environmental managers in the UK and Ireland?
- What are the current learning processes, qualifications and professional membership requirements for ecologists and environmental managers in the UK and Ireland?
• What learning processes, qualifications and professional membership appear to be expected and what will be required to support the future priorities and direction of ecologists and environmental managers (including what employers are looking for)?

2.3 Of the documents reviewed, the following were found to be particularly helpful in answering these questions:

• IEEM (Revised 2010) Career Planning and Development in Ecology and Environmental Management (widely known as ‘Annex A’)
• British Ecological Society (BES) and IEEM (2007) Rooting for a Career in Ecology or Environmental Management?
• Linnean Society (2010) Systematics and Taxonomy – Priorities for the Future
• TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Desk Analysis of Graduate and Associate Member Survey Results

2.4 A survey with a mixture of pre-coded and open questions was designed by IEEM and distributed to its Graduate and Associate Members in 2009 to find out about their roles, their skills needs and how well these were being met by their initial education and Continuing Professional Development (CPD) opportunities.

2.5 384 respondents completed the survey, of whom 57% were Graduate Members and 43% were Associate Members. The vast majority of respondents to the Graduate and Associate Member survey consider themselves to be generalists rather than specialists.

Desk Analysis of Continuing Professional Development Records

2.6 Graduate, Associate, Full Members and Fellows of IEEM supply an annual Continuing Professional Development (CPD) record detailing any skills developed (sector specific and/or generic), the provider of the course/training, whether the training was structured and the number of hours spent on their continuous professional development.

2.7 761 records completed by members in 2009-10 were analysed to identify:

• the key sector specific skills members developed
• the key generic skills members developed
• the nature of the CPD (structured or unstructured).

Online Survey of Professionals (individual members)

2.8 An online professionals survey (December 2010) was completed by 696 individual IEEM members (not including students).

2.9 The online questionnaire investigated the:

• types of work in which professionals are engaged
• the knowledge and skills required to carry out this work
• their level of confidence in their knowledge and skills to meet future demands.
2.10 The majority of respondents (51%) work in the consultancy sector, mainly in large consultancies (20%) or as sole traders (14%). The breakdown in Figure 3 closely mirrors IEEM’s membership, with the consultancy sector being slightly under-represented (59% of IEEM’s members work in consultancies) and the other sectors being correspondingly slightly over-represented.

Fig 3. Breakdown of Professionals Responses by Organisation Type

2.11 Figure 4 shows the percentages of respondents working in England, Ireland (including Northern Ireland), Scotland and Wales. This breakdown closely mirrors IEEM’s membership, with England being slightly under-represented (79% of IEEM’s membership is based in England compared with 72% for the respondents) and the other nations correspondingly slightly over-represented.

Fig 4. Breakdown of Professionals Responses by Nation
2.12 The majority of respondents, 80%, work mainly in the terrestrial biotope. 14% work mainly in the freshwater biotope, 4% in the coastal biotope and 2% in the marine biotope. The majority of respondents, however, work across more than one biotope.

Fig 5. Breakdown of Professionals Responses by Biotope

2.13 To understand the knowledge and skills required at different stages in professionals' careers, the survey asked how many years individuals had been practising since qualifying/graduating. Over three-quarters of respondents have been working for at least four years, and nearly half (45%) working more than ten years.

Fig 6. Breakdown of Professionals Responses by Length of Experience
Online Survey of Employers

2.14 An employers online survey (December 2010) was completed by 192 employers.

2.15 The online questionnaire investigated:

- the types of work in which the employing organisations are engaged
- the knowledge and skills required to carry out this work
- their level of confidence in their employees’ and job applicants’ levels of knowledge and skills to meet future demands.

2.16 It also explored any recruitment problems experienced by employers in order to identify any shortages in supply of suitably qualified professionals.

2.17 The majority of respondents (56%) were consultancy based; large consultancies employing more than 50 staff (19%) and small consultancies employing between 2-5 staff (15%). See Figure 7.

![Breakdown of Employers responses by organisation type: n = 192](image)

**Fig 7. Breakdown of Employers Responses by Organisation Type**

2.18 The majority (66%) are based in England. Figure 6 shows the percentages working in England, Ireland (including Northern Ireland), Scotland and Wales.
2.19 The majority (84%) work in the terrestrial biotope. 12% work in the freshwater biotope, 3% in the marine biotope and 2% in the coastal biotope. The majority of respondents, however, work across more than one biotope.

Fig 9. Breakdown of Employers Responses by Biotope

Fig 8. Breakdown of Employers Responses by Nation
Semi-structured Interviews with Key Stakeholders

2.20 In parallel with the online surveys for professionals and employers, the consultants conducted semi-structured interviews with a representative sample of key stakeholders from across the UK and Republic of Ireland selected by IEEM. The full list of stakeholder organisations interviewed is provided in the box below.

<table>
<thead>
<tr>
<th>Association of Local Government Ecologists (ALGE)</th>
<th>Freshwater Biological Association (FBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atkins</td>
<td>Farming and Wildlife Advisory Group (FWAG)</td>
</tr>
<tr>
<td>Belfast City Council</td>
<td>Golder Associates (Ireland)</td>
</tr>
<tr>
<td>British Trust for Ornithology (BTO)</td>
<td>Heritage Council, Ireland</td>
</tr>
<tr>
<td>Cardiff University</td>
<td>Linnean Society</td>
</tr>
<tr>
<td>Centre for Evidence-based Conservation, Bangor University</td>
<td>Marine Biological Association (MBA)</td>
</tr>
<tr>
<td>Cofnod (North Wales Environmental Information Service)</td>
<td>Natural England</td>
</tr>
<tr>
<td>Countryside Council for Wales (CCW)</td>
<td>Natural History Museum</td>
</tr>
<tr>
<td>Environment Agency</td>
<td>Open University</td>
</tr>
<tr>
<td>Fermanagh District Council</td>
<td>Parliamentary Office of Science and Technology</td>
</tr>
<tr>
<td>Forest Research</td>
<td>Royal Botanic Gardens Kew</td>
</tr>
<tr>
<td></td>
<td>Scottish Environment Protection Agency (SEPA)</td>
</tr>
</tbody>
</table>

2.21 The interviews were future-oriented, asking stakeholders to identify the current trends and future developments and their likely impact on the knowledge and skills requirements of ecologists and environmental managers.

2.22 The interviews also invited experts to review the draft KSA Framework for Ecologists and Environmental Managers and to either confirm its completeness or recommend amendments.

2.23 The list of key stakeholders was determined so as to provide representation across all nations, sectors and biotopes and to balance out any bias due to the self-selecting nature of the quantitative surveys. Almost all organisations approached were willing to be interviewed, some with multiple respondents.

Technical Workshop

2.24 A Technical Workshop was held on 10 February 2011 and attended by 47 invited experts.

2.25 The purpose of the workshop was to:
   - verify the emerging research findings
   - confirm the key issues
   - deliberate options for addressing the priorities.

2.26 Participants reviewed the KSA Framework and, through specialist sector groupings (statutory, industry, applied research, conservation management, higher education), considered priority issues.

2.27 Participants at the Technical Workshop were determined so as to provide representation across all nations, sectors and biotopes (see Annex E for list of participants). A limitation of the Technical Workshop is that not all invitees attended (although many sent substitutes) and there was no representation from Ireland.
Limitations and Mitigation

2.28 The quantitative elements of the methodology (Graduate and Associate Member Survey, IEEM Member CPD Records, Online Survey of Professionals and of Employers) have two key limitations: (a) they only surveyed IEEM members and (b) respondents were self-selecting.

2.29 It is possible that non-members and non-respondents have different knowledge and skills needs. However, this risk is to some extent mitigated by the volume of responses (696 respondents to the Online Survey of Professionals), representing a significant proportion of practising ecologists and environmental managers. This limitation is further mitigated by the qualitative elements of the methodology (Literature Review, Semi-structured Interviews with Key Stakeholders and Technical Workshop) that sought wider views and obtained validation of the emerging findings from experts representing the different stakeholder groups/organisations.

2.30 There were relatively few responses from professionals and employers working in the coastal and marine biotopes so these findings cannot claim to be representative of the skills needs of professionals working in these biotopes. These sectors were directly addressed through the Semi-structured Interviews with Key Stakeholders and through participation in the Technical Workshop.

2.31 Subsequent to the Technical Workshop further scrutiny of the revised KSA Framework was sought from the Marine Biological Association and the Freshwater Biological Association.
3. INITIAL FINDINGS
This chapter provides an overview of the initial findings from each strand of the research.

Literature Review
3.1 The following documents were found to be particularly helpful in answering the project’s questions (see 2.2) and were key sources for the KSA Framework, discussed in Chapter 4:

- **IEEM (Revised 2010) Career Planning and Development in Ecology and Environmental Management** (widely known as “Annex A”). This document provides a classified listing of the knowledge and skills germane to ecologists and environmental managers (dependant on their role). It also identifies four levels (basic, intermediate, operational, advanced), roughly equating to grades of IEEM membership (student, graduate, associate, full).

- **British Ecological Society (BES) and IEEM (2007) Rooting for a Career in Ecology or Environmental Management?** This publication provides information for individuals, schools and universities on the range of job opportunities available and the knowledge and skills required.

- **Environment Research Funders Forum (ERFF) (2010) Updated Postgraduate Skills Framework**. Focusing on research at postgraduate level across the full range of environmental sciences, this report identifies eight drivers of change, the challenges these create and the knowledge and skills required to address these challenges. It also begins to identify shortages of postgraduate knowledge and skills relating to research in specific areas. This report highlighted a number of underpinning drivers and challenges (Chapter 4) and also indicated a number of important skills shortages (Chapter 6).

- **Linnean Society (2010) Systematics and Taxonomy – Priorities for the Future**. This report makes a number of recommendations for maintaining and developing taxonomic expertise, including training and development, international cooperation, use of volunteers, quality control of data and improving the accessibility of collections and documentation. The more recent report, Professor David Cutler and Dr Ruth Temple (December 2010) *The Linnean Society of London Taxonomy and Systematics Review*, underpins these recommendations with data on the current level of taxonomic expertise and provides a list of priority actions.

- **TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB**. This report emphasises the importance of the climate change driver, the need for deeper dialogue between economists, climate scientists and ecologists, and the need for ecologists to have competence in a wide range of sophisticated economic models and tools.

Desk Analysis of Graduate and Associate Member Survey Results
3.2 Key findings from the pre-coded questions are:

- 47% of respondents agreed or strongly agreed that their undergraduate/postgraduate/further education courses provided them with sufficient knowledge to be proficient in their current job or the kind of job they are looking for, while 31% disagreed or strongly disagreed.
• Since completing their undergraduate/postgraduate/further education, the key areas in which respondents have needed to develop their knowledge and skills are:
  – field skills, surveying and species identification (45% of respondents)
  – legislation and policy (27%)
  – specialist information relating to the respondent’s area of expertise (19%).

• Respondents felt that the most important areas in which they need to develop skills to further their careers were:
  – taxonomy and species identification (66%)
  – protected species (63%)
  – habitat creation, restoration and management (63%).

• Respondents considered on-the-job training as the most effective method of learning new skills, followed by self-teaching, voluntary work and field-based courses. Day-release for education or training or sabbaticals for full-time education were considered less practical alternatives.

3.3 Key findings from the open questions are that:

• There are significant financial obstacles to gaining necessary skills and knowledge. Many respondents found courses expensive and gaining experience through voluntary work caused respondents to compromise either their financial situation or their career prospects.

• There are fewer positions for new ecologist available across all organisations, particularly consultancies, due to the current economic climate.

• Funding of training and development should mainly be provided by the employer. Respondents did acknowledge that employers’ budgets are limited and individuals have a responsibility for their own professional development.

• The content of current provision at undergraduate/postgraduate/further education levels tends to be focused on research skills. Courses lack both the commercial awareness required by ecologists and the understanding of the current demands of an ecological job.

• There is a lack of training courses in Ireland for ecologists.

• A mix of learning methods is essential to gain further knowledge and skills and become a good all-round ecologist or specialist.

• Lack of time for sharing experience and knowledge and training staff is an issue.

• IEEM workshops are considered to be invaluable for professional development; however, wider geographical availability is sought.
Desk Analysis of Continuing Professional Development (CPD) Records

3.4 The most popular areas for generic skills development were: Financial Management and Health and Safety, followed by Communication and Project Management. Figure 10 shows the full listing of generic skills developed and the balance between structured\(^6\) and unstructured\(^7\) development.

