Living With Environmental Change

NATURAL ENVIRONMENT RESEARCH COUNCIL

MOST WANTED II
Postgraduate and Professional Skills Needs in the Environment Sector

LWEC REPORT 2012

WHO IS THIS REPORT FOR?

This report is designed as a guide for students, supervisors and those responsible for designing and funding studentship training.

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FOREWORD

"Skills shortages contribute to the productivity gap between the UK and other leading industrial countries"

Vince Cable (Secretary of State for Business, Innovation and Skills)

Professor Duncan Wingham

In today's knowledge-based economy, economic success relies on the availability of a highly skilled workforce. In particular, the future prosperity of the UK environmental sciences sector depends on a healthy supply of people with the right skills to tackle the diverse and dynamic challenges we face. This skills review highlights specialist and transferable skills that are urgently needed to build a strong, vibrant economy.

I was pleased to receive this report, the purpose of which was to refresh and update the data from the first 'Most Wanted' report. Both the first report (2010) and this, the second 'refreshed' report (2012), are based on information provided directly by the environmental sciences sector about the skills gaps that exist in the workforce. The results of the 'refresh' exercise indicate that the skills gaps identified in the first report persist. These include areas such as modelling, multi-disciplinary working, data management, numeracy and skills in translating research into practice.

This document details the top fifteen identified skills gaps. It is designed to help guide students when making career choices, and to highlight priority areas for investment.

I therefore welcome this report, which was conducted by NERC on behalf of the Living With Environmental Change (LWEC) programme. The 'Most Wanted' reports are important and useful resources. Maintaining these resources and updating the information they contain is the vital first step in stopping skills needs becoming gaps we cannot fill

Professor Duncan Wingham
NERC Chief Executive

INTRODUCTION

"I see at first-hand the huge benefits realised when research and business work together, and the importance of maintaining a dialogue between those two communities."

Professor Robert Allinson (Vice-Chancellor and President, Loughborough University)
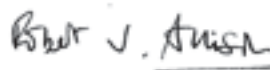
PROFESSOR ROBERT ALLISON

I am very pleased to have had another opportunity to work with the Living With Environmental Change (LWEC) cross-government initiative, on this new edition of 'Most Wanted'. This focused analysis of skills needs and gaps is a huge asset to the research community. It enables us to plan for the long-term, to ensure the UK not only continues to produce world-leading environmental science, but can apply that knowledge to meet the economic and societal challenges we currently face.

From the perspective of a training provider, I believe it's crucial that research funders work together and take an holistic approach to the provision of skills training, and tools like this Review enable us to do that more effectively.

At Loughborough University, in our academic Schools, at the Innovation Centre, and on our Science Park, I see at first-hand the huge benefits realised when research and business work together, and the importance of maintaining a dialogue between those two communities. It is therefore reassuring to see that LWEC is committed to keeping its report current and the on-going consultations with business that this entails will be an important part of that dialogue.

I know this Skills Review will continue to be a valuable resource for students and trainers, and will help ensure that our investment in skills and expertise is designed with long-term growth in mind, both personal and economic.

Robert J. Allison

Professor Robert Allison,
Vice-Chancellor & President Loughborough University

OVERVIEW

FIRST REPORT: 2010 'MOST WANTED SKILLS NEEDS IN THE ENVIRONMENTAL SECTOR'

Between 2008 and 2010, NERC led the Review of Skills Needs in the Environment Sector on behalf of the Environment Research Funders' Forum (ERFF). The purpose of the first report and associated Skills Framework was to identify critical skills[1] gaps for the environment sector[2] over the following ten years. It was also the first inventory of the postgraduate and professional skills required by the environmental sciences sector, with the need for each skill clearly explained. The review's outputs provided a point of reference for anyone considering further training to pinpoint skills that will enhance their employability. It also acts as an

important resource for anyone involved in planning training provision, designing new or revising existing programmes of study, and preparing qualification frameworks.

The Most Wanted report was published in 2010 and represents a detailed piece of work which took two years to complete. The substantial investment of time was made to ensure information had been properly gathered and analysed though consultation across the environmental sciences sector including business, government and the research base.

