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Climate change, the land-based labour market and rural land use in Scotland

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1 Executive summary

The Scottish Government's 2020 Update to the Climate Change Plan 2018-32 recognises the need for large scale and rapid changes to the way we use and manage our land to help reach Scotland's net zero targets. The Scottish Government is also committed to significant improvements in nature restoration, to tackle the twin crises of climate change and biodiversity loss.

Critical to delivery of these land use changes will be the size and skills of the workforce in land-based activities. In turn, the size and location of the workforce will be critical to the sustainability of many rural and island communities.

This report explores the condition and composition of the land-based labour market and the potential for scenario-based modelling to project future labour market requirements. We conducted a review of literature and of statistical data, and a small number of stakeholder interviews.

1.1 Key findings

Scotland's national labour market, as in many other Organisation for Economic Co-operation and Development (OECD) countries, has experienced a number of changes over the past few decades, including demographic ageing, advancing technological change and an increase in people with higher level skills. The Covid-19 pandemic, EU exit and the net zero transition have also led to shifts in the labour market.

1.1.1 The composition of the land-based workforce

It is difficult to build a reliable picture of the composition of the land-based workforce in Scotland for several reasons:

- There is **no formal, widely accepted definition** of the land-based sector, and therefore no clear, agreed set of Standard Industrial Classification (SIC) codes that describe it.
- There is a **lack of consistency in the evidence** collected for the sector. It can be defined narrowly and traditionally to focus on primary agricultural production, or expanded to include food processing, or used much more broadly to include, for example, forestry and aquaculture.
- The **evidence base is mixed** for the sectors that are usually regarded as making it up, with a substantial amount of information for the agriculture and forestry sectors, but much less detail for game and wildlife activities, peatland restoration and nature-based activities, with the latter term increasingly used but also poorly defined.
- Commonly cited **employment figures lack direct comparability**, notably in forestry and agriculture, due to differences in the way that employment is measured, the breadth of industry definitions used and temporality.
- Self-employed **contractors**, which are important across several kinds of land-based activities, **may not be registered in formal statistics**, particularly if they fall beneath the PAYE and/or VAT thresholds.
- There is a reliance on **unpaid and informal family labour**, particularly in agriculture.

Accepting the above caveats, some of the most widely used recent workforce estimates are given in Table 1 below.

Table 1: Widely used workforce estimates in land-based activities

Area and source	Employment measure	Direct employment	Total employment
Agriculture June Agricultural Census (2021)	Headcount*	67,400 headcount* agricultural workers in 2021	-
Forestry CJC Consulting (2015)	Full-time equivalent (FTE)**	12,423 FTE in forestry and timber processing	-
Forestry Scotland's Forestry Strategy 2019 - 2029	FTE		19,555 in forestry and timber processing 25,000 FTE if including forest recreation and tourism -
Game and wildlife Thomson et al. (2018)	FTE	-	2,500 jobs directly and indirectly supported by grouse shooting in 2009
Nature-based employment Hirst and Lazarus (2020)	Headcount FTE	195,345 nature based jobs in 2019 equivalent to 166,721 FTE	-
Peatland restoration	No reliable estimate of the current workforce***		

*headcount estimates do not distinguish between part-time and full-time workers.
**full-time equivalent (FTE) estimates are adjusted on the basis of working patterns.
***a range of estimates for the potential future workforce are detailed in section 8.1.3

1.1.2 The current condition of the rural land-based labour market

The research revealed a partial picture of the current condition of the sector, particularly in rural locations. Our analysis at local authority level showed:

- The number of employees in the agriculture and forestry sectors increased between 2010 and 2021. The greatest increase occurred in mainly rural local authority areas. Within agriculture, the increase in the number of employees is offset by a decrease in the number of working owners, meaning that the agricultural workforce is roughly the same in 2021 as it was in 2010. Within agriculture, a substantial difference between the number of employees and number of full-time workers suggests the importance of part-time and seasonal employees in this sector.
- Recruitment, retention and labour shortages are a problem for employers in some rural areas. Competition between sub-sectors may prove to be a challenge for employers in the short term, given the tightness of the current labour market. Evidence from stakeholder interviews suggests that competition already exists.
- Small numbers in rural areas make it challenging at sub-local authority level to explore the condition and size of the labour market using the Scottish Government's Urban Rural Classification.
- Lack of access to affordable and appropriate public transport, childcare and housing may make it harder for rural employers to recruit employees and reduce the mobility of the rural workforce.
- Rural areas tend to have higher proportions of small businesses and microbusinesses, which are likely to face challenges in ensuring that staff have access to relevant training and skills development as the labour market changes.

1.2 Conclusion

This project has explored the existing evidence base for the land-based sector's labour market and revealed a very partial picture in terms of current knowledge and evidence, and therefore challenges in projecting future labour market requirements.

Actions to expand and improve both the coverage and the consistency of the quantitative and qualitative evidence base now will help to better understand the size, shape, location and seasonal patterns in the future land-based labour market. This improved understanding will inform decisions about future skills and training opportunities and wider infrastructure provision across Scotland's rural and urban areas in order to deliver Scotland's net zero-related land use targets.