![Fig 10. Generic Skills Developed by IEEM Members through CPD](image)

3.5 The most popular areas for sector specific skills development were:

- **Survey Skills** (covering the theory or practical experience of any part(s) of the process, including: planning, survey techniques/methodologies, involved with collecting field data for monitoring, classification, assessment or research purposes)

- **Species Ecology** (aspects of a species' interactions with other individuals and its environment)

- **Species Identification** (increasing the ability to identify living things, by sight, by sound or by field signs, to the family/species/subspecies level, and between sexes within species. As such, may also include gaining a better understanding of taxonomy and anatomy, and the use or development of identification keys).

3.6 Figure 11 shows the full listing of sector specific skills developed and the balance between structured and unstructured development.

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\(^6\) *Structured CPD* includes attendance as a participant or lecturer at short courses, conferences and seminars; project experience (where this is new to the member concerned and involves a structured learning process); formal home study such as with distance learning; or participation on technical committees.

\(^7\) *Unstructured CPD* includes private reading and study, technical research for practical work, ‘on the job’ project work which is consciously and systematically undertaken within the work environment, and some lecture preparation.
Fig 11. Sector Specific Skills Developed by IEEM Members through CPD

3.7 Figure 12 shows the average number of hours a sample of members spent on IEEM courses from October 2009 – September 2010, according to their grade of membership.

Fig 12. Average Number of Hours Spent on IEEM Courses by IEEM Membership Grades
Online Survey of Professionals (individual members)

3.8 The overarching findings from this strand of research are reported in Chapter 6, with detailed examination by Context, Biotope and Length of Experience in Annexes A, B and C.

Online Survey of Employers

3.9 The findings from this strand of the research are not reported separately due to the small sample sizes responding to some of the questions. However, the overarching findings are incorporated into Chapter 6.

Semi-structured Interviews with Key Stakeholders

3.10 The views of the 23 organisations interviewed served to moderate the findings from the quantitative strands of the research. Rather than reporting these interviews separately, the views expressed have been integrated throughout this report, particularly in Chapter 4 Underpinning Drivers and Challenges, Chapter 6 Priority Knowledge and Skills Gaps and Shortages and Chapter 7 Education, Training, Career and Professional Development.

Technical Workshop

3.11 Whilst there were many suggestions for amending and improving the KSA Framework, which have been included in the revised version in Chapter 5, there was consensus that the KSA Framework could provide a common language to be used by educationalists, employers and professionals alike.

3.12 The priority issues to emerge from the Technical Workshop and options for addressing them can be grouped into five broad areas:

- **Education, training and professional development in ecology and environmental management requires a coherent structure that** will allow the:
  - identification of a set of core skills for graduates
  - identification of specific skills for job roles
  - structured planning of development of knowledge and skills for new roles and career progression
  - accreditation of courses – providing knowledge and skills through both traditional and innovative ways of learning (the KSA Framework could provide the required structure)
and recognises the need for continued practice throughout individuals’ careers so as to maintain and develop their skills.

- **Ecological skills, particularly those in species identification and taxonomy, are being eroded** through lack of field work and focus on these subjects in secondary and tertiary education and through the retirement of experts in these areas. This issue is well understood and is, in part, being addressed by changes to curricula and initiatives undertaken by the Natural History Museum, the Field Studies Council, the Linnean Society and others.

- **Ecosystems services** is a more recent concept, poorly understood by many ecologists and environmental managers and ignored by the public at large. Training and a coherent communications strategy, involving a wide range of stakeholders, will be needed to address this issue.
• **Technological developments**, particularly in GIS, genetics and data analysis, recording and management, are likely to radically change approaches to survey work which will require professionals to learn a new range of skills.

• Ecology and environmental management requires a **multidisciplinary approach** due to the nature of the work and the current scarcity of financial resources. Ecologists and environmental managers need to be recognised as having parity of status with other professionals, which implementation of the recommendations of this report will help achieve.
4. UNDERPINNING DRIVERS AND CHALLENGES

Findings from Environment Research Funders Forum Research

4.1 The Environment Research Funders Forum (ERFF) research, (see 3.1) identified eight drivers impacting on the knowledge and skills requirements in the environment sector for researchers at postgraduate level across the full range of environmental sciences. The ERFF drivers, listed below, are equally relevant to ecologists and environmental managers at all levels:

- climate change
- sustainable use of natural resources
- changing technologies
- changing ecosystems
- societal change
- economic-political change
- earth system science and natural hazards
- environment and health.

4.2 Following two years’ research, the summary document, ERFF (2010) Most Wanted: Skills Needs in the Environment Sector, prioritises the 15 most critical skills gaps for the environment sector:

- modelling
- multidisciplinarity
- data management
- numeracy
- translating research
- fieldwork
- risk and uncertainty
- taxonomy and systematics
- soil science
- environmental epidemiology
- sustainability science and planning
- microbiology
- food supply
- energy supply
- freshwater science.
Findings from the Ecological Skills Project Research

Similarities with the ERFF Research

4.3 Many of the items in this list of ‘most wanted’ skills concur with the key challenges emerging from this research, in particular:

- the requirement for ecologists and environmental managers to work effectively in **multidisciplinary teams** on a par with other professionals
- the need for improved collation and management (including quality assurance) of **ecological data** for national and international databases and access to these
- decline in the availability of both professionals and volunteers with **fieldwork skills in both species identification and survey methods and techniques** (including the use of advanced technologies)
- the need for ecologists to understand and manage **risk and uncertainty**, and, furthermore, to be able to communicate risk, uncertainty and probability to clients and policy makers
- the critical state of **taxonomy and systematics**, due to many factors, including the retirement of experts and the lack of investment in taxonomy by universities, statutory bodies etc.
- the need for ecologists and environmental managers to have knowledge, understanding and skills of **economic models and tools** so as to be able to plan for sustainable development and incorporate ecosystem values into Strategic Environmental Assessment, Environmental Impact Assessment, Sustainability Analysis and Biodiversity Offsetting
- **soil science, environmental epidemiology** (including biosecurity), **microbiology**, **energy supply** and its impact on the environment, and **freshwater science** were also priorities raised in our research.

Additional Challenges Identified in the Current Research

4.4 Other key overarching challenges identified during the current research, particularly through the Literature Review, Semi-structured Interviews with Stakeholders and the Technical Workshop, included:

- **reduced resources** for ecological and environmental management activities as a result of significant budget cuts across the statutory and education sectors and reduced margins in the consultancy and industry sectors in both Britain and Ireland
- constantly developing **legislation and regulations** and the lack of coherence between legislation at one level (e.g. European) and its application at another (e.g. national)
- **changes to the spatial planning system** and the devolution of powers to local and neighbourhood levels
- the lack of understanding of the concept of **ecosystem goods and services** amongst professionals, the public and policy makers
- the need to adopt an **evidence-based approach** to demonstrate the benefits of biodiversity and ecosystem services
• the challenge of **engaging stakeholders** at all levels, including clients, policy makers and the public

• the need to **mainstream ecology** and the challenge of communicating the value of the profession

• the need for ecologists and environmental managers to develop a different mix of specialist and transferable skills as they move through their careers. This involves the concept of the **T-shaped scientist** with basic level knowledge in a broad range of scientific topics (the top bar of the T), plus specialist knowledge (deep expertise) in a single topic (the upright).

**The Challenge of the Marine Environment**

4.5 A specific challenge emerging from those working in the marine environment is to develop professionals’ appreciation that marine planning and monitoring requires different methods and techniques to those employed on land.
5. KNOWLEDGE, SKILLS AND APPLICATIONS FRAMEWORK

5.1 Originally conceived simply as a tool for identifying, classifying and analysing skills needs, the KSA Framework for Ecologists and Environmental Managers has developed into an important output in its own right, since it identifies the core knowledge, skills and applications for the profession.

Development of the KSA Framework

5.2 The initial draft of the KSA Framework was based on the sources consulted in the literature review, particularly: IEEM’s Career Mapping for Ecologists and Environmental Managers, ERFF’s Postgraduate Skills Framework, LANTRA’s Functional Map of Environmental Conservation, and IEEM’s Membership Survey and CPD records. This was refined by the Ecological Skills Project Board and used in the online questionnaires for professionals and employers. This has subsequently been refined by nearly 1,000 responses from ecologists and environmental managers through the following processes:

- online questionnaire for professionals analysis
- online questionnaire for employers analysis
- structured interviews with key stakeholders
- technical workshop.

5.3 The framework presented depicts the knowledge, skills and applications requirements of the ecological and environmental management professions across all biotopes at a very high level. It should be considered as the skeleton from which the levels of detail will be developed.

5.4 Over 90% of respondents felt that the KSA Framework was comprehensive, at the level of detail presented. Some respondents identified gaps and anomalies in the draft, which have now been addressed in the revised version presented in this report.

KSA Framework Categories

5.5 The high-level KSA Framework, shown on the page 32, groups skills, knowledge and applications into four categories:

- knowledge
- specialist skills
- transferable skills
- applications.

5.6 The Knowledge category comprises the full range of principles, methods, systems, processes, legislation, policies, regulations etc. that ecologists and environmental managers are required to know, depending on their role.

5.7 The Specialist Skills category includes all those field and laboratory skills that are particular to ecologists and environmental managers. No professional would be expected to possess all these skills and the level of expertise they need to have in these skills depends on their role.
Transferable Skills are those skills common to many other professional groups; some are highly generic, such as management and communication; others, such as forecasting and modelling or GIS, are only required by certain groups of professionals.

The Applications category covers the range of applications to which ecologists and environmental managers apply their skills. The draft KSA Framework has been used to identify the knowledge and skills needed by ecologists and environmental managers according to:

- the context in which they are working (consultancy, industry, land/sea management, research, statutory, teaching)
- the biotope in which they are working (coastal, freshwater, marine, terrestrial)
- the length of working experience (0-2 years, 2-4 years, 4-10 years, 10+ years).

The findings from this project show clear differences in the knowledge and skills requirements according to the context and biotope in which professionals are working and the duration of working experience.
### Knowledge, Skills and Applications Framework

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Specialist Skills</th>
<th>Transferable Skills</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of ecology (including soil ecology)</td>
<td>Field experimentation</td>
<td>Aerial interpretation, mapping and GIS</td>
<td>Access management</td>
</tr>
<tr>
<td>Principles of biology (including microbiology)</td>
<td>Habitat surveying</td>
<td>Contract management</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Principles of nature conservation</td>
<td>Instrumentation set-up, calibration, maintenance and use</td>
<td>Data collation, analysis and management</td>
<td>Arboriculture</td>
</tr>
<tr>
<td>Principles of environmental management</td>
<td>Species identification (algae; birds; fish; fungi; higher plants; lichens; lower plants; macro/micro invertebrates; mammals; reptiles and amphibians)</td>
<td>Development and management of organisational processes</td>
<td>Construction and development</td>
</tr>
<tr>
<td>Principles of genetics</td>
<td>Ecological survey, sampling and monitoring of populations/communities (birds, fish; macro/micro invertebrates; mammals; plants and vegetation; reptiles and amphibians)</td>
<td>Development of strategies and plans</td>
<td>Corporate responsibility</td>
</tr>
<tr>
<td>Principles of habitat classification</td>
<td>Ecological survey, sampling and monitoring of habitats (coastal; freshwater; marine; terrestrial)</td>
<td>Evidence-based practice and systematic review</td>
<td>Ecotourism</td>
</tr>
<tr>
<td>Principles of sustainable development</td>
<td>Ecological analysis, assessment and evaluation (atmospheric condition; bird populations; fish populations; macro/micro invertebrate populations; mammal populations; plant and vegetation populations; reptiles and amphibian populations; soil condition; water condition)</td>
<td>Financial management (including fundraising)</td>
<td>Ecosystems assessment and valuation</td>
</tr>
<tr>
<td>Principles of hydrology</td>
<td>Habitat design, creation, restoration, translocation and management (coastal; freshwater; lowland grassland; marine; upland; urban/Brownfield; woodland)</td>
<td>Health and safety management</td>
<td>Education and training</td>
</tr>
<tr>
<td>Principles of sustainable development</td>
<td></td>
<td>Marketing and sales</td>
<td>Environmental assessment</td>
</tr>
<tr>
<td>Principles and methods of research</td>
<td></td>
<td>Networking</td>
<td>Environmental management system (EMS) and audit</td>
</tr>
<tr>
<td>Principles and methods of statistical, data recording and presentation</td>
<td></td>
<td>People development and management</td>
<td>Expert witness</td>
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<tr>
<td>Coastal systems and processes</td>
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<td>Policy analysis</td>
<td>Fisheries</td>
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<tr>
<td>Freshwater systems and processes</td>
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<td>Policy/legislation development</td>
<td>Forestry</td>
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<td>Marine systems and processes</td>
<td></td>
<td>Prediction and modelling</td>
<td>Green infrastructure and ecological connectivity/networks</td>
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<td>Terrestrial systems and processes</td>
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<td>Project management</td>
<td>Habitat design, creation, translocation, restoration and management</td>
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<td>Taxonomy and systematics</td>
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<td>Quality management</td>
<td>Horticulture</td>
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<td>Environmental economics</td>
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<td>Research design, analysis and reporting</td>
<td>Interpretation</td>
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<td>Environmental legislation and policy</td>
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<td>Risk analysis and management</td>
<td>Land management advice</td>
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<td>Environmental/ecosystem modelling</td>
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<td>Spoken communication (presentations, influencing etc.)</td>
<td>Policy interpretation and advice</td>
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<tr>
<td>Human impact on ecological systems</td>
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<td>Stakeholder engagement and management</td>
<td>Pollution prevention, control and management</td>
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<tr>
<td>Industry and organisational structures in the sector</td>
<td></td>
<td>Use of information technology</td>
<td>Protected areas management</td>
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<tr>
<td>Land use planning and management systems</td>
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<td>Working across professional boundaries (including providing professional advice)</td>
<td>Research</td>
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<tr>
<td>Technology and its application to ecology</td>
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<td>Written communication (reports, papers etc.)</td>
<td>Spatial planning</td>
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<td>Species management</td>
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<td>Waste management</td>
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<td>Water resource management</td>
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Further Development of the KSA Framework

5.11 This project has focused on developing the Framework as a tool for identifying skills needs, gaps and shortages for ecologists and environmental managers. It has achieved consensus around the breadth of knowledge and skills that are involved in ecology and environmental management and the applications to which they are put (Dimension A in Figure 13). However, the Framework remains at a very high level.