SECOND REPORT: 2012 'MOST WANTED II: POSTGRADUATE AND PROFESSIONAL SKILLS NEEDS IN THE ENVIRONMENT SECTOR'

The aim of this second report is to 'refresh' the data produced by the first report. The review sought feedback on the state of the skills gaps previously identified and information on any new or emerging gaps. Information was gathered through open and targeted consultation and in-depth interviews. More than 130 responses were received in total. Business and industry made

up an increased contribution to the 2012 refresh as almost a quarter of the responses received were from that part of the sector. In addition to this report, the original Skills Framework (a far-ranging compilation of 224 skills needs) has been updated, and a new Skills Framework[3] has been produced, as a quick reference to the top 30 critical skills areas identified.

FINDINGS OF THE SECOND REPORT

This second report adds to the substantial picture of postgraduate and professional skills gaps provided by the first. The most noticeable outcome of the latest consultations with the environment sector is that, in the two years since the last review was published, the critical skills gaps headlined by those

consulted have not changed, and nor has their priority order. This outcome is not unexpected, given the time it takes to train people once skills gaps have been identified. Nevertheless, the second report confirms the need for these skills and the need to invest in training to provide them.

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[1] *The review took a broad definition of skills and considered both knowledge and skills areas.*
[2] *For the purposes of the review the Environment Sector is defined as "those parts of the UK that significantly rely on, or generate, knowledge concerned with the state and condition of the Earth".*
[3] *The short form framework is available along with the outputs of the 2012 review on the NERC website: http://www.nerc.ac.uk/funding/available/postgrad/skillsreview/review2012.asp*

The table below sets out the 15 critical skills gaps (in priority order) that were headlined by the consultation process.

In total the review identified 224 skills areas and 83 skills gaps. All of these are presented in detail in the Skills Framework. This is a far-ranging statement of skills needs and is freely available and accessible online[4]. The 2012 refresh updated the original Skills Framework and produced a short summary of the top 30 transferable and environmental research skill areas, but with references to more information for those who need to delve deeper.

Following feedback on the first report, this new review recognises that some of the skills gaps identified are more cross-disciplinary than others.

It identifies a shortage in eight types of specialist research skills and seven types of more transferable research skills.

The table below divides the 15 skills gaps into these two categories, in recognition that employers place a high value on cross-disciplinary skills.

- *Students* (*current or potential*) should strive to gain some cross-disciplinary skills, for example numeracy or modelling, particularly if their core training is discipline-specific.

- *Training funders/ providers* should aim to cover some of the skills gaps in the cross-disciplinary section as well as the discipline-specific skills.

Most Wanted Skills:

1. Modelling
2. Multi-disciplinarity
3. Data Management
4. Numeracy
5. Translating Research Into Practice
6. Fieldwork
7. Risk and Uncertainty
8. Taxonomy and Systematics
9. Soil Science
10. Environmental Epidemiology
11. Sustainability Science and Planning
12. Microbiology
13. Food Supply
14. Energy Supply
15. Freshwater Science

Cross-Disciplinary Skills:

Modelling

Multi-disciplinarity

Data Management

Numeracy

Translating Research Into Practice

Fieldwork

Risk and Uncertainty

Discipline Specific Skills:

Taxonomy and Systematics

Soil Science

Environmental Epidemiology

Sustainability Science and Planning

Microbiology

Food Supply

Energy Supply

Freshwater Science

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MOST WANTED SKILLS

THE CRITICAL SKILLS GAPS

This section details the top 15 skills which are 'most wanted' in the environment sector.

The information provided in this section is based on the needs of the environmental sciences sector. More details about each skills gap (and other identified skills areas and gaps) can be found in the Skills Framework summary and technical reports.

The reference numbers (shown below the title of each of the 15 critical skills) link to the Skills Framework which can be found at: http://www.nerc.ac.uk/funding/available/postgrad/skillsreview/review2012.asp. This allows users to search easily for areas of interest and shows how information in the Skills Framework has been summarised for this report. All quotes are paraphrased from consultation responses.

Modelling
A014 B010 D019

"We simply don't have enough environmental scientists with modelling skills."

Summary:
We need people with specific modelling skills who have a broad experience and in-depth understanding of environmental sciences. This skill is particularly needed to help drive innovation through the exchange of knowledge and experience across different disciplines.