These challenges in establishing a reliable picture of the current land-based workforce in Scotland mean that carrying out accurate modelling to understand the future size, scale and location of this workforce is difficult. Some recent studies, including by the Climate Change Committee (2023), have attempted to estimate the impacts on employment in different sectors from net zero-related land use change.

Contents

1 Executive summary 1
2 Acknowledgements 6
3 Glossary of abbreviations and technical terms 6
4 Introduction 8
5 Understanding the land-based workforce and associated skills 8
6 The current rural land-based labour market and key trends 10
7 Modelling the likely future workforce 25
8 Net Zero and Land Based Employment 27
9 Conclusions 37
10 References 40
11 Appendix 1: Project aim, objectives and outline methodological approach 45
12 Appendix 2: Policy context for the land-based labour market 47
13 Appendix 3: Web of Science database search terms 53
14 Appendix 4: Defining the land-based sector 54
15 Appendix 5: Key data and evidence sources on the UK and Scottish labour markets 57
16 Appendix 6: Green skills and green jobs 64
17 Appendix 7: Information on the rural labour market 68
18 Appendix 8: Background information on the agricultural sector 71
19 Appendix 9: Background information on the Forestry sector 76
20 Appendix 10: Background information on the game and wildlife management sector 82
21 Appendix 11: Background information on the nature-based activities sector 86
22 Appendix 12: Seasonality 88
23 Appendix 13: Summary of existing research work exploring future labour market and skills requirements 91
24 Appendix 13: Reviewing approaches to scenario creation 106

25 Appendix 14: Our approach to the scenario-based modelling for peatland restoration and woodland creation 117

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3 Glossary of abbreviations and technical terms

Abbreviation or acronym	**Explanation and further information**
AHDB	Agriculture and Horticulture Development Board – a statutory levy board funded by farmers, growers and others in the supply chain.
AKIS	Agricultural knowledge and innovation system
BRES	Business Register and Employment Survey
CCPU	Climate Change Plan 2018-2032 Update (2020)
CESAP	Climate Emergency Skills Action Plan
CIPD	The Chartered Institute of Personnel and Development
CLBLR	Commission for the Land-Based Learning Review
EGSS	Environmental Goods and Services Sector
ELM	Environmental Land Management scheme
EU	European Union
EU Exit	The exit of the UK from the European Union (often referred to as Brexit)
FTE	Full-time equivalent
GVA	Gross Value Added – GVA measures the contribution to the economy of each individual producer, industry or sector in Scotland and is used in the estimation of GDP. GVA is the difference between the value of goods and services produced and the cost of raw materials and other inputs, which are used up in production.
Hectare	ha – A ha is a unit of measurement for an area with one ha representing 10,000 square metres. 100ha is one square km.

Abbreviation or acronym	Explanation and further information
HMRC	His Majesty's Revenue and Customs - the tax, payments and customs authority of the UK Government.
ILO	International Labour Organisation
I-O Analysis	Input-Output Analysis
I-O Tables	Scottish Government's Supply and Use Tables
IUCN	The International Union for the Conservation of Nature
LCREE	Low Carbon and Renewable Energy Economy
LFA	Less Favoured Area – this is an EU designation to define land areas where agricultural production is challenging due to poor soils, topography, climate, etc. 86% of Scotland's land area is defined in this way.
LiDAR	LiDAR (light detection and ranging) is a new technology which uses laser light to create a 3D representation of the earth's surface.
LMI	The Scottish Labour Market Information and Intelligence Framework
LULUCF	The Land use, land use change and forestry sector
NSET	National Strategy for Economic Transformation
ONS	The Office for National Statistics
PAYE	Pay As You Earn refers to the HM Revenue and Customs system to collect Income Tax and National Insurance from employment, that employers have to operate as part of their payroll. An employer does not have to register for PAYE if none of their employees are paid £123 or more a week, get expenses and benefits, have another job, or get a pension.
SDS RSA	SDS' Regional Skills Assessments
SDS	Skills Development Scotland
SIC code	Standard Industrial Classification code – 2007 – the widely used system for classifying business units into industry types (based on their main activity) in a standardised way for statistical purposes.
SDS	Skills Development Scotland
SOC code	Standard Occupational Classification code – 2020 – the widely used system for classifying jobs into occupational types in a standardised way for statistical purposes.
SRUC	Scotland's Rural College
SDS SSA	SDS' Sectoral Skills Assessments
VAT	Value Added Tax is the tax paid when goods and services are bought. The standard rate of VAT in the UK is 20%.

4 Introduction

The Scottish Government recognises the need for large-scale and rapid changes to the way land is managed to meet the country's target of net zero by 2045 in its Climate Change Plan 2018-2032 Update (CCPU) published in 2020. Critical to the delivery of these changes are the size, skill levels and location of the workforce across rural and island communities, and indeed the sustainability of those communities themselves.