5.12 For the Framework to be useful as a tool for other purposes (e.g. designing curricula, accrediting education and training, developing job descriptions and person specifications, planning CPD), it would need to be developed along two dimensions:

- expanding each of the knowledge, skills and applications items to finer levels of detail (Dimension B); and
- identifying the different levels of knowledge and skills required by professionals in different roles and at different stages in their careers (Dimension C).

Fig 13. Dimensions of the Knowledge, Skills and Applications Framework

5.13 Further development of Dimension B would involve sub-dividing each of the knowledge, skills and applications items into their constituent components, in a hierarchical structure. This would provide more detailed specifications, for example, to define learning outcomes for educational programmes or knowledge and skills requirements for person specifications. Some of the skills items are already sub-divided into lists (shown on page 32 in parentheses) containing the next level of detail (e.g. “Species identification” sub-divides into algae, birds, fish, fungi etc.), but clearly finer levels of detail may be required.

5.14 Development of Dimension C, on the other hand, would require specification of the depth of knowledge or skill a professional in a particular role is required to have. Not every ecologist is required to have the same depth of knowledge of, for example, ecosystem services. It may be useful to develop definitions of different levels of knowledge and skills, for example:

- has a basic understanding of ecosystem goods and services
- has an in-depth knowledge of ecosystem goods and services
- is a point of reference for expertise on ecosystem goods and services within the organisation
- is recognised as a national expert on ecosystem goods and services.
6. KNOWLEDGE AND SKILLS GAPS AND SHORTAGES

6.1 Drawing on all the different strands of research, a number of overarching priorities\(^8\) have emerged in the knowledge and skills gaps and shortages of ecologists and environmental managers. These overarching priorities are discussed in this chapter. Annexes A and B consider the priorities according to the organisational context and biotope in which professionals are working. Annex C takes a different perspective and studies the differing knowledge and skills needs of professionals at various stages in their careers.

Knowledge Gaps and Shortages

6.2 The Online Survey of Professionals sought information on an individual's particular knowledge requirements and their level of confidence in their knowledge (see Figure 14).

6.3 **Environmental economics, including understanding of ecosystem goods and services, is an area where not all professionals are fully confident that their knowledge is sufficient to meet foreseeable future challenges.** This is confirmed by responses to the Online Survey of Employers and by the Semi-Structured Interviews with Key Stakeholders. These identified the need for ecologists to demonstrate value through the use of economic models and emphasised the links to ecosystem valuation and biodiversity offsetting.

6.4 **Professionals recognise their lack of knowledge in freshwater, coastal and marine systems and processes (relative to terrestrial systems and processes).** This is again confirmed by employers and stakeholders who have concerns that reduced funding will exacerbate the problem. Professionals not specialising in marine ecology have a poor understanding of marine systems and processes and that marine biotopes are subject to different planning principles to those that apply to terrestrial environments.

6.5 **Professionals identified gaps in their knowledge of cartography and data, environmental management systems and audit, and industry and organisational structures.** However, these areas of knowledge were not identified as priorities by employers or stakeholders.

6.6 **By contrast, professionals are relatively confident in their knowledge of environmental legislation and policy.** This view is not shared by employers and stakeholders who are often disappointed with graduates’ level of knowledge and understanding about key European and national policies. IEEM members spent nearly 4,000 hours developing their knowledge of environmental policy and law during 2009-10, the sixth most important area of their CPD.

6.7 **Microbiology was an area of knowledge not addressed by the Online Survey of Professionals, but raised as a priority by a number of stakeholders in different contexts.** For example, microbes in marine biotopes, micro aquatics, micro invertebrates, plant pathology and biosecurity.

6.8 **Stakeholders also drew attention to the need for ecologists to have a good understanding of the requirements of spatial planning systems at various levels and of construction techniques to mitigate threats to habitats.**

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\(^8\) Priorities are areas where a significant percentage of respondents require knowledge and skills but where their level of confidence is relatively low.
Fig 14. Knowledge Requirements and Confidence: Professionals

Note on interpretation of the figures. This figure shows, for example, that knowledge of Principles of biodiversity conservation is required by 92% of respondents. 62% of respondents are very confident, 29% are fairly confident and 1% not at all confident about their level of knowledge in this area. By contrast, only 46% of respondents are required to have knowledge of Marine systems and processes; only 3% are very confident about their level of knowledge in this area, whilst 15% are fairly confident and 28% are not at all confident.
Specialist Skills Gaps and Shortages

6.9 Those consulted commented on the difficulty of distinguishing between *knowledge* and *skills*, the latter requiring the application of the former. Taxonomy was listed under the title *knowledge* in the Online Surveys and certain gaps were recognised. **However, it is the erosion of skills in taxonomy and systematics which is giving cause for concern, as highlighted by the House of Lords Science and Technology Committee’s report in 2008: Systematics and Taxonomy Follow-up.** Taxonomy was raised as a key priority by a number of stakeholders, including the Linnean Society, the Natural History Museum and the Heritage Council Ireland.

6.10 Closely related to taxonomy and systematics are *species identification skills*. Figure 15 shows the percentage of respondents to the Online Survey of Professionals who are required to have species identification skills and their level of confidence in their skills.

6.11 **Employers and stakeholders agree with professionals that species identification skills are reasonably good in respect of mammals, birds, reptiles and amphibians and higher plants, but poor in respect of fish, lower plants, lichens, algae and fungi.** One stakeholder pointed out the need to distinguish between macro-invertebrates and micro-invertebrates, since identification skills in respect of the former are good, but in respect of the latter are poor.

6.12 The causes of lack of species identification skills are manifold – lack of fieldwork in schools, lack of species identification teaching at universities, decline of active participation in natural history activities, ageing population of naturalists – and there are a number of initiatives in place to address these causes. However, stakeholders emphasised the need to tackle the erosion of species identification skills in a strategic way, possibly linked to addressing the deficit in taxonomic skills. IEEM members spent more than 12,000 hours developing their species identification skills during 2009-10, the third most important area of CPD.
Fig 15. Species Identification Skills Requirements and Confidence: Professionals

Species ID skills requirements and confidence ratings (Professionals): n = 558

- **Mammals**
  - Very Confident: 45%
  - Fairly Confident: 31%
  - Not at all confident: 6%

- **Birds**
  - Very Confident: 24%
  - Fairly Confident: 31%
  - Not at all confident: 22%

- **Invertebrates**
  - Very Confident: 9%
  - Fairly Confident: 23%
  - Not at all confident: 33%

- **Fish**
  - Very Confident: 4%
  - Fairly Confident: 13%
  - Not at all confident: 29%

- **Reptiles and amphibians**
  - Very Confident: 44%
  - Fairly Confident: 24%
  - Not at all confident: 7%

- **Higher plants**
  - Very Confident: 30%
  - Fairly Confident: 45%
  - Not at all confident: 11%

- **Lower plants**
  - Very Confident: 6%
  - Fairly Confident: 23%
  - Not at all confident: 38%

- **Lichens**
  - Very Confident: 1%
  - Fairly Confident: 8%
  - Not at all confident: 45%

- **Algae**
  - Very Confident: 2%
  - Fairly Confident: 6%
  - Not at all confident: 39%

- **Fungi**
  - Very Confident: 2%
  - Fairly Confident: 8%
  - Not at all confident: 41%
6.13 Figure 16 shows the percentage of professionals required to have specialist skills and their levels of confidence in their skills.

6.14 Professionals recognise there are gaps in their ecological survey, sampling, analysis, assessment, evaluation and monitoring skills, particularly in respect of invertebrates, fish and bird communities. Presumably, this is linked to some extent with their levels of confidence in their species identification skills.

6.15 Stakeholders also raised concerns about the variable quality of surveys and the need for IEEM, as the professional body, to support improvement in the quality of surveys through education and training, provision of tools and guidance and where necessary disciplinary action. IEEM members spent over 22,000 hours developing their ecological survey skills during 2009-10, the most important area of their CPD.

6.16 Stakeholders also emphasised the importance for those carrying out Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA) to have the necessary skills. They commented that the quality of EIAs and SEAs is extremely variable.

6.17 Professionals are fairly confident about their skills in habitat creation, restoration and management in woodland, lowland grassland and urban/brownfield environments. They are less confident about their skills in marine, coastal and upland environments, where fewer respondents are required to practise. Stakeholders made the point that habitat translocation will become a skill increasingly in demand as a result of climate change and biodiversity offsetting. IEEM members spent over 7,000 hours developing their habitat management skills during 2009-10, the fifth most important area of their CPD.

6.18 The Online Survey asked about professionals’ skills in aerial interpretation, mapping and GIS, about which they feel moderately confident. Stakeholders, however, pointed out the urgent need for ecologists and environmental managers to develop skills in the use of new technologies, particularly IT, mobile technology and genetics, which have the potential to revolutionise survey approaches.

6.19 Other priority skills areas identified by stakeholders included developing effective and ethical approaches to invasive species and combating the spread of diseases.

6.20 Finally, stakeholders emphasised the need for ecologists and environmental managers to focus less on individual species or habitats and instead to take a landscape approach, recognising the importance of ecological networks and connectivity.
Fig 16. Specialist Skills Requirements and Confidence: Professionals

Specialist skills requirements and confidence ratings (Professionals): n = 558

ECOLOGICAL SURVEY AND SAMPLING OF: plant communities and vegetation
  invertebrate communities: 32% Very Confident, 28% Fairly Confident, 40% Not at all Confident
  fish: 34% Very Confident, 20% Fairly Confident, 46% Not at all Confident
  reptiles and amphibian communities: 34% Very Confident, 21% Fairly Confident, 45% Not at all Confident
  bird communities: 34% Very Confident, 25% Fairly Confident, 41% Not at all Confident
  mammal communities: 37% Very Confident, 25% Fairly Confident, 38% Not at all Confident

ECOLOGICAL ANALYSIS, ASSESSMENT AND EVALUATION OF: plant communities and vegetation
  invertebrate communities: 32% Very Confident, 29% Fairly Confident, 40% Not at all Confident
  fish: 34% Very Confident, 21% Fairly Confident, 45% Not at all Confident
  reptiles and amphibian communities: 34% Very Confident, 25% Fairly Confident, 41% Not at all Confident
  bird communities: 34% Very Confident, 25% Fairly Confident, 41% Not at all Confident
  mammal communities: 37% Very Confident, 25% Fairly Confident, 38% Not at all Confident

ECOLOGICAL MONITORING OF: plant communities and vegetation
  invertebrate communities: 30% Very Confident, 32% Fairly Confident, 38% Not at all Confident
  fish: 28% Very Confident, 35% Fairly Confident, 37% Not at all Confident
  reptiles and amphibian communities: 32% Very Confident, 28% Fairly Confident, 40% Not at all Confident
  bird communities: 34% Very Confident, 25% Fairly Confident, 41% Not at all Confident
  mammal communities: 33% Very Confident, 25% Fairly Confident, 42% Not at all Confident

HABITAT CREATION, RESTORATION AND MANAGEMENT OF: marine
  coastal: 16% Very Confident, 28% Fairly Confident, 56% Not at all Confident
  freshwater: 18% Very Confident, 31% Fairly Confident, 51% Not at all Confident
  woodland: 25% Very Confident, 33% Fairly Confident, 42% Not at all Confident
  upland: 24% Very Confident, 31% Fairly Confident, 45% Not at all Confident
  lowland grassland: 28% Very Confident, 31% Fairly Confident, 41% Not at all Confident
  urban/brownfield: 25% Very Confident, 26% Fairly Confident, 49% Not at all Confident

AERIAL INTERPRETATION, MAPPING AND GIS
  23% Very Confident, 33% Fairly Confident, 44% Not at all Confident
Transferable Skills Gaps and Shortages

6.21 The Online Survey of Employers sought information on the transferable skills requirements of job applicants and their confidence that they will find applicants who possess the skills to a satisfactory level (see Figure 17).