Specific needs:
- Physical systems modelling:
  - carbon and nitrogen systems
  - soil systems
  - coastal systems
  - climate systems
- Model interrogation and interpretation.
- Spatial analysis and Geographic Information Systems (GIS).
- Numerical and mathematical modelling.

These skills are crucial, for example:
- Developing appropriate climate adaptation strategies.
- Preventing coastal erosion and flooding.

Multi-disciplinarity

A010 A003 A015 D028

"Multidisciplinary communication is crucial if we are to solve today's environmental challenges."

Summary:

Some of the most ground-breaking science is at interdisciplinary boundaries. If we are to find innovative solutions to tackle climate change and other challenges we need people who can drive and develop this cutting-edge work.

These skills are crucial, for example:

- Understanding and responding to the impacts of:
  - extreme weather and climate events
  - changing populations.

Specific needs:

- Working across the natural-social science boundary.
- Experience and understanding of working with multi-disciplinary teams and outputs.
- Work at the interface of science and engineering.

Data Management

A004 C012 D016 D025 D023

"We need scientists with skills in computing techniques for storing, analysing and modelling data and meta-data."

Summary:

We need to ensure that environmental science data can be stored, shared and used effectively. It is also important that the environmental sector as a whole understands the importance of data management and shares the resource more widely.

These skills are crucial, for example:

- Understanding climate feedback, processes and adapting to climate change.
- Environmental monitoring and modelling.

Specific needs:

- Interrogating large datasets and data mining.
- Large scale data manipulation.
- Understanding data integrity protocols, assurance and archiving.
- Environmental informatics.
- Genomics.
- Parameterisation and assimilation.

Numeracy

A020 A011

"It's a big challenge getting mathematicians to work in environmental science."

Summary:

People with numeracy skills are critical for the environmental sciences. Strong quantitative skills which can be applied to a broad range of situations and disciplines make people highly employable.

These skills are crucial, for example:

- Using and understanding: predictions and forecasts of the rates, magnitude and types of environmental change.
- Development and application of emerging technologies.

Specific needs:

- Applying advanced statistical skills to meteorology.
- Developing mathematical models to predict natural phenomenon.
- Statistical methods for handling, analysing and interpreting large datasets.

Translating Research into Practice

for policy makers, businesses and society.

A003 A018 A002 A012 C008 C016 D017

"We need people who can explain their science to policy-makers."

Summary:

If research is to inform and benefit wider society we must be able to explain that research and its implications clearly to non-specialists, including policy-makers and regulators, business, non-governmental organisations, the public and the media. This includes translating research into products and services.

These skills are crucial, for example:

- Coordinating unified responses to climate change through legislation and policy.
- Promoting sustainable behaviour.
- Increasing the effectiveness of public services and policy.
- Increasing the economic competitiveness of the United Kingdom.

Specific needs:

- Understanding the requirements of policy-makers (science to policy).
- Business and management skills.
- Media training.
- Innovation and commercialisation.
- Emerging technologies.
- Science communication.

Fieldwork

A008 C019 D017

"Fieldwork and academic learning must go hand-in-hand."

Summary:
There is high demand from employers for good fieldwork skills. Fieldwork underpins environmental observation and monitoring, which in turn can increase our understanding of environmental issues.

Specific needs:
- Survey skills including species identification.
- Sampling techniques.
- Collection and recording protocols and methodologies.
- Technology use e.g. Unmanned Aerial Vehicles (UAVs).
- Fieldwork.
- Field observation.

These skills are crucial, for example:
- Improving and developing new monitoring techniques.
- Improving development and deployment of sensors and instruments.
- Understanding the vulnerabilities of ecosystem structures and functions.
- Testing theoretical and mathematical models with real-world data.

Risk and Uncertainty

A017 A005 D005

"We need people who can analyse risk and uncertainty and apply this to policy."

Summary:
Being able to understand and quantify the uncertainty, complexity and scientific principles of risk is vital so that research outputs can be effectively interpreted, especially when being used as evidence for decision making.

These skills are crucial, for example:
- Risk assessment of chemical substances including nanomaterials.
- The assessment of risk and uncertainty for hazards.