This report takes a system-wide overview of the existing statistics and what they tell us about the current land-based labour market. This informs the design of a potential methodology for scenario-based modelling work to understand future land-based labour market needs (more detailed information about the project's aim, objectives, and the associated tasks and methodological approach adopted is provided in Appendix 1).

A number of different sector-specific and general policies and strategies form the context for this work, and there are close links between this project and the work of the Commission for the Land-Based Learning Review which reported in January 2023. The policy context demonstrates the importance of understanding the future land-based labour market but also that this is a complex area which is rapidly evolving. A brief introduction to this policy context can be found in Appendix 2, including detail on the CCPU policy targets.

5 Understanding the land-based workforce and associated skills

5.1 Defining the land-based labour market

It is critical to clearly define what is meant by the term 'land based', and in particular which sectors or economic activities are included – and which are not.

There is no 'formal, official' definition of the land-based sector, for example, by the Office for National Statistics in their Standard Industrial Classification (SIC) codes[1], and we found no significant discussion in the academic literature (see Appendix 3). However, several organisations in the employment, skills and training domain do (either explicitly or implicitly) provide definitions and/or explanations (which are not all consistent), such as Lantra, the National Land Based College, the SQA and other private training providers such as Pearson. These are summarised in Appendix 4.

The Commission for the Land Based Learning Review (CLBLR) was appointed by the Scottish Government to undertake a 'root and branch' review of learning in Scotland's land-based and aquaculture sectors, from early years to adulthood. The Commission reported to Scottish Government in January 2023, and discussed (amongst a range of other issues) the need to reframe the land-based sectors to the nature-based sectors noting that:

[1] SIC codes is the widely used system for classifying business units into industry types (based on their main activity) in a standardised way for statistical purposes

> "…the term land-based has long been used to collectively describe the range of different industries which use land and the marine environment to produce food and renewable resources. It has also encompassed what have in the past been seen as key supporting roles, such as engineering, equine and environmental conservation. Collectively these industries utilise and manage the majority of Scotland's land and coastal areas, and have the largest impact on our environment. More recently, the land-based industries have been included within 'Green Careers' recognising the key role the Sector plays in nature restoration, climate change mitigation and adaptation."

This means achieving an accurate and up-to-date understanding of the exact size, composition and location of the land-based workforce is difficult.

5.2 The availability of labour market data in Scotland

There is a wealth of labour market data for Scotland, but it is difficult to build a complete and accurate picture across sectors and geographies.

Data on the UK labour market as a whole, and on individual regions and devolved areas (including Scotland) and sectors, is available from a number of sources[2], with Skills Development Scotland's (SDS) Regional Skills Assessments (RSA) and Sector Skills Assessments (SSA) particularly useful in providing data on all of the main sectors in the current and future labour market (more information on the data available can be found in Appendix 5).

However, in addition to the lack of a land-based definition, the activities that are usually regarded as being 'land-based' are not always easy to disaggregate from other activities (e.g. land-based engineering from other forms of engineering, and food and drink processing from wider manufacturing activities). It is also sometimes the case that, while the original data may be collected at national level broken down for SIC codes (e.g. through the BRES and the Census, for example), when that data is made publicly available, the SIC codes are combined, for example in SDS's SSA for agriculture, forestry and fishing. Consequently, a detailed understanding of individual sectors may be hard to achieve.

5.3 Key challenges in understanding the land-based workforce

The labour market generally, and perhaps particularly for land-based sectors, is complex, and there are key factors that contribute to this complexity:

1. Many of those working in land-based activities, such as agriculture, forestry and peatland restoration, are self-employed and/or contractors running their own small or micro business, and so they may not show up in formal statistics. This may be the

[2] including the Office for National Statistics (and particularly the Business Register and Employment Survey and the Labour Force Survey), the Scottish Government, Skills Development Scotland (SDS) and a variety of other organisations, including academic researchers, working on labour market issues

case, for example, if their business falls below the PAYE or VAT threshold and so does not show up in statistics which only include registered businesses.

2. 'Official' statistics on the size or composition of the rural economy therefore underestimate its true size and shape (for more discussion of this, see Section 2 in SRUC's Rural Scotland in Focus 2016 report, for example). One way to gather information on these unregistered businesses is through HMRC data (tax return data for example) but this data is understandably difficult to access and to analyse for confidentiality reasons[3].
3. Not everyone will feature in the data – women and other family members may not always be visible in the statistics (perhaps because they work unpaid on-farm or in farm-related economic activities such as running linked accommodation or shops). Detailed research work has been carried out about women in the agricultural sector, including the 2017 report for Scottish Government for example, and by academic researchers[4].

For a variety of reasons, we do not have a clear, detailed understanding of the composition of the land-based labour market and its constituent parts. This means that it is difficult to plan for current and future workforce and skills needs, including in different geographical locations. This evidence base is critical to ensuring that the land-based sector can meet its net zero obligations and that appropriate skills and training provision, and wider housing, digital connectivity and transport infrastructure is in place to support employers and their workforce where it is required.