6.22 Written communication skills are a key requirement but more than a quarter of employers are not at all confident that applicants possess report writing and other written communication skills to the level required. Stakeholders also commented on deficiencies in written communication, particularly that reports often do not address the key questions and that they fail to show the evidence that supports their findings. IEEM members spent over 1,200 hours developing their report writing skills during 2009-10, the sixth most important generic skills area in their CPD.

6.23 Project management and, for commissioners, contract management skills are also strongly in demand, but employers identify a shortage of applicants with the appropriate standard of skills. Again, stakeholders confirm these findings, commenting that often commissioners are unable to judge the quality of a survey report they have commissioned. IEEM members spent over 1,700 hours developing their project management skills during 2009-10, the fourth most important generic skills area in their CPD.

6.24 Employers are relatively relaxed about professionals' skills in data collection and analysis; it is the management of data and its accessibility at national and international level that give employers and stakeholders concern.

6.25 Influencing skills and the ability to engage with stakeholders – whether they are policy-makers, the public, developers or other professionals – are seen as skills which will be increasingly in demand. Ecologists particularly need to improve their skills in:

- engaging with local residents,
- influencing politicians and policy-makers
- working on a par with other professionals in multidisciplinary teams.

6.26 Every ecologist and environmental manager needs to be able to communicate the value of investment in biodiversity and, as the professional body, IEEM has a particular role to play in this.

6.27 Financial management skills are seen by employers as both important and lacking in applicants. IEEM members recognise this skills gap and, during 2009-10, spent over 3,500 hours developing their financial management skills, the most important generic skills area in their CPD.

6.28 There are a number of other areas where employers have identified shortages in the transferable skills of applicants. Risk analysis and management, although required by just over half of employers, was identified during the Semi-structured Interviews with Key Stakeholders as being of special significance. It is not only the technical aspects of risk analysis and management but the ability to communicate risks and assumptions to clients and policy makers – the understanding and acceptance that there are no absolutes; ecology is a science of probability.
Transferable skills requirements and confidence ratings (Employers of Applicants): n = 84

![Pie chart showing confidence levels for various skills](chart.png)

Fig 17. Transferable Requirements and Confidence: Employers
Key Differences by Context

6.29 Annex A provides an analysis of the knowledge and skills gaps and shortages according to the context in which respondents work.

6.30 The majority of findings are consistent across all contexts. The table below summarises the key differences according to each context.

<table>
<thead>
<tr>
<th>Context</th>
<th>Key Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultancy</td>
<td>• Knowledge requirements and levels of confidence are relatively high for this group.</td>
</tr>
<tr>
<td>Industry</td>
<td>• Gaps in knowledge of cartography and data and ecosystems services are relatively marked.</td>
</tr>
<tr>
<td>Land or Sea Management</td>
<td>• Gaps in knowledge of cartography and data, ecosystem service, freshwater systems and processes and taxonomy are relatively marked.</td>
</tr>
<tr>
<td>Research</td>
<td>• Gaps in knowledge of cartography and data, ecosystem service, freshwater systems and processes, environmental legislation and policy and principles of sustainable development are relatively marked.</td>
</tr>
<tr>
<td>Statutory/Regulatory</td>
<td>• Gaps in knowledge of ecosystem service, environmental legislation and policy and principles of sustainable development are relatively marked.</td>
</tr>
<tr>
<td></td>
<td>• The majority of respondents are expected to possess skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of invertebrates, but their level of confidence in this area is only moderate.</td>
</tr>
<tr>
<td></td>
<td>• The majority of respondents are expected to have species identification skills in respect of invertebrates, but their confidence levels are only moderate (but higher than for respondents working in other contexts).</td>
</tr>
<tr>
<td>Teaching</td>
<td>• Gaps in knowledge of cartography and data, ecosystem service, taxonomy and industry and organisational structures are relatively marked.</td>
</tr>
</tbody>
</table>
### Key Differences by Biotope

6.31 Annex B provides an analysis of the knowledge and skills gaps and shortages according to the biotope in which respondents mainly work.

6.32 The majority of findings are consistent across all contexts. The table below summarises the key differences according to each biotope.

<table>
<thead>
<tr>
<th>Biotope</th>
<th>Key Differences</th>
</tr>
</thead>
</table>
| **Terrestrial** | Respondents have:  
- higher levels of confidence in their knowledge of terrestrial systems and processes than those working in other biotopes.  
- higher levels of confidence in their skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring birds and reptiles and amphibians.  
Respondents are:  
- less confident about their skills in habitat creation, restoration and management in upland environments compared to lowland grassland, woodland and urban/brownfield environments.  
- required to have a wider range of species identification skills than those working in other biotopes. |
| **Freshwater** | Respondents have:  
- higher levels of confidence in their knowledge of freshwater systems and processes than those working in other biotopes.  
- lower levels of confidence in their knowledge of principles of environmental legislation and policy, sustainable development and taxonomy.  
- relatively low confidence in their species identification skills for lower plants, birds, fish and invertebrates. |
| **Coastal** | Respondents have:  
- higher levels of confidence in their knowledge of coastal systems and processes than those working in other biotopes.  
- relatively low confidence in their species identification skills for lower plants, birds, fish, reptiles and amphibians and invertebrates are. |
| **Marine** | Respondents have:  
- higher levels of confidence in their knowledge of marine systems and processes than those working in other biotopes.  
- low requirement for species identification skills relative to other biotopes. |
Key Differences by Length of Experience

6.33 Annex B provides an analysis of the knowledge and skills gaps and shortages according to respondents’ length of experience, i.e. the numbers of years they have been practising since graduating/qualifying.

6.34 The table below summarises the key differences according to length of experience.

<table>
<thead>
<tr>
<th>Length of Experience</th>
<th>Key Differences</th>
</tr>
</thead>
</table>
| <2 years             | • Requirements for knowledge and specialist skills are more limited.  
                      | • Confidence levels in their knowledge, ecological analysis,  
                      | assessment and evaluation skills and species identification skills are  
                      | fairly high.  
                      | • By contrast, confidence levels in their habitat creation, restoration  
                      | and management skills are relatively low. |
| 2-4 years            | • Requirements for knowledge and specialist skills increase.  
                      | • Confidence levels in both knowledge and specialist skills tend to be  
                      | lowest after 2-4 years’ experience. |
| 4-10 years           | • Requirements for knowledge and specialist skills are highest.  
                      | • Confidence levels in most areas of knowledge and specialist skills  
                      | increase markedly. |
| >10 years            | • Requirements for knowledge and specialist skills are less than at 4-  
                      | 10 years, suggesting that some senior professionals take on more  
                      | strategic and/or supervisory roles, with reduced requirement for  
                      | specialist skills.  
                      | • Confidence levels in knowledge and specialist skills are maintained  
                      | or enhanced from their levels at 4-10 years. |
7. EDUCATION, TRAINING, CAREER AND PROFESSIONAL DEVELOPMENT

7.1 The findings of this research have a number of implications for the education, training, career and professional development of ecologists and environmental managers. These will need to be addressed by Government, educational institutions, IEEM, employers, and training providers through an agreed common strategy.

7.2 Identified needs include:

- the definition of a set of core competences – knowledge and skills that all ecologists and environmental managers are expected to have regardless of role
- the definition of role profiles – sets of competences required for particular roles, including both core and specialist competences
- the definition of competence requirements – levels of knowledge and skills required at different career stages and/or roles – for example, as required for entry into different grades of IEEM membership
- planning tools to help ecologists and environmental managers develop their careers and the competences required to take the next step
- a system of accreditation of first degrees that ensures students develop a required basic set of knowledge and skills
- a system of accreditation of postgraduate courses that develops the knowledge and skills required for different specialisms
- a system of accreditation of short courses across the profession
- the development of short courses of greater breadth and depth, that also address the specialist skills gaps and shortages identified in the research
- the accreditation of professionals’ specialist areas of competence
- a structured approach to continuing professional development (CPD) that requires professionals to:
  - plan their development to meet current and future needs
  - develop their knowledge, skills and competence through accredited learning and other routes
  - record their learning and its outcomes.

7.3 The KSA Framework, if developed to a finer level of detail and with definitions of different depths of knowledge and skills, could provide the coordinating link between education, training, career and professional development of ecologists and environmental managers.
Fig 18. Education, Training, Career and Professional Development for Ecologists and Environmental Managers

Career Development

7.4 The KSA Framework could provide a common language to describe the core competences – the knowledge, specialist and transferable skills – required by all ecologists and environmental managers. This would require further research and the development of consensus on the core competences amongst the various stakeholder groups.

7.5 If developed to a finer level of detail and greater depth, the KSA Framework could also provide the structure for developing role profiles – the sets of core and specialist competences required for various roles at different levels of seniority. Again, this would require consensus amongst those organisations which require the particular roles.

7.6 The role profiles would support the development of career planning tools to help ecologists and environmental managers identify career objectives, focus on roles which are within their potential and start to develop the new knowledge and skills they will require in these roles. This would link in closely with CPD and short course provision.

Education and Training

7.7 For society to benefit from trained and competent professional ecologists and environmental managers working to the highest standards, it is imperative that the profession is seen as an attractive and rewarding career. IEEM, British Ecological Society, Field Studies Council and others should work together to develop tools to more successfully inspire young people to choose to study ecology and environmental management. Inevitably, this work needs to start at primary level and be developed throughout the secondary curriculum by the provision of opportunities, including field trips, to learn about the natural world and human impact on the environment. It should also encompass stimulating and effective career marketing materials and activities.

7.8 IEEM is already developing a methodology for accrediting those first degree courses providing a suitable foundation for a career in ecology or environmental management. This
research provides evidence of an increasing level of urgency and the KSA Framework offers the prospect of the objective criteria for accreditation that IEEM has been seeking.

7.9 Post-graduate courses are also in need of accreditation to show those specialist areas of knowledge and skills to which they apply. It is recognised that the KSA Framework will need to be developed to a finer level of detail and greater depth to accredit post-graduate courses.

7.10 The gaps and shortages in specialist knowledge and skills are clear from the research. The range of workshops, short courses and other learning opportunities offered by training providers needs to be significantly broadened to meet this demand. Using a fully developed KSA Framework, learning opportunities could be accredited and linked directly to members’ CPD plans.

7.11 The issue of competence was raised a number of times during the research, particularly in the Semi-structured Interviews with Key Stakeholders and the Technical Workshop. How can a client know whether a professional is competent to carry out an ecological survey in a particular field or provide consultancy in a specialism? The KSA Framework offers the opportunity to provide accreditation for professionals’ specialist competence, in addition to the generic assurance provided through IEEM membership.

Professional Development

7.12 Over and above the definition of core competences referred to above, the more fully develop KSA Framework would have wider implications for setting expectations and standards for competent practice. In the case of IEEM as a professional membership body, for example, it could define more competence-based requirements, in terms of knowledge, skills and experience, for the various grades of membership. It could also lead to the development of new mechanisms for assessing evidence when existing members apply for new grades of membership.

7.13 CPD is a requirement of any professional. Linked to the career planning tools mentioned above, CPD for ecologists and environmental managers should:

- be planned to address current skills gaps, meet future challenges and support ongoing career development
- make use of the extended range of accredited short courses and other learning opportunities as appropriate, and
- record their learning and the outcomes in terms of performance, career and professional development.