Specific needs:
- Uncertainty modelling.
- Quantitative risk assessment.
- Risk evaluation.
- Managing uncertainty.
- Communicating uncertainty.
- Hazard and risk assessment.

Taxonomy and Systematics
A022

"Training students in taxonomy is essential."

Summary:
We need people with skills in taxonomy (describing, delimiting and naming organisms) and systematics (organising taxonomic information). Both these skills are currently in short supply, from core practical field skills to basic theoretical understanding.

These skills are crucial, for example:
- onitoring and understanding the functionality of the marine environments.
- Recognising the role and value of biodiversity and ecosystem services.

Specific needs:
- Applying understanding of taxonomy and systematics to:
  - Oceanography (the biological pump);
  - Physiology;
  - Ecological function;
  - Biomathematics; and
  - Data management.
- Identification skills – across all organisms.
- Biological monitoring.

Soil Science
A019

"There is a need for more soil carbon scientists."

Summary:
We badly need soil scientists, especially in food and energy security, but also across the environmental sciences sector. The shortage of soil scientists is due to a lack of training courses in the UK.

These skills are crucial, for example:
- Security of agricultural land and food supply under demographic and environmental change.
- Energy Security.

Specific needs:
- Soil carbon monitoring and modelling.
- Understanding of soil system functions.
- Impact of land use on soils.

Environmental Epidemiology

A007 D018 D026

"Universities are simply not producing enough graduates with these skills."

Summary:

We need more people who can bridge the gap between environmental conditions and hazards that may pose a risk to human health. These skills are expected to become increasingly important over the next decade.

These skills are crucial, for example:

• Understanding the impact of disease vectors on human and non-human health.
• Assessing the health effects of exposure to environmental pollutants.
• Identifying the development and policy implications of human migration.

Specific needs:

• Predicting emergent diseases.
• Understanding population fluxes.
• Understanding the effects of climate change on disease.
• Environmental epidemiology.
• Health impact assessment.
• Public health and wellbeing.

Sustainability Science and Planning

A021 A023

"As responsible citizens we need to teach sustainability at every level."

Summary:

Technical skills will ensure that sustainability, and the promotion of sustainable behaviour, are at the heart of policy and economic activity. In parallel with this we need people with the skills to plan sustainably in response to increasing urbanisation.

These skills are crucial, for example:

• Protection of natural landscapes.
• Using legislation and policy to deliver sustainable uses of natural resources.

Specific needs:

• Environmental impact assessment.
• Strategic environmental assessment.
• Economic analysis.
• Developing indicators for sustainable consumption.
• Sustainability appraisal.
• Town and country planning.
• Environmental ethics.

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Microbiology

A013 B003 B006 C017 C004

"Microbial ecology is poorly understood and under-represented."

Summary:

We need people skilled in microbial physiology and basic microbiology. Skills in microbiology are required to understand issues such as ecosystem change and anaerobic digestion, which is used in renewable energy and waste management technologies.

Specific needs:

• Quantitative microbial community analysis.
• Measurement and monitoring of microbial catalysts of geochemical processes.
• Microbial ecology.
• Understanding anaerobic digestion.
• Bioremediation.

These skills are crucial, for example:

• Understanding the role of biodiversity in maintaining healthy ecosystems.
• Applying technology to the fields of energy provision.
• Increasing energy from waste.

Food Supply

A001

"We need people who can integrate new developments in agriculture with more traditional scientific fields."

Summary:

We need people who are skilled in the new and emerging fields of science, particularly those at the boundaries of disciplines, such as food supply. We especially need people who are skilled in fostering and applying learning between subjects; so that we can successfully tackle emerging environmental problems and ensure the security of the world's food.

Specific needs:

• Combining agricultural understanding with biological modelling.
• Understanding and managing diffuse pollution from food production.
• Understanding the effects of agriculture on soil systems.

These skills are crucial, for example:

• Security of agricultural land and food supply under demographic and environmental change.
• Protection and management of existing soil resources.

Energy Supply

A006 A016

"Renewable energy technology is a growing field which requires particular skills."

Summary:

We need energy specialists who have technical skills and an understanding of environmental science issues. Different energy sources present their own challenges so specialist skills associated with developing energy sources and emerging technologies are particularly valuable.