6 The current rural land-based labour market and key trends

6.1 Key characteristics

The Scottish Government's 'Understanding the Scottish Rural Economy' report published in 2018 provided a useful summary, albeit from several years ago before the Covid-19 pandemic and EU exit, on the key characteristics of businesses and employment in rural Scotland. The report confirmed:

- the relatively low proportion (4%) of Gross Value Added (GVA) in the islands and remote rural areas which is directly attributable to the Agriculture, Forestry and Fishing sector, with an even lower proportion (3%) in mainly rural Scotland (and 1.3% for Scotland as a whole).

[3] Work is currently underway involving Scottish Government RESAS staff and SRUC researchers to facilitate access to HMRC data for Strategic Research Programme work on the rural economy. This process will take time, but it is hoped that if it is possible to access this data, we will be able to get a much more detailed picture of the entire population of rural businesses.

[4] Professor Sally Shortall at Newcastle University, for example, has a number of publications and projects on this theme.

- the growth in GVA in Scotland as a whole since 1997, with the lowest growth observed in the Agriculture, Forestry and Fishing sector over this period.
- the considerable variation in performance across Scotland's rural local authorities with some experiencing employment growth and others not.
- the tendency for unemployment rates to be generally lower in rural areas while employment and activity rates are higher, with part-time, seasonal, self-employment and multiple job-holding particularly prevalent in rural areas.

It is worth noting again here, however, the problem of combining Agriculture, Forestry and Fishing activities as all have had different growth trajectories in recent years. Forestry, for example, has experienced considerable growth in both scale and value since 1997, but that growth is often masked in the data by different trends in the other sectors.

6.1.1 Wider challenges that impact on the labour market

Wider structural challenges face many rural households and may impact on their ability to fully participate in the labour market now and in future. These include:

- Their generally higher spending levels (than equivalent urban households), on food and fuel particularly (combined with lower wages and salaries, as explored in the Joseph Rowntree Foundation-led Minimum Income Standards work for example).
- rural poverty being under-reported in official statistics.
- poor, unreliable, infrequent and expensive public transport provision in many areas.
- a shortage of appropriate and affordable housing for purchase and rent.
- a lack of flexible and affordable childcare.

Housing is a significant and long-standing challenge in many rural and island communities, with poor affordability (both for purchase and rent) and low levels of supply due to a lower rate of new house building and high numbers of second and holiday homes. Rural dwellers, reliant on local, low wage employment, are often priced out of the local housing market. More information on all of these issues is provided in the recent Rural Lives report and in SRUC's Rural and Island Insights Report 2023.

Evidence suggests more self-employment and part-time/seasonal working in Scotland's rural communities. While at face value this may be taken as evidence of a flexible labour market with many ways for individuals to engage with work, and of high levels of entrepreneurship, rural and island dwellers are often reliant on multiple jobs through necessity rather than choice. The RSN's 2021 Cultivating Rural Growth report examines this issue in more detail.

6.1.2 The significance of language – Scotland's 'green' labour market

Terms such as 'green transition', 'green skills' and 'green jobs' have become more widely used to describe the changes required in labour markets to meet climate and environmental goals (such as implementing circular economy practices, enhancing biodiversity, etc.), and to ensure a sustainable recovery from the Covid-19 pandemic (see the Scottish Government's Covid Recovery Strategy for example). As noted in SDS's February 2022 SSA for the Agriculture, Forestry and Fishing sectors:

> "green jobs are at the forefront of the Government's plans for recovery. Demand for green jobs (and green skills) is expected to increase rapidly as a result of policy and legislative drivers and consumer choice."

However, these terms remain poorly defined and there is no single agreed way to quantify them. This matters, because it influences how data is collected and the size, scale, location, gender breakdown, etc., of projections about future skills requirements.

Some approaches take a very narrow definition for green jobs, such as only including jobs that contribute substantially to preserving or restoring environmental quality. In contrast, broader definitions could potentially include all jobs on the basis that everyone has an obligation to take action to protect the environment and that there is a huge number of skills which will support the net zero transition. These different interpretations make it difficult to assess the current and likely future spatial distribution of the green labour market (for example, in terms of the spread of jobs between rural and urban areas) and thus the geographical variations in required skills and training provision. A detailed discussion of different definitions is provided in Appendix 6, along with information on the 2022 Green Jobs in Scotland report, Greensoc, the new green occupational definition, the Green Jobs Workforce Academy, and the UK Green Taxonomy which may provide greater clarity.

The Scottish Government has increasingly recognised the importance of green jobs and green skills to Scotland's future labour market as the country recovers from the Covid-19 pandemic. However, without a clear definition of what is (or is not) included, it is hard to quantify where these jobs are, their type, pay and skill levels, in order that education and training providers and businesses and individuals can respond appropriately.