7.14 There is a clear need for leadership in the provision of education and training for ecologists and environmental managers in order to develop a structured and accredited career development path along the lines of (for example) that of similar professional bodies such as the Landscape Institute.
8. RECOMMENDATIONS

8.1 A robust structure of education, training, continuing professional development and accreditation must be developed. This will ensure the profession and its professionals are able to deliver the knowledge and skills required to achieve effective protection and enhancement of the natural environment, biodiversity and the provision of ecosystem goods and services. The following recommendations collectively set out an ambitious but critically important agenda of actions

Strategy for Education, Training, Career and Professional Development of Ecologists and Environmental Managers

8.2 A strategy for the education, training, career and professional development of ecologists and environmental managers should be developed in line with the proposals in Chapter 6, including:

- the definition of a set of core competences
- the definition of role profiles
- a system of accreditation of first degrees and postgraduate courses based on the detailed Knowledge, Skills and Applications Framework
- the definition of competence requirements linked to recognised professional standards and professional body membership grades
- the production of materials and activities to promote the career opportunities in ecology and environmental management to secondary school and post-16 students
- planning tools to help ecologists and environmental managers develop their careers and the competences required to take the next step
- a system of accreditation for short courses
- the accreditation of professionals’ specialist areas of competence
- a structured approach to continuing professional development (CPD)
- support to employers in providing structured professional development programmes.

Further Development of the Knowledge, Skills and Applications Framework (KSA)

8.3 The KSA Framework should be developed further, in particular:

- expanding the knowledge, skills and applications to finer levels of detail
- developing levels that describe the various depths of knowledge or skill required by professionals at different stages in their careers.

Addressing Knowledge and Skills Gaps and Shortages

8.4 A strategy for addressing the knowledge and skills gaps and shortages identified in this research should be produced to stimulate a range of accessible, flexible and affordable learning opportunities to meet these needs.

8.5 The priority knowledge and skills requirements identified in this research should be published. Members of the profession should be encouraged and supported to address their individual CPD needs in these priority areas, either through self-study or through a range of accredited courses and other learning opportunities.
Assuring the Quality of Professional Work

8.6 To ensure that ecologists and environmental managers deliver work to the highest standards (for example in survey work) a needs-based programme of training, tools and good practice guidance should be provided. Whilst not a regulated profession, self-regulation should continue to be promoted through membership of the appropriate professional membership body that has the mechanisms in place to take action against those whose competency falls below the required standards.

Communicating the Importance of the Natural Environment, Biodiversity and the Value of Ecosystem Goods and Services

8.7 Communicating to and influencing politicians, policy makers, other professionals and the public of the importance and value of the natural environment and biodiversity and the ecosystem goods and services they provide is fundamental to meeting biodiversity targets and hence human welfare requirements. Succeeding in this communications challenge will lead to a greater understanding and valuing of the role of ecologists and environmental managers in protecting and enhancing these assets which, in turn, will make a career as an ecologist or environmental manager more attractive to future generations. Key stakeholders should consider formulating a communications strategy to achieve these goals.
ANNEXES

A. KEY ISSUES BY CONTEXT

A.1 This chapter provides a detailed analysis of the knowledge and skills requirements, together with identified gaps and shortages according to the context in which ecologists and environmental managers are working. The six contexts analysed are:

- Consultancy
- Industry
- Land or Sea Management
- Research
- Statutory/Regulatory
- Teaching.

A.2 Based on the Online Survey of Professionals, the analysis identifies:

- the knowledge and skills required of ecologists and environmental managers working in the context
- the level of confidence of professionals and their employers that their knowledge and skills are sufficient to meet foreseeable future challenges.

A.3 Each section concludes with a summary of the key knowledge and skills issues for that context, drawing on the findings from both the Online Surveys and the qualitative research, particularly the Semi-structured Interviews with Key Stakeholders and the Technical Workshop.
Key Issues for the Consultancy Context

A.4 271 professionals provided information from the consultancy context.

Knowledge Requirements and Confidence

A.5 Figure 19 sets out consultancy professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 76% of the 271 respondents require knowledge of principles of ecology, but only 54% felt fully confident that their knowledge of the principles of ecology was sufficient to meet foreseeable future challenges. 21% felt fairly confident about their knowledge in this area and just 1% felt not at all confident.

![Knowledge requirements and confidence ratings of Professionals (Consultancy): n = 271](image)

**Fig 19. Knowledge Requirements and Confidence: Professionals in the Consultancy Context**
A.6 There are lower levels of confidence in coastal and marine systems and processes, which are required by less than half of respondents.

A.7 There are also low levels of confidence in knowledge of industry and organisational structures, environmental economics and environmental management system and audit.

Specialist Skills Requirements and Confidence

A.8 Figure 20 sets out consultancy professionals’ specialist skills requirements and their confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 58% of respondents. 25% are confident that their level of skill is sufficient to meet foreseeable future challenges, 28% are fairly confident and 5% are not at all confident.
A.9 The requirement for ecological survey, sampling, analysis, assessment, evaluation and monitoring of fish is significantly lower than for the other communities, as are respondents’ levels of confidence in their skills in this area.

A.10 Only around 30% of professionals working in the consultancy context are required to have skills in habitat creation, restoration and management in marine and coastal environments, perhaps reflecting a bias in the self-selected sample of respondents.

Species Identification Requirements and Confidence

A.11 Figure 21 sets out consultancy professionals’ species identification skills requirements and their confidence in those skills. For example, 62% of respondents are required to have the skills to identify species of mammals. 34% are confident that their level of skill is sufficient to meet foreseeable future challenges, 23% are fairly confident and 5% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Consultancy): n = 271](image)

Fig 21. Species Identification Skills Requirements and Confidence: Professionals in the Consultancy Context
A.12 Over half of respondents working in the consultancy context are expected to have species identification skills for: mammals, birds, reptiles and amphibians and higher plants; just under half are expected to have them for invertebrates and lower plants. Significantly fewer respondents are expected to have them for fish, lichens, algae and fungi and correspondingly their confidence levels in their skills in these areas are very low.

Consultancy Professionals' Summary

A.13 In summary, the knowledge and skills requirements and deficits of professionals working in the consultancy context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - principles of habitat classification
  - principles of environmental management
  - principles of sustainable development
  - terrestrial systems and processes
  - environmental legislation and policy
  - human impact on ecological systems
  - freshwater systems and processes
  - taxonomy
  - cartography and data
  - ecosystem services.

  Levels of confidence in these knowledge areas are relatively high.

- The majority work in terrestrial or freshwater environments. Levels of confidence in their knowledge of coastal and marine systems and processes and in their skills in habitat creation, restoration and management in marine and coastal environments is consequently relatively low.

- There are gaps in their knowledge of:
  - industry and organisational structures
  - environmental economics
  - environmental management systems and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
- reptiles and amphibians
- birds
- mammal communities.
Levels of confidence in these areas are relatively high.

- A minority are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish.
Levels of confidence in these areas are significantly lower.

- The majority are expected to have species identification skills in respect of:
  - mammals
  - birds
  - reptiles and amphibians
  - higher plants.
Levels of confidence in these areas are relatively high.

- At least a third of respondents have significant gaps in species identification skills for:
  - invertebrates
  - lower plants
  - fish
  - lichens
  - algae
  - fungi.
Key Issues for the Industry Context

A.14 46 professionals provided information from the industry context

Knowledge Requirements and Confidence

A.15 Figure 22 sets out industry professionals’ knowledge and their level of confidence in their knowledge. For example, 81% of the 46 respondents require knowledge of principles of ecology, but only 57% felt fully confident that their knowledge of the principles of ecology was sufficient to meet foreseeable future challenges. 22% felt fairly confident about their knowledge in this area and just 2% felt not at all confident.

![Knowledge requirements and confidence ratings of Professionals (Industry): n = 46](image)

Fig 22. Knowledge Requirements and Confidence: Professionals in the Industry Context
A.16 There are lower levels of confidence of coastal and marine systems and processes but these are required by only a third of respondents.

A.17 There are also low levels of confidence in knowledge of:

- ecosystem services
- industry and organisational structures
- environmental economics
- environmental management system and audit.

A.18 Low levels of confidence in cartography and data, required by nearly half of respondents, may also provide cause for concern.
Specialist Skills Requirements and Confidence

A.19 Figure 23 sets out industry professionals’ specialist skills requirements and their confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 66% of respondents. 20% are confident that their level of skill is sufficient to meet foreseeable future challenges, 39% are fairly confident and 7% are not at all confident.

![Specialist skills requirements and confidence ratings of Professionals (Industry): n = 46](image.png)

A.20 The requirement for ecological survey, sampling, analysis, assessment, evaluation and monitoring of fish and invertebrate communities is significantly lower than for the other communities, as are respondents’ levels of confidence in their skills in these areas.
A.21 Less than 40% of professionals working in the industry context are required to have skills in habitat creation, restoration and management in marine environments, perhaps reflecting a bias in the self-selected sample of respondents. Levels of confidence in habitat creation, restoration and management in both marine and coastal environments are low.

**Species Identification Skills**

A.22 Figure 24 sets out industry professionals’ species identification skills requirements and their confidence in those skills. For example, 74% of respondents are required to have the skills to identify species of mammals. 46% are confident that their level of skill is sufficient to meet foreseeable future challenges, 26% are fairly confident and 2% are not at all confident.

**Fig 24. Species Identification Skills Requirements and Confidence: Professionals in the Industry Context**
A.23 At least half of respondents working in the land/sea management context are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants; fewer are expected to have species identification skills for in fish, lichens, algae and fungi consequently their confidence levels are very low in these areas.

Industry Summary

A.24 In summary, the knowledge and skills requirements and deficits of professionals working in the industry context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - environmental legislation and policy
  - principles of habitat classification
  - principles of environmental management
  - principles of sustainable development
  - human impact on ecological systems
  - freshwater systems and processes
  - taxonomy.
  Levels of confidence in these knowledge areas are relatively high.

- Less than 40% work in marine and coastal environments. Levels of confidence in knowledge of coastal and marine systems and processes and in skills in habitat creation, restoration and management in marine and coastal environments are consequently relatively low.

- There are gaps in knowledge of:
  - cartography and data
  - ecosystem services
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
  - reptiles and amphibians
- birds
- mammal communities.
  Levels of confidence in these areas are relatively high.

- A minority are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish.
  Levels of confidence in these areas are significantly lower.

- The majority are expected to have species identification skills in respect of:
  - mammals
  - birds
  - invertebrates
  - reptiles and amphibians
  - higher plants.
  Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates they are low.

- At least a third of respondents have significant gaps in species identification skills for:
  - fish
  - lower plants
  - lichens
  - algae
  - fungi.
Key Issues for the Land/Sea Management Context

A.25 96 professionals provided information from the land/sea management context.

Knowledge Requirements and Confidence

A.26 Figure 25 sets out land/sea management professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 96% of the 96 respondents require knowledge of principles of biodiversity conservation, but only 58% felt fully confident that their knowledge of the principles of biodiversity conservation was sufficient to meet foreseeable future challenges. 32% felt fairly confident about their knowledge in this area. None of the respondents felt not at all confident about their knowledge in this area.
A.27 There are lower levels of confidence of coastal and marine systems and processes than for terrestrial and freshwater systems and processes.

A.28 There are also low levels of confidence in knowledge of environmental economics, environmental management system and audit, and industry and organisational structures.

A.29 Lower levels of confidence in ecosystem services and cartography and data, required by more than half of respondents, may also provide cause for concern.

**Specialist Skills Requirements and Confidence**

A.30 Figure 26 sets out the land/sea management professionals' specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 59% of respondents. 22% are confident that their level of skill is sufficient to meet foreseeable future challenges, 28% are fairly confident and 9% are not at all confident.

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**Specialist skills requirements and confidence ratings of Professionals (Land/Sea Management): n = 96**

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Fig 26. Specialist Skills Requirements and Confidence: Professionals in the Land/Sea Management Context
A.31 The requirement for ecological survey, sampling, analysis, assessment, evaluation and monitoring of fish is significantly lower than for the other communities, as are respondents’ levels of confidence in their skills in these areas.

A.32 Levels of confidence in habitat creation, restoration and management in both marine and coastal environments are low.

**Species Identification Skills and Confidence**

A.33 Figure 27 sets out the land/sea management professionals’ species identification skills requirement and their levels of confidence in those skills. For example, 65% of respondents are required to have the skills to identify species of mammals. 35% are confident that their level of skill is sufficient to meet foreseeable future challenges, 27% are fairly confident and 3% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Land/Sea Management): n = 96](image-url)
A.34 At least half of respondents working in the land/sea management context are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants.

A.35 Fewer respondents are expected to have species identification skills for fish, lichens, algae and fungi and their confidence levels in their skills in these areas are very low.

**Land/Sea Management Professionals’ Summary**

A.36 In summary, the knowledge and skills requirements and deficits of professionals working in the land/sea management context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - environmental legislation and policy
  - principles of habitat classification
  - principles of environmental management
  - principles of sustainable development
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - ecosystem services
  - freshwater systems and processes
  - taxonomy
  - cartography and data
  - coastal systems and processes.
  Levels of confidence in these knowledge areas are only moderate.