These skills are crucial, for example:

- Energy Security.
- Means and impacts of increasing energy provision.
- Exploring new sources of energy (e.g. algal bioenergy, shale gas, and methane hydrates etc.).

Specific needs:

- Energy provision.
- Marine energies and their impact.
- Energy technologies such as Geoengineering.
- Economics of energy supply and demand.

Freshwater Science

A009 D011

"Freshwater resources have never been more important."

Summary:

We particularly need people with skills in integrated freshwater sciences, which bring together the physical, chemical and biological aspects of the subject. The skills are linked to the efficient and sustainable use of water resources, an issue of increasing importance.

These skills are crucial, for example:

- Ensuring water quality under changing demand.
- Understanding the importance of water resources to ecosystems and agriculture.

Specific needs:

- Evaluating and interpreting indicators for the state of freshwater ecosystems.
- Understanding longitudinal links along water pathways.
- Ecological community dynamics.
- Understanding environmental legislation.

WHAT NEXT?

CONTINUING THE PROCESS

To help develop this major resource, to help students choose careers, and to prevent future skills gaps occurring, the skills framework has to be a living document. It cannot sit on the shelf gathering dust; it is only useful if it is regularly challenged, reviewed and updated so that developing shortages can be identified.

The recommendations made in the 2010 report still stand:

ONE – **The environmental sciences community should: use it, learn from it, replicate the process and help develop the work further.**

TWO – **NERC should nurture this community resource, refreshing the work regularly.**

NERC has agreed both to manage the review outputs on behalf of the environment sector, and to refresh the work regularly. This is important because skills needs change, and gaps will have been missed, overstated or understated.

The full outputs of the review can be found on the NERC website (see Annex A). If you would like further information or wish to contribute to the skills review, please contact NERC at: skills@nerc.ac.uk.

OUTPUTS FROM THE REVIEWS

This annex sets out all of the outputs from the review. They are also available on the NERC website http://www.nerc.ac.uk/funding/available/ postgrad/skillsreview/review2012.asp. For any further information please contact skills@nerc.ac.uk.

2012 REVIEW OUPUTS:

1) The Summary Report - 'Most Wanted' ERFF Report Number 7

2) The Skills Framework: the summary of all the postgraduate and professional skills needs for the environment sector.

3) Overview and Outputs Paper:

1. Overview
2. Guide to the Skills Framework for the Environment Sector
3. The Skills Framework for the Environment Sector
4. The Postgraduate and Professional Skills Needs Inventory
5. Report on additional feedback from the consultation
6. Report on the Methodology
7. The Way Forward

4) Annexes Paper:

1. Membership of the Board
2. Membership of the Review Group
3. Glossary
4. Documentation to the Public Consultation
5. Hierarchy of Drivers, Topics and Challenges
6. Bibliography
7. Inventory of Skills
8. Documentation for Public Consultation – Guidance
9. Documentation for Public Consultation – Response Form
10. Documentation for Public Consultation – Draft Skills Framework
11. Documentation for Public Consultation – Further information on the Review
12. Detailed record of the methodology for analysis of the responses to the Review
13. Documentation for Review Group Input – Guidance
14. Documentation for Review Group Input – Response Form
15. Documentation for Review Group Input – Updated Postgraduate Skills Framework
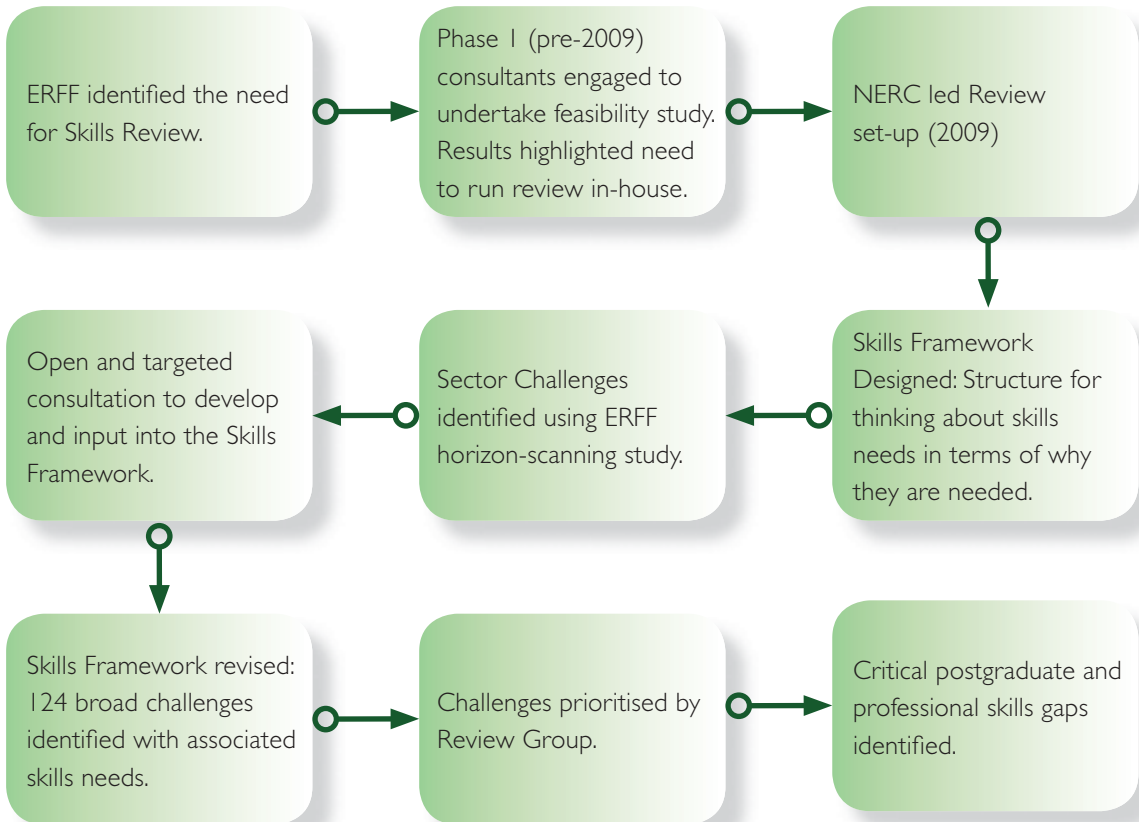
ANNEX B

THE REVIEW METHODOLOGY

The skills reviews (the 2010 and the refreshed 2012 reviews) have helped bring clarity to a complex and dynamic community, by gathering evidence about what skills are needed and why they are needed.

Evidence was gathered by consultation with the environmental sciences community, industry and policy makers. A framework of question was used and through this a useful body of evidence was collected.

The review used a different approach to standard skills and employment research because:

i.   The environment sector is characterised by its multi-disciplinary nature: there is high connectivity both within the community and through links to other communities; and it is reliant on capabilities and expertise from a broad range of subject areas.

ii. From the perspective of either an academic discipline or an economic activity, the community is not well captured in standard classifications.

iii. It is a relatively new and rapidly evolving area of activity and expertise.

iv. There are no comprehensive sources of information about, or definitions of, the current stock of skills.

v.   It was important to ask why as well as what skills are needed.

The sequence of the review process can be found overleaf.

ERFF identified the need for Skills Review.

Phase 1 (pre-2009) consultants engaged to undertake feasibility study. Results highlighted need to run review in-house.

NERC led Review set-up (2009)

Skills Framework Designed: Structure for thinking about skills needs in terms of why they are needed.

Sector Challenges identified using ERFF horizon-scanning study.

Open and targeted consultation to develop and input into the Skills Framework.

Skills Framework revised: 124 broad challenges identified with associated skills needs.

Challenges prioritised by Review Group.

Critical postgraduate and professional skills gaps identified.

ANNEX C

THE PROJECT BOARDS AND TEAMS

2012 SKILLS REFRESH

The Project Board

KIRSTY GRAINGER	Natural Environment Research Council
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DR SIMON JACKMAN	Natural Environment Research Council

The Project Team

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2010 SKILLS REVIEW

The Project Board

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We would especially like to thank Professor Robert Allison, Dr Simon Jackman and Miss Helen Dewberry for their contributions to this review.