6.2 Recent trends in Scotland's national labour market

Scotland's national labour market, similar to other OECD countries, has been affected by a number of longer-term trends over recent years, including:

- Demographic ageing
- Technological advancement, including mechanisation
- Robotisation and digitalisation (e.g. artificial intelligence, machine learning, etc.)
- Changes in emerging markets at the global scale
- Changing work-life preferences, including a shift to flexible and home-based working in some sectors
- Changing land and housing values
- Changing methods of education and training delivery
- Circular economy, bioeconomy and net zero trends and targets.

In addition, there are a number of short-term shifts which have occurred more recently:

- the Covid-19 pandemic, which has accelerated processes of digital transformation and increased levels of remote or hybrid working but has particularly benefited those in higher skilled, higher paid jobs.
- the UK's exit from the EU has led to changes in the availability of overseas workers in some land-based sectors, including agriculture.
- there have been wider international economic and political shifts, including the war in Ukraine and the cost of living crisis, which have further impacted on supply chains,

prices, labour markets and household decision-making (in relation to house purchasing for example).

It is likely that, in future, some sectors in the economy will see an increasing demand for workers and new skills required from both new workers and those already in employment who may be required to reskill or upskill. However, the 'tight' labour market, plus restrictions on workers coming in from overseas, raises concerns as to the extent to which the UK labour market (both rural and non-rural) may be in a position to flexibly respond to these new demands.

While the terms 'green jobs' and 'green skills' are being widely used internationally and in Scotland (see for example, Hirst and Lazarus' work for NatureScot in 2020; and work by Ecuity Consulting for the Local Government Association in England projecting future green jobs requirements), they are not well defined (see Section 6.1.2).

6.3 Key activities in the land-based labour market

Much of the economic and employment data that is publicly available is at relatively large geographic scale (e.g. local authorities) mainly to protect the confidentiality of individuals and businesses, and often is not analysed for rural and urban differences. This makes it difficult to achieve a detailed understanding of the labour market in Scotland's sub-regions and localities. Appendix 7 summarises some information on the rural labour market; more up-to-date information can be found in SRUC's Rural and Island Insights Report 2023, published in August 2023 and in the Scottish Government's Rural Scotland Data Dashboard and accompanying report which were published in December 2023.

We found very limited academic literature on the labour market in land-based sectors (see Appendix 3), with most information found in industry or government sources. Considerably more information was found for the largest sectors of agriculture (see Appendix 8) and forestry (see Appendix 9). We also found information relevant to the game and wildlife management sector (see Appendix 10) which, while not featured in the policy targets in the 2020 CCPU , is an important sector in terms of understanding current and future land use change. There is an emerging body of academic research and practitioner experience on peatland restoration and on nature-based activities (see Appendix 11).

6.3.1 Agriculture

Agriculture is the most significant land use in Scotland, with 80% of Scotland's land mass under agricultural production. Employment in agriculture is a key component of the land-based labour market, particularly in rural areas. However, there are a number of different sources of data on the agricultural labour market collected by national statistical agencies and by sector-based organisations (by which the agriculture sector is well served[5]) and

[5] This includes Skills Development Scotland's SSA for Agriculture, forestry and fishing and for Food and Drink - Primary Food Production, the Agriculture Census, Science and Advice for Scottish Agriculture (SASA), the Industry Leadership Group on Food and Drink, work by researchers at SRUC and the James Hutton Institute (for example) on the sector (for example, through the Scottish Government's Strategic Research Programme), and data gathering work by the National Farmers

based on different ways of measuring employment (see Table 2). As a result, it is difficult to obtain a definitive clear, accurate picture of the size of this sector's current labour market, as well as to make predictions for the future. The primary sources are set out here. Additional sources are detailed in Appendix 8.

- The June 2021 Agricultural Census estimated the total agricultural workforce in Scotland to be around 67,400 workers[6] in 2021. One year earlier, the 2020 Agricultural Census estimated a total workforce of 66,700. In 2018, the number of people employed in agriculture was estimated at 67,000, accounting for 2.5% of the total number of people employed in Scotland, and around 8% of the total rural workforce.
- According to NFUS, based on 2020 Agricultural Census data, agriculture is the third largest employer in rural Scotland after the service and public sectors. It is estimated that, in addition to the (just under) 67,000 direct employees, a further 360,000 jobs (1 in 10 of all Scottish jobs) are dependent on agriculture.
- These estimates are somewhat lower than the data from the Business Register and Employment Survey (BRES) which estimated employment in two-digit SIC code 01: Crop and animal production to be 75,000 in Scotland in 2021.

Union Scotland, Quality Meat Scotland, the Agriculture and Horticulture Development Board, the Scottish Agricultural Organisations Society, the Women in Agriculture movement and others.

[6] Work is currently going on at SRUC within the NISRIE project, which forms part of the Scottish Government's Strategic Research Programme 2022-27, to explore the accuracy of this figure. Initial analysis of data from the Farm Structure Survey (the latest of which took place in 2016) suggests the real figure may be somewhat different and that a more nuanced approach is needed to calculating the workforce. The 67,400 total refers to 'headcount' which includes people who may only work on a very limited basis. It also does not include family labour. It is also difficult to define an FTE in agriculture when so many workers will work 'overtime'.