- Less than half of respondents are expected to have knowledge of marine systems and processes and skills in habitat creation, restoration and management in marine environments. Confidence levels in these areas are low.

- There are gaps in knowledge of:
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.
• About half of respondents are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  – plants and vegetation
  – reptiles and amphibians
  – birds and mammal communities
Levels of confidence in these areas are relatively high.

• A minority are expected to have skills in ecological survey and sampling of:
  – invertebrate communities
  – fish
Levels of confidence in these areas are significantly lower.

• The majority are expected to have species identification skills in respect of:
  – mammals
  – birds
  – invertebrates
  – reptiles and amphibians
  – higher plants and lower plants.
Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates and lower plants they are low.

• There are significant gaps in their species identification skills, required by a least a third of respondents, in respect of:
  – fish
  – lichens
  – algae
  – fungi.
Key Issues for the Research Context

A.37 89 professionals provided information from the research context.

Knowledge Requirements and Confidence

A.38 Figure 28, sets out research professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 76% of the 89 respondents require knowledge of principles of ecology, but only 55% felt fully confident that their knowledge of the principles of ecology was sufficient to meet foreseeable future challenges. 21% felt fairly confident about their knowledge in this area. None of the respondents felt not at all confident about their knowledge in this area.

![Knowledge requirements and confidence ratings of Professionals (Research): n = 89](image)

**Fig 28. Knowledge Requirements and Confidence: Professionals in the Research Context**

A.39 There are lower levels of confidence of marine systems and processes than for terrestrial, freshwater and coastal systems and processes.
A.40 There are also low levels of confidence in knowledge of environmental economics, environmental management system and audit, and industry and organisational structures.

**Specialist Skills Requirements and Confidence**

A.41 Figure 29 sets out the research professionals' specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 64% of respondents. 26% are confident that their level of skill is sufficient to meet foreseeable future challenges, 31% are fairly confident and 7% are not at all confident.

**Fig 29. Specialist Skills Requirements and Confidence: Professionals in the Research Context**

A.42 The requirement for ecological survey, sampling, analysis, assessment, evaluation and monitoring of invertebrate communities and fish is significantly lower than for the other communities, as are respondents' levels of confidence in their skills in these areas.
A.43 Less than 50% of professionals working in the research context are required to have skills in habitat creation, restoration and management in marine or coastal environments, perhaps reflecting a bias in the self-selected sample of respondents. Levels of confidence in habitat creation, restoration and management in both marine and coastal environments are low.

Species Identification Skills and Confidence

A.44 Figure 30 sets out research professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 71% of respondents are required to have the skills to identify species of mammals. 34% are confident that their level of skill is sufficient to meet foreseeable future challenges, 35% are fairly confident and 2% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Research): n = 89](chart)

**Fig 30. Species identification Skills Requirements and Confidence: Professionals in the Research Context**

A.45 At least half of respondents working in the research context are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants.
A.46 Fewer respondents are expected to have species identification skills for fish, lichens, algae and fungi and their confidence levels in their skills in these areas are very low.

Research Professionals’ Summary

A.47 In summary, the knowledge and skills requirements and deficits of professionals working in the research context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - principles of habitat classification
  - principles of environmental management
  - taxonomy
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - environmental legislation and policy
  - principles of sustainable development
  - ecosystem services
  - freshwater systems and processes
  - cartography and data.
  Levels of confidence in these knowledge areas are only moderate.

- Less than half of respondents are expected to have knowledge of: coastal and marine systems and processes and in skills in habitat creation, restoration and management in coastal and marine environments. Their confidence levels in these areas are low.

- There are gaps in their knowledge of:
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
  - reptiles and amphibians
- birds
- mammal communities.
Levels of confidence in these areas are relatively high.

- A minority are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish.
Levels of confidence in these areas are significantly lower.

- The majority are expected to have species identification skills in respect of:
  - mammals
  - birds
  - invertebrates
  - reptiles and amphibians
  - higher plants
  - lower plants.
Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates and lower plants they are low.

- There are significant gaps in their species identification skills, required by a least a third of respondents, in respect of:
  - fish
  - lichens
  - algae
  - fungi.
Key Issues for the Statutory Context

A.48 147 professionals provided information from the statutory context.

Knowledge Requirements and Confidence

A.49 Figure 31 sets out the statutory professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 77% of the 147 respondents require knowledge of principles of ecology, but only 47% felt fully confident that their knowledge of the principles of ecology was sufficient to meet foreseeable future challenges. 30% felt fairly confident about their knowledge in this area. None of the respondents felt not at all confident about their knowledge in this area.
A.50 There are lower levels of confidence of coastal and marine systems and processes than for terrestrial and freshwater systems and processes.

A.51 There are also low levels of confidence in knowledge of ecosystem services, taxonomy, cartography and data, environmental economics, industry and organisational structures, and environmental management system and audit.

Specialist Skills Requirements and Confidence

A.52 Figure 32 sets out the statutory professionals’ specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 61% of respondents. 22% are confident that their level of skill is sufficient to meet foreseeable future challenges, 35% are fairly confident and 4% are not at all confident.
A.53 The requirement for ecological survey, sampling, analysis, assessment, evaluation and monitoring of invertebrate communities and fish is significantly lower than for the other communities, as are respondents’ levels of confidence in their skills in these areas.

A.54 Less than 40% of professionals working in the statutory context are required to have skills in habitat creation, restoration and management in marine or coastal environments, perhaps reflecting a bias in the self-selected sample of respondents. Levels of confidence in habitat creation, restoration and management in both marine and coastal environments are low.

Species Identification Skills and Confidence

A.55 Figure 33 sets out statutory professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 81% of respondents are required to have the skills to identify species of mammals. 30% are confident that their level of skill is sufficient to meet foreseeable future challenges, 36% are fairly confident and 5% are not at all confident.

Fig 33. Species identification Skills Requirements and Confidence: Professionals in the Statutory Context
A.56 At least half of respondents working in the statutory context are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants.

A.57 Fewer respondents are expected to have species identification skills for fish, lichens, algae and fungi and their confidence levels in their skills in these areas are very low.

Statutory Professionals’ Summary

A.58 In summary, the knowledge and skills requirements and deficits of professionals working in the statutory context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - principles of habitat classification
  - principles of environmental management
  - freshwater systems and processes
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high

- The majority are also expected to have knowledge of:
  - environmental legislation and policy
  - principles of sustainable development
  - ecosystem services.
  Confidence levels in these knowledge areas are only moderate.

- Less than half of respondents are expected to have knowledge of: coastal and marine systems and processes and in skills in habitat creation, restoration and management in coastal and marine environments. Their confidence levels in these areas are low.

- There are gaps in their knowledge of:
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
− invertebrates
− reptiles and amphibians
− birds
− mammal communities.
Levels of confidence in these areas are relatively high, except for invertebrates where they are only moderate.

• A minority are expected to have skills in ecological survey and sampling of fish. The level of confidence in this area is significantly lower.

• The majority are expected to have species identification skills in respect of:
  − mammals
  − birds
  − invertebrates
  − reptiles and amphibians
  − higher plants
  − lower plants.
Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates and lower plants they are low.

• There are significant gaps in their species identification skills, required by nearly half of respondents, in respect of:
  − fish
  − lichens
  − algae
  − fungi.
**Key Issues for the Teaching Context**

A.59 65 professionals provided information from the Teaching context.

**Knowledge Requirements and Confidence**

A.60 Figure 34 sets out the teaching professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 69% of the 65 respondents require knowledge of principles of biodiversity conservation, but only 49% felt fully confident that their knowledge of the principles of biodiversity conservation was sufficient to meet foreseeable future challenges. 20% felt fairly confident about their knowledge in this area. None of the respondents felt not at all confident about their knowledge in this area.

![Knowledge requirements and confidence ratings of Professionals (Teaching): n = 65](image)

**Fig 34. Knowledge Requirements and Confidence: Professionals in the Teaching Context**

A.61 There are lower levels of confidence of coastal and marine systems and processes than for terrestrial and freshwater systems and processes.
A.62 There are also low levels of confidence in knowledge of cartography and data, environmental economics, industry and organisational structures, and environmental management system and audit.

Specialist Skills Requirements and Confidence

A.63 Figure 35 sets out the teaching professionals' specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 67% of respondents. 31% are confident that their level of skill is sufficient to meet foreseeable future challenges, 25% are fairly confident and 11% are not at all confident.

![Figure 35. Specialist Skills Requirements and Confidence: Professionals in the Teaching Context](#)

A.64 The level of confidence in ecological survey, sampling, analysis, assessment, evaluation and monitoring of fish is significantly lower than for the other communities.
A.65 Less than 50% of professionals working in the teaching context are required to have skills in habitat creation, restoration and management in marine, coastal or upland environments. Levels of confidence in habitat creation, restoration and management in the marine, coastal and upland environments are low.

**Species Identification Skills and Confidence**

A.66 Figure 36 sets out the teaching professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 72% of respondents are required to have the skills to identify species of mammals. 29% are confident that their level of skill is sufficient to meet foreseeable future challenges, 34% are fairly confident and 9% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Teaching): n = 65](image)

Fig 36. Species Identification Skills Requirements and Confidence: Professionals in the Teaching Context

A.67 At least 60% of respondents working in the teaching context are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants although levels of confidence in species identification for invertebrates and lower plants are significantly lower than for the other communities.
A.68 Fewer respondents are expected to have species identification skills for fish, lichens, algae and fungi and their confidence levels in their skills in these areas are very low.

Teaching Professionals’ Summary

A.69 In summary, the knowledge and skills requirements and deficits of professionals working in the teaching context are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - principles of habitat classification
  - environmental legislation and policy
  - principles of sustainable development
  - principles of environmental management
  - freshwater systems and processes
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - taxonomy
  - ecosystem services
  Confidence levels in these knowledge areas are only moderate.

- Less than half of respondents are expected to have knowledge of: coastal and marine systems and processes and in skills in habitat creation, restoration and management in coastal and marine environments. Confidence levels in these areas are low.

- There are gaps in their knowledge of:
  - cartography and data
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
  - reptiles and amphibians
- birds
- mammal communities.
Levels of confidence in these areas are relatively high.

• A minority are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish
Levels of confidence in these areas are significantly lower.

• the majority are expected to have species identification skills in respect of:
  - mammals
  - birds
  - invertebrates
  - reptiles and amphibians
  - higher plants
  - lower plants.
Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates and lower plants they are low.

• There are significant gaps in their species identification skills, required by a least a third of respondents, in respect of:
  - fish
  - lichens
  - algae
  - fungi.
B. KEY ISSUES BY BIOTOPE

B.1 This chapter provides a detailed analysis of the knowledge and skills requirements, together with identified gaps and shortages according to the biotope in which ecologists and environmental managers are working for at least 50% of their time. The four biotopes analysed are:

- Terrestrial
- Freshwater
- Coastal
- Marine.

B.2 Based on the Online Survey of Professionals, the analysis identifies:

- the knowledge and skills required of ecologists and environmental managers working in the biotope
- the level of confidence of professionals and their employers that their knowledge and skills are sufficient to meet foreseeable future challenges.

B.3 Each section concludes with a summary of the key knowledge and skills issues for that biotope, drawing on the findings from both the Online Surveys and the qualitative research, particularly the Semi-structured Interviews with Key Stakeholders and the Technical Workshop.
Key Issues for the Terrestrial Biotope

B.4 339 professional provided information on the Terrestrial Biotope.

Knowledge Requirements and Confidence

B.5 Figure 37 sets out the terrestrial biotope professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 76% of the 339 respondents require knowledge of principles of biodiversity conservation, but only 52% of the 339 respondents felt fully confident that their knowledge of the principles of biodiversity conservation was sufficient to meet foreseeable future challenges. 24% felt fairly confident about their knowledge in this area. None of the respondents felt not at all confident about their knowledge in this area.

![Knowledge requirements and confidence ratings of Professionals (Terrestrial): n = 339](image)

Fig 37. Knowledge Requirements and Confidence: Professionals in the Terrestrial Biotope
B.6 The percentage of respondents required to have knowledge in taxonomy, ecosystem services, cartography and data, environmental economics, environmental management system and audit, industry and organisational structures is lower, and their levels of confidence in these areas are significantly lower.

**Specialist Skills Requirements and Confidence**

B.7 Figure 38 sets out the terrestrial biotope professionals’ specialist skills requirements and the levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 67% of respondents. 31% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges, 25% are fairly confident and 11% are not at all confident.

![Fig 38. Specialist Skills Requirements and Confidence: Professionals in the Terrestrial Biotope](image-url)
B.8 The requirement for, and levels of confidence in, ecological survey, sampling, analysis, assessment, evaluation and monitoring of fish and invertebrate communities are significantly lower than for the other communities.

B.9 Fewer professionals working in the terrestrial biotope are required to have skills in habitat creation, restoration and management in upland environments than in woodland, lowland grassland or urban/brownfield environments.

*Species Identification Skills and Confidence*

B.10 Figure 39 sets out the terrestrial biotope professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 68% of respondents are required to have the skills to identify species of mammals. 37% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges, 26% are fairly confident and 5% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Terrestrial): n = 339](image)

Fig 39. Species Identification Skills Requirements and Confidence: Professionals in the Terrestrial Biotope
B.11 At least 50% of respondents working in the terrestrial biotope are expected to have species identification skills for mammals, birds, invertebrates, reptiles and amphibians and higher plants and lower plants although levels of confidence in species identification for invertebrates and lower plants are significantly lower than for the other communities.

B.12 Fewer respondents are required to have species identification skills for fish, lichens, algae and fungi and their confidence levels in their skills in these areas are very low.

Terrestrial Biotope Professionals’ Summary

B.13 In summary, the knowledge and skills requirements and deficits of professionals working in the terrestrial biotope are:

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - terrestrial systems and processes
  - principles of habitat classification
  - principles of environmental management
  - environmental legislation and policy
  - principles of sustainable development
  - taxonomy
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - ecosystem services
  - cartography and data.
  Confidence levels in these knowledge areas are only moderate.

- There are gaps in knowledge, required by at least a third of respondents, of:
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
  - reptiles and amphibians
- birds
- mammal communities.
Levels of confidence in these areas are relatively high.

- A minority are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish.
Levels of confidence in these areas are significantly lower.

- Skills in habitat creation, restoration and management in lowland grassland, woodland and urban/brownfield environments are required by at least 50% of respondents and confidence levels are relatively high; similar skills in upland environments are slightly less in demand and confidence levels are only moderate.

- The majority are expected to have species identification skills in respect of:
  - mammals
  - birds
  - invertebrates
  - reptiles and amphibians
  - higher plants
  - lower plants.
Levels of confidence in species identification skills for mammals, reptiles and amphibians and higher plants areas are relatively high, for birds confidence levels are only moderate, and for invertebrates and lower plants they are low.

- There are significant gaps in their species identification skills, required by a least a third of respondents, in respect of:
  - fish
  - lichens
  - algae
  - fungi.
### Key Issues for the Freshwater Biotope

B.14 79 professionals provided information on the Freshwater Biotope.

#### Knowledge Requirements and Confidence

B.15 Figure 40 sets out the freshwater biotope professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 80% of the 79 respondents require knowledge of freshwater systems and processes, but only 52% of the 79 respondents felt fully confident that their knowledge of the freshwater systems and processes was sufficient to meet foreseeable future challenges. 25% felt fairly confident about their knowledge in this area and 3% felt not at all confident.

#### Knowledge requirements and confidence ratings of Professionals (Freshwater): n = 79

<table>
<thead>
<tr>
<th>Area</th>
<th>Very Confident</th>
<th>Fairly Confident</th>
<th>Not at All Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater systems and processes</td>
<td>52%</td>
<td>25%</td>
<td>3%</td>
</tr>
<tr>
<td>Principles of ecology</td>
<td>54%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Environmental legislation and policy</td>
<td>35%</td>
<td>35%</td>
<td>9%</td>
</tr>
<tr>
<td>Principles of environmental management</td>
<td>35%</td>
<td>35%</td>
<td>9%</td>
</tr>
<tr>
<td>Principles of biodiversity conservation</td>
<td>28%</td>
<td>44%</td>
<td>3%</td>
</tr>
<tr>
<td>Human impact on ecological systems</td>
<td>28%</td>
<td>35%</td>
<td>6%</td>
</tr>
<tr>
<td>Principles of sustainable development</td>
<td>8%</td>
<td>32%</td>
<td>8%</td>
</tr>
<tr>
<td>Principles of habitat classification</td>
<td>4%</td>
<td>39%</td>
<td>3%</td>
</tr>
<tr>
<td>Taxonomy</td>
<td>16%</td>
<td>32%</td>
<td>3%</td>
</tr>
<tr>
<td>Ecosystem services</td>
<td>3%</td>
<td>34%</td>
<td>28%</td>
</tr>
<tr>
<td>Cartography and data</td>
<td>11%</td>
<td>24%</td>
<td>15%</td>
</tr>
<tr>
<td>Environmental economics</td>
<td>14%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Industry and organisational structures in the sector</td>
<td>8%</td>
<td>15%</td>
<td>11%</td>
</tr>
<tr>
<td>Environmental management system (EMS) and audit</td>
<td>6%</td>
<td>11%</td>
<td>15%</td>
</tr>
</tbody>
</table>

**Fig 40. Knowledge Requirements and Confidence: Professionals in the Freshwater Biotope**
B.16 The percentage of respondents required to have knowledge in ecosystem services, cartography and data, environmental economics, environmental management system and audit, industry and organisational structures is lower, and their levels of confidence in these areas is significantly lower.

**Specialist Skills and Confidence**

B.17 Figure 41 sets out the freshwater biotope professionals’ specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 67% of respondents. 31% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges, 25% are fairly confident and 11% are not at all confident.

**Specialist skills requirements and confidence ratings of Professionals (Freshwater): n = 79**

<table>
<thead>
<tr>
<th>Category</th>
<th>Very Confident</th>
<th>Fairly Confident</th>
<th>Not at All Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECOLOGICAL SURVEY AND SAMPLING OF: plant communities and vegetation</td>
<td>16%</td>
<td>20%</td>
<td>24%</td>
</tr>
<tr>
<td>invertebrate communities</td>
<td>8%</td>
<td>16%</td>
<td>23%</td>
</tr>
<tr>
<td>fish</td>
<td>8%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>reptiles and amphibian communities</td>
<td>13%</td>
<td>18%</td>
<td>23%</td>
</tr>
<tr>
<td>bird communities</td>
<td>8%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>mammal communities</td>
<td>6%</td>
<td>14%</td>
<td>19%</td>
</tr>
<tr>
<td>ECOLOGICAL ANALYSIS, ASSESSMENT AND EVALUATION OF: plant communities and vegetation</td>
<td>16%</td>
<td>22%</td>
<td>29%</td>
</tr>
<tr>
<td>invertebrate communities</td>
<td>8%</td>
<td>14%</td>
<td>19%</td>
</tr>
<tr>
<td>fish</td>
<td>6%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>reptiles and amphibian communities</td>
<td>10%</td>
<td>15%</td>
<td>19%</td>
</tr>
<tr>
<td>bird communities</td>
<td>6%</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>mammal communities</td>
<td>4%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>ECOLOGICAL MONITORING OF: plant communities and vegetation</td>
<td>16%</td>
<td>22%</td>
<td>28%</td>
</tr>
<tr>
<td>invertebrate communities</td>
<td>8%</td>
<td>14%</td>
<td>19%</td>
</tr>
<tr>
<td>fish</td>
<td>6%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>reptiles and amphibian communities</td>
<td>10%</td>
<td>15%</td>
<td>19%</td>
</tr>
<tr>
<td>bird communities</td>
<td>6%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>mammal communities</td>
<td>4%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>HABITAT CREATION, RESTORATION AND MANAGEMENT: freshwater</td>
<td>16%</td>
<td>22%</td>
<td>28%</td>
</tr>
<tr>
<td>AERIAL INTERPRETATION, MAPPING AND GIS</td>
<td>8%</td>
<td>14%</td>
<td>19%</td>
</tr>
</tbody>
</table>

**Fig 41. Specialist Skills Requirements and Confidence: Professionals in the Freshwater Biotope**
B.18 There are significant deficits in the specialist skills of professionals working in the freshwater biotope in ecological survey, sampling, analysis, assessment, evaluation and monitoring in respect of all types of communities.

B.19 There is a strong requirement for professionals working in the freshwater biotope to have skills in habitat creation, restoration and management in freshwater environments (64%) and they have high levels of confidence (59% are very confident or fairly confident) in this area.

Species Identification Skills and Confidence

B.20 Figure 42 sets out the freshwater biotope professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 69% of respondents are required to have the skills to identify species of mammals. 23% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges, 30% are fairly confident and 6% are not at all confident.

![Species ID skills requirements and confidence ratings of Professionals (Freshwater): n = 79](image)

**Fig 42. Species Identification Skills Requirements and Confidence: Professionals in the Freshwater Biotope**
B.21 At least 50% of respondents working in the freshwater biotope are expected to have species identification skills for mammals, higher plants and lower plants and at least 40% for birds, invertebrates, fish, reptiles and amphibians and algae.

B.22 Confidence levels in species identification skills for fish and algae are relatively low (only 8% and 6% respectively are very confident in these areas) and for lichens and fungi confidence levels are very low (although they are not strong requirements in the freshwater biotope).

**Freshwater Biotope Professionals’ Summary**

B.23 In summary, the knowledge and skills requirements and deficits of professionals working in the freshwater biotope are:

- The majority are expected to have knowledge of:
  - freshwater systems and processes
  - principles of ecology
  - principles of biodiversity conservation
  - principles of habitat classification
  - principles of environmental management
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - environmental legislation and policy
  - principles of sustainable development
  - taxonomy
  - ecosystem services.
  Confidence levels in these knowledge areas are only moderate.

- There are gaps in knowledge, required by at least a third of respondents, of:
  - cartography and data
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- The majority are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
  - plants and vegetation
  - mammal communities.
  Levels of confidence in these areas are relatively high.
• A third to a half of respondents are expected to have skills in ecological survey and sampling of:
  – invertebrates
  – fish
  – reptiles and amphibians
  – birds.
  Levels of confidence in these areas are significantly lower.

• Skills in habitat creation, restoration and management in freshwater environments are required by at least nearly two thirds of respondents and confidence levels are high.

• The majority are expected to have species identification skills in respect of:
  – mammals
  – higher plants
  – lower plants.
  Levels of confidence in species identification skills for mammals and higher plants areas are relatively high, for lower plants they are low.

• There are significant gaps in species identification skills, required by 30% or more respondents, in respect of:
  – birds
  – invertebrates
  – fish
  – lichens
  – algae.

• Less than one fifth of respondents require skills to identify fungi, and confidence levels are very low even amongst those who do require them.
Key Issues for the Coastal Biotope

B.24 17 professionals provided information on the Coastal Biotope. The findings from this part of the survey may not be representative of the population of those working in the coastal biotope as a whole.

Knowledge Requirements and Confidence

B.25 Figure 43 sets out the coastal biotope professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 82% of the 17 respondents require knowledge of principles of environmental management, but only 47% of the 17 respondents felt very confident that their knowledge of the principles of environmental management was sufficient to meet foreseeable future challenges. 29% felt fairly confident about their knowledge in this area and 6% felt not at all confident.

![Knowledge requirements and confidence ratings of Professionals (Coastal): n = 17](image)

**Fig 43. Knowledge Requirements and Confidence: Professionals in the Coastal Biotope**
The percentage of respondents required to have knowledge in cartography and data, ecosystem services and taxonomy is lower, and their levels of confidence in these areas are also lower.

The percentage of respondents required to have knowledge in environmental economics, industry and organisational structures and environmental management system and audit is significantly lower, and their levels of confidence in these areas are significantly lower.

**Specialist Skills Requirements and Confidence**

Figure 44 sets out the coastal biotope professionals' specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 53% of respondents. 18% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges and 35% are fairly confident. No respondent was not at all confident about their skill in this area.

![Specialist Skills Requirements and Confidence: Professionals in the Coastal Biotope](image_url)
B.29 The focus of specialist skills for those working in the coastal biotope is in ecological survey, sampling, analysis, assessment, evaluation and monitoring of plant communities, with some emphasis also on mammal communities and reptile and amphibian communities. Confidence levels in these areas are relatively high.

B.30 There is a lesser requirement for those working in the coastal biotope to have specialist skills in ecological survey, sampling, analysis, assessment, evaluation and monitoring of invertebrate, fish and bird communities, and confidence levels in these areas are significantly lower.

B.31 The requirement for professionals working in the coastal biotope to have skills in habitat creation, restoration and management is also low (only 24% are required to have skills in this area) and levels of confidence are also low (18% fairly confident, 6% not at all confident with no respondent feeling very confident in this area).