Table 2: Employment in Agriculture by employment measure and survey

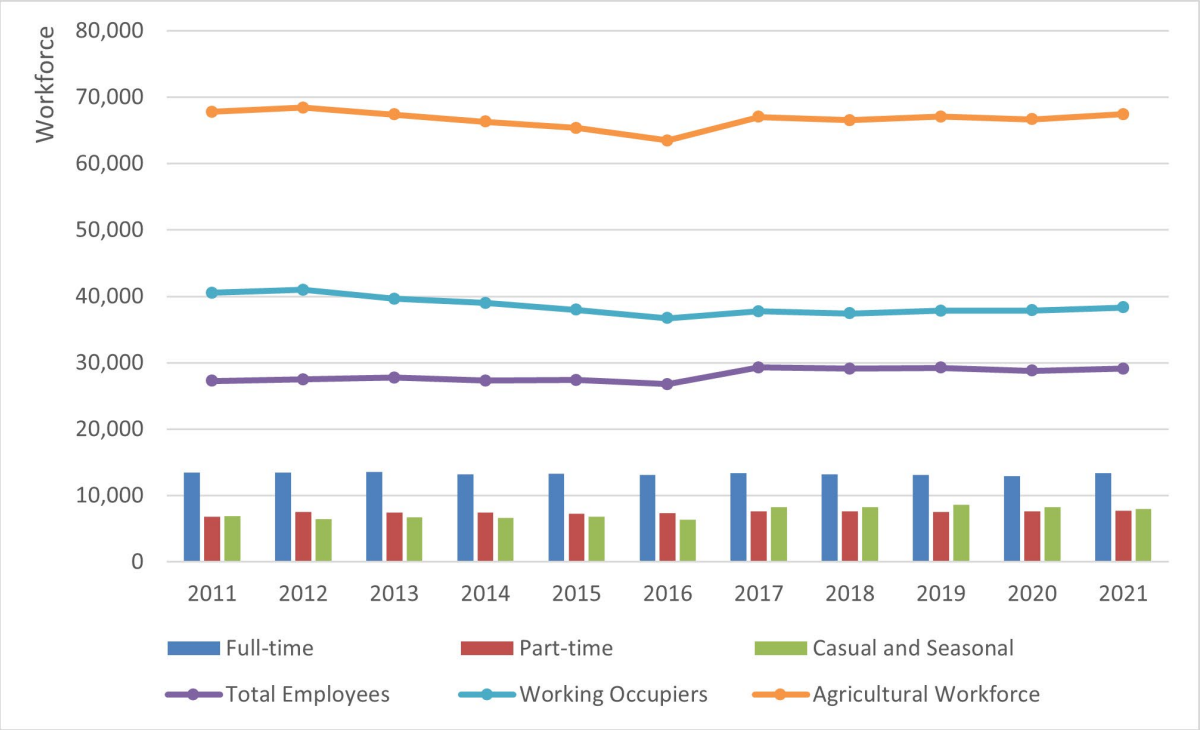
Industry Definition	Employment Measure	Direct Employment	Source
Scottish Agriculture	Agricultural Workforce	(headcount) 67,400	June Agricultural Census (2021)
	Working Occupiers/ spouses	(headcount) 38,300	
	Agricultural Employees	29,100	
	Full-time staff	13,400	
	Part-time staff	7,700	
	Seasonal labour	8,000	
01: Crop and animal production, hunting and related service activities (Scotland)	Employment[7]	75,000	Business Register and Employment Survey (2021), Nomis
	Employees	34,000	
	Full- time employees	17,000	
	Part- time employees	17,000	
Scottish Agriculture	Seasonal migrant workers in 2017	9,255	Thomson et al. (2018)

The Scottish Government's Rural Scotland Key Facts publication in 2021, based on data from the Inter Departmental Business Register from March 2020, described agriculture, forestry and fishing as accounting for 15% of the remote rural workforce and 12% of the accessible rural workforce in 2020 (0.5% in the rest of Scotland).

Figure 1 depicts data from the June Agricultural Census from 2011-2021. The Census data shows that the agricultural workforce is roughly the same in 2021 as it was in 2011, having declined from 67,800 in 2011, to 63,500 in 2016 (a 6% decrease), before recovering to 67,400 in 2021.

[7] The *Employment* statistic within the Business Register and Employment Survey further includes working owners.

Figure 1: The Agricultural Workforce 2011 to 2021, June (2021) Agricultural Census data, Scotland



Source: June (2021) Agricultural Census. Note: Total employees calculated as sum of full-time, part-time and casual and seasonal.