**Specialist Skills Requirements and Confidence**

B.32 Figure 45 sets out the coastal biotope professionals' species identification skills requirements their levels of confidence in those skills. For example, 48% of respondents are required to have the skills to identify species of mammals. 18% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges, 24% are fairly confident and 6% are not at all confident.
B.33 At least 50% of respondents working in the coastal biotope are expected to have species identification skills for mammals, birds, higher plants and lower plants. Confidence levels in these areas are relatively high, except for the confidence level of species identification skills for lower plants which is significantly lower.

B.34 Confidence levels in species identification skills for invertebrates and reptiles and amphibians are also relatively low and confidence levels in respect of fish, lichens, algae and fungi are very low.

Coastal Biotope Professionals’ Summary

B.35 In summary, the knowledge and skills requirements and deficits of professionals working in the coastal biotope are (the following findings should be treated with caution due to the small sample size):

- The majority are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - coastal systems and processes
  - principles of habitat classification
  - principles of environmental management
  - principles of sustainable development
  - taxonomy
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- The majority are also expected to have knowledge of:
  - environmental legislation and policy
  - ecosystem services
  - cartography and data.
  Confidence levels in these knowledge areas are only moderate.

- There are gaps in knowledge, required by at least a third of respondents, of:
  - taxonomy
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- At least 40% are expected to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring of:
- plants and vegetation
- reptiles and amphibians
- mammal communities.
Levels of confidence in these areas are relatively high.

- Between 20-40% are expected to have skills in ecological survey and sampling of:
  - invertebrate communities
  - fish
  - birds.
Levels of confidence in these areas are significantly lower.

- Surprisingly, only a quarter of respondents are expected to have skills in habitat creation, restoration and management in coastal environments and their levels of confidence in this area are moderate to low.

- At least 40% are expected to have species identification skills in respect of:
  - mammals
  - birds
  - invertebrates
  - reptiles and amphibians
  - higher plants
  - lower plants
  - lichens.
Levels of confidence in species identification skills for mammals and higher plants areas are relatively high, for birds, invertebrates, reptiles and amphibians confidence levels are only moderate, and for lower plants and lichens they are low.

- There are significant gaps in species identification skills, required by at least a quarter of respondents, in respect of
  - fish
  - algae
  - fungi.
### Key Issues for the Marine Biotope

**B.36** 11 professionals provided information on the Marine Biotope. The findings from this part of the survey may not be representative of the population of those working in the marine biotope as a whole.

### Knowledge Requirements and Confidence

**B.37** Figure 46 sets out the marine biotope professionals’ particular knowledge requirements and their level of confidence in their knowledge. For example, 53% of the 11 respondents require knowledge of human impact on ecological systems, but only 9% of the 11 respondents felt very confident that their knowledge of the human impact on ecological systems was sufficient to meet foreseeable future challenges. 45% felt fairly confident about their knowledge in this area; no respondent felt not at all confident.

![Knowledge requirements and confidence ratings of Professionals (Marine): n = 11](image)

**Fig 46. Knowledge Requirements and Confidence: Professionals in the Marine Biotope**
B.38 The percentage of respondents required to have knowledge of industry and organisational structures, cartography and data, environmental management system and audit, ecosystem services and environmental economics is lower, and their levels of confidence in these areas are significantly lower.

**Specialist Skills Requirements and Confidence**

B.39 Figure 47 sets out the marine biotope professionals’ specialist skills requirements and their levels of confidence in those skills. For example, ecological survey and sampling of plant communities and vegetation is a skill required by 18% of respondents. 9% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges and 9% are fairly confident. No respondent was not at all confident about their skill in this area.

---

**Specialist skills requirements and confidence ratings of Professionals (Marine): n = 11**

<table>
<thead>
<tr>
<th>Specialist Skills</th>
<th>Very Confident</th>
<th>Fairly Confident</th>
<th>Not At All Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological survey and sampling of plant communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>and vegetation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invertebrate communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Fish</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Reptiles and amphibian communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Bird communities</td>
<td>9%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Mammal communities</td>
<td>9%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Ecological analysis, assessment and evaluation of plant</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>communities and vegetation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invertebrate communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Fish</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Reptiles and amphibian communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Bird communities</td>
<td>9%</td>
<td>9%</td>
<td>0%</td>
</tr>
<tr>
<td>Mammal communities</td>
<td>9%</td>
<td>9%</td>
<td>0%</td>
</tr>
<tr>
<td>Ecological monitoring of plant communities and vegetation</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Invertebrate communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Fish</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Reptiles and amphibian communities</td>
<td>9%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Bird communities</td>
<td>9%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Mammal communities</td>
<td>9%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Habitat creation, restoration and management: marine</td>
<td>0%</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Aerial interpretation, mapping and GIS</td>
<td>0%</td>
<td></td>
<td>9%</td>
</tr>
</tbody>
</table>

**Fig 47. Specialist Skills Requirements and Confidence: Professionals in the Marine Biotope**

B.40 In contrast to the other biotopes, it is striking that, for those working in the marine biotope, specialist skills in ecological survey, sampling, analysis, assessment, evaluation and monitoring are not priority requirements. Where professionals possess these skills, their confidence levels in these areas are relatively high.
B.41 The requirement for professionals working in the marine biotope to have skills in habitat creation, restoration and management is also not particularly high (only 36% are required to have skills in this area), but levels of confidence in this area are relatively low (18% fairly confident, 18% not at all confident, with no respondent feeling fully confident in this area).

B.42 Aerial interpretation, mapping and GIS is not a requirement in the marine biotope.

Species Identification Skills and Confidence

B.43 Figure 48 sets out the marine biotope professionals’ species identification skills requirements and their levels of confidence in those skills. For example, 36% of respondents are required to have the skills to identify species of mammals. 9% of respondents are confident that their level of skill is sufficient to meet foreseeable future challenges and 27% are fairly confident. No respondent was not at all confident about their skills in this area.

![Species ID skills requirements and confidence ratings of Professionals (Marine): n = 11](image)

**Fig 48. Species Identification Skills Requirements and Confidence: Professionals in the Marine Biotope**

B.44 Again, it is striking that species identification skills are relatively unimportant for ecologists and environmental managers working in the marine biotope, compared to their colleagues working in other biotopes. Levels of confidence are also relatively low.
B.45 In summary, the knowledge and skills requirements and deficits of professionals working in the marine biotope are (the following findings should be treated with caution due to the small sample size):

- At least one third are expected to have knowledge of:
  - principles of ecology
  - principles of biodiversity conservation
  - marine systems and processes
  - principles of habitat classification
  - principles of environmental management
  - principles of sustainable development
  - taxonomy
  - environmental legislation and policy
  - human impact on ecological systems.
  Levels of confidence in these knowledge areas are relatively high.

- There are gaps in knowledge, required by about a quarter of respondents, of:
  - cartography and data
  - industry and organisational structures
  - environmental economics
  - environmental management system and audit.

- Whilst the requirement for professionals working in the marine biotope to have skills in ecological survey and sampling, analysis, assessment, evaluation and monitoring is low, their levels of confidence in these areas are relatively high.

- A third of respondents are expected to have skills in habitat creation, restoration and management in marine environments and their levels of confidence in this area are moderate to low.

- Species identification skills are relatively unimportant for respondents working in the marine biotope. Confidence levels in species identification skills are also relatively low, except in respect of mammals and invertebrates where they are more strongly in demand.
C. **KEY ISSUES BY LENGTH OF EXPERIENCE**

C.1 This chapter seeks to understand how seniority – the length of time professionals have been working as ecologists or senior managers – impacts on the knowledge and skills they are required to have and their levels of confidence in their knowledge and skills.

C.2 Based on the Online Survey of Professionals, the knowledge and skills requirements and levels of confidence have been analysed according to the numbers of years respondents have been practising since graduating/qualifying, grouped as follows:

- up to 2 years
- 2-4 years
- 4-10 years
- more than 10 years.
Knowledge

C.3 Figure 49 shows that the amount or depth of knowledge an ecologist or environmental manager is required to have increases significantly in almost all areas over the first ten years as a professional. (The greater the area within the coloured lines, the higher the percentage of professionals with that length of experience required to possess this specialist knowledge).

C.4 It is interesting to note that there is a slight reduction in the knowledge requirements in most areas for those who have been practising for more than ten years. A possible cause, common to other professions, may be that some senior professionals are working in management roles where strategic and management knowledge sets (not covered by this research) become important requirements.

Fig 49. Professionals’ Knowledge Requirements by Length of Experience
C.5 Figure 50 shows the percentage of ecologists with a certain length of experience who state they are *very confident or fairly confident* that they have sufficient knowledge in that area to meet foreseeable future challenges. (The greater the area within the coloured lines, the higher the percentage of professionals with that length of experience who feel *very confident or fairly confident* about their knowledge).

C.6 It is striking that professionals at the beginning of their careers (blue line) have high confidence levels in most areas (except marine systems and processes, coastal systems and processes, environmental management and audit and cartography and data), many are less confident in certain areas after two years (red line) and after four years (green line) their confidence builds up again and remains high after ten years (purple line).
Skills in Ecological Analysis, Assessment and Evaluation

C.7 Figure 51 shows the percentage of professionals requiring ecological analysis, assessment and evaluation skills, according to their length of experience.

C.8 It is clear that the demand for these skills increases markedly with seniority during the first ten years of practice. However, some senior ecologists and environmental managers (those with at least ten years' experience) have less need for these practical skills, possibly because they delegate these responsibilities or supervise others carrying out these activities, as happens in other professions.
Fig 51. Professionals’ Requirements for Skills in Ecological Analysis, Assessment and Evaluation by Length of Experience

C.9 Figure 52 shows the percentage of professionals who are very confident or fairly confident about their ecological analysis, assessment and evaluation skills, according to their length of experience.

C.10 As with knowledge, confidence levels in some areas (e.g. bird communities and invertebrate communities) drop after two years’ experience but build up again after four years to higher levels, which are then enhanced or maintained after ten years.
Skills in Habitat Creation, Restoration and Management

C.11 The picture regarding skills in habitat creation, restoration and management is slightly different. Figure 53 shows the percentage of professionals requiring habitat creation, restoration and management, according to their length of experience.

C.12 Again, demand for these skills increases markedly with seniority during the first ten years of practice. However, some senior ecologists and environmental managers (those with at least ten years’ experience) have less need for these practical skills, possibly because they delegate these responsibilities or supervise others carrying out these activities.
Habitat creation, restoration and management requirements by length of experience (Professionals)

C.13 Figure 54 shows the percentage of professionals who are very confident or fairly confident about their habitat creation, restoration and management skills, according to their length of experience.

C.14 The percentage of recent graduates who are very confident or fairly confident about their skills in this area is markedly lower (except in coastal environments) than professionals with 2-4 years’ experience. Confidence levels in habitat creation, restoration and management skills continue to build with experience over 4-10 years and even after 10 years.
Fig 54. Professionals’ Confidence in their Skills in Habitat Creation, Restoration and Management by Length of Experience

Species Identification Skills
C.15 The picture regarding species identification skills is less clear cut. Figure 55 shows the percentage of professionals requiring species identification skills, according to their length of experience.

C.16 There is a slight increase in demand for these skills with seniority during the first ten years of practice. However, after ten years this demand reduces, possibly because some senior ecologists and environmental managers have less need for these practical skills because they delegate these responsibilities or supervise others carrying out these activities.
C.17 Figure 56 shows the percentage of professionals who are very confident or fairly confident about their species identification skills, according to their length of experience.
C.18 The picture here is not at all clear cut, apart from the fact that confidence levels for all groups of respondents are very low in respect of lower plants, lichens, algae and fungi. Overall, however, confidence levels in species identification tend to increase with experience. As one stakeholder interviewed commented, “there is no substitute for experience”.

![Species ID skills confidence ratings by length of experience](image)

**Fig 56. Professionals' Confidence in their Skills in Species Identification Skills by Length of Experience**

**Conclusions**

C.19 It would appear that demands for specialist knowledge and skills in ecology and environmental management increase with seniority, at least for the first ten years of practice. After ten years or so, specialist knowledge and skills are less important for some ecologists and environmental managers, possibly because they take on management roles and delegate specialist responsibilities or supervise others carrying out these tasks. This is a common phenomenon found in most professions.
C.20 It would also appear that many recent graduates may be over-confident about their specialist knowledge and skills. They get a rude awakening in their first couple of years and reappraise their knowledge and skills levels after exposure to the demands of their work. They gradually develop their knowledge and skills, possibly through both practice and further study, until, after ten years or so, they develop a more realistic sense of their own levels of knowledge and skills. In training jargon, they become “consciously competent”
D. LITERATURE REVIEWED


### TECHNICAL WORKSHOP PARTICIPANTS

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