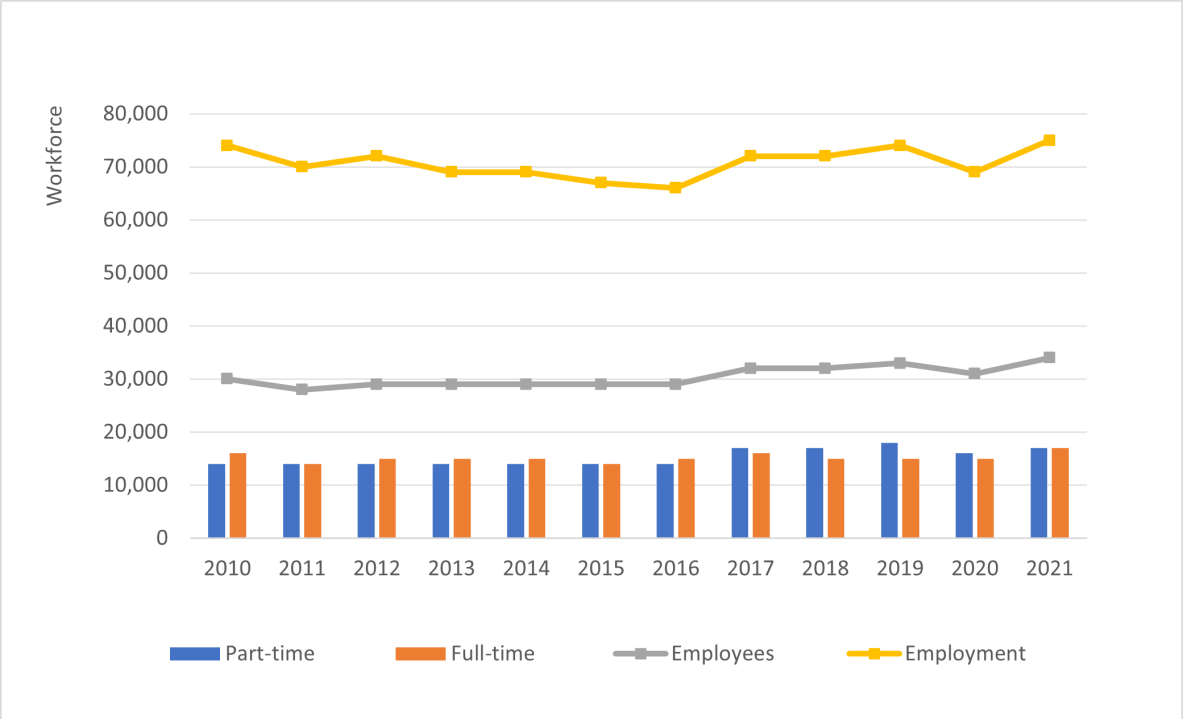
Working occupiers are highly significant to the workforce in agriculture and make up more than half of the total workforce. Nonetheless the workforce composition has shifted slightly between 2011 and 2021. While the total number of employees has increased by 7% over the period, driven by an increase in part-time staff (13%) and casual staff (15%), over the same period the number of working occupiers has decreased by 6%.

Data from the BRES shows a similar trend in terms of the overall size and composition of the workforce in agriculture. Figure 2 reports various measures of employment in the agricultural sector between 2010 and 2021 using the 2-digit SIC code (01: Crop and animal production, hunting and related service activities).

According to the BRES, mirroring the broad trend seen in the Agriculture Census data, between 2011 and 2021 total employment (including working owners)[8] declined from 70,000 in 2010 to 66,000 in 2016 before recovering to 75,000 in 2021. However, a slightly stronger trend is seen for the change in composition than in the Agricultural Census data. Measured by BRES, the number of agricultural employees increased by 21.43% from 2011 to 2021. This estimate is however somewhat sensitive to the choice of base year. For example, measured from 2010 to 2021, the increase is 13.33%.

[8] The difference between *Employment* and *Employees* within the BRES data again highlights the significance of working owners within the agricultural workforce.

Figure 2: Employment in 01: Crop and animal production in Scotland 2010 to 2021, Scotland

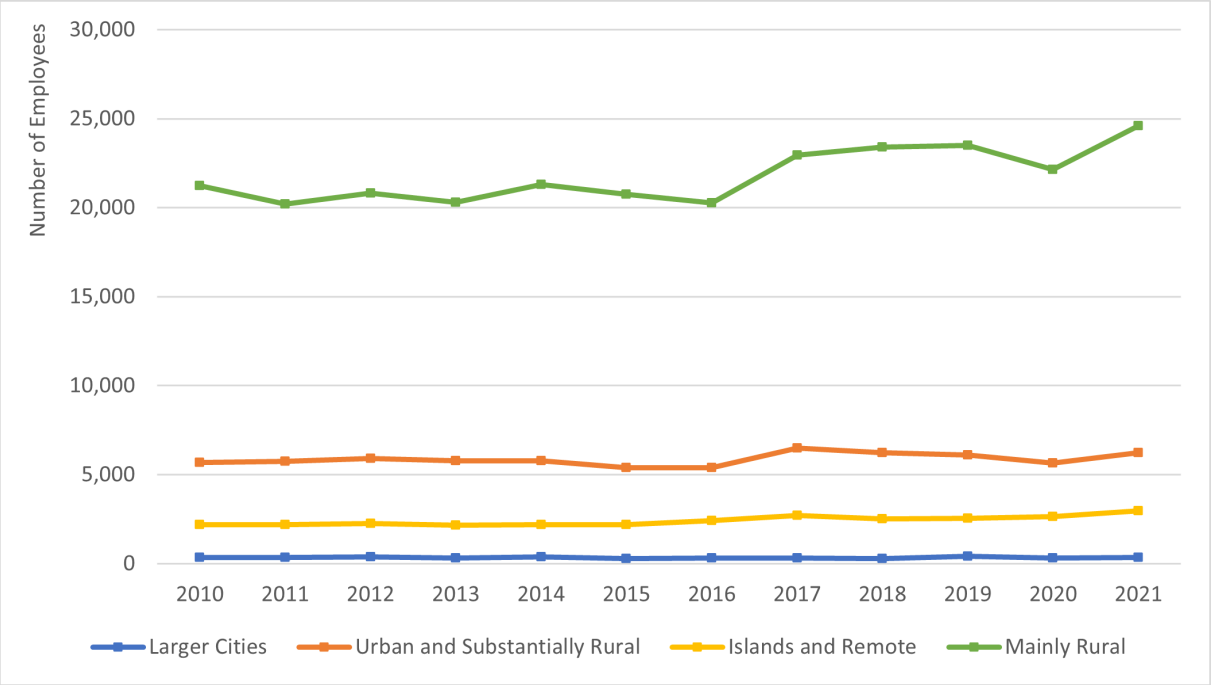


Source: Nomis (2023). Note: The information between 2010 and 2014 excludes units registered for PAYE.

Figure 3 below shows the strong rurality of employment in agriculture and depicts employment in relation to rural and urban local authorities using the Scottish Government's RESAS 2018 rural-urban local authority classification: Larger cities, Urban with substantial rural areas, Mainly rural areas, and Islands and remote areas. Figure 3 demonstrates that the majority of agricultural employees are in the mainly rural local authority areas. The number increased from 21,250 persons in 2010 to 24,600 persons in 2021.

SDS's SSA in 2022 reports a decline in the current workforce in the agriculture, forestry and fishing sectors of 11% between 2012 and 2019. Geographically the highest number of workers in these three sectors combined is in the Highlands and Islands, Tayside and the South of Scotland areas.

Figure 3: The number of employees in the agricultural sector in Scotland by the RESAS Local Authority-level Rural-Urban classifications between 2010 and 2021, Scotland



Source: Nomis (2023). Note: The information between 2010 and 2014 excludes units registered for PAYE.

Based on data provided by SDS in their 2022 SSA for the Agriculture, Forestry and Fishing sectors, looking forward, in the 2022-2025 period, the number of people in employment in the Agriculture, Forestry and Fishing sector is forecast to grow by 1.1 per cent (400 people). This is a slightly smaller percentage growth than is forecast overall across Scotland where employment is predicted to rise by 1.2 per cent (31,900 people). Most of this growth will be in the skilled agricultural trade occupations. The forecasts for 2022-2025 suggest there will be 10,200 job openings in the sector due to some jobs growth and opportunities created as a result of the need to replace workers leaving the labour market due to retirement and other reasons (i.e. replacement demand). Whilst positive, caution is needed as a wide range of factors may impact the future labour market. At the time of writing the economic outlook is uncertain and labour shortages continue to be a dominant issue.

In terms of the longer-term (2025-2032), the short-term growth will cease and decline in employment is predicted by 2.6 per cent (-1,000 people) (to a level of 37,500 people in 2032). This is in contrast with employment growth forecast overall across Scotland where employment is predicted to rise by 1.5 per cent (40,700 people). It is also expected that there could be an ongoing requirement for skilled people to fill opportunities created by people leaving the labour market. Forecasts show that there will be 21,000 job openings in the long-term. This will be driven by the need to replace workers leaving the labour market in Agriculture, Forestry and Fishing (i.e. a predicted expansion demand of -1000 people, combined with a predicted replacement demand of 22,000 people creates a total requirement of 21,000 people).

6.3.2 Forestry

As is the case with agriculture, the forestry sector is also reasonably well served in terms of sector bodies of different kinds[9] and there is a substantial amount of information on employment and skills available through some of these organisations. Again however different approaches are taken to measuring the size and shape of the labour market. Employment figures for forestry are given in Table 3. Key points include:

- A study by CJC Consulting in 2015 estimated that direct employment in the Scottish forestry and wood processing sector[10] was 12,143 FTE in 2012/13, total employment was 19,555 FTE, and GVA was £771 million.
- Adopting a wider definition of the forestry sector that includes forest recreation and tourism,[11] Scotland's Forestry Strategy 2019-29 reported that in 2015, Scottish forestry was estimated to contribute almost £1 billion to Scotland's GVA and employed approximately 25,000 FTE (total employment).
- Most recently, Forest Research's (2022) Forestry Statistics note that direct employment in UK forestry in 2019 stood at 18,000 (with data taken from the BRES), with a further 7,400 employed in primary wood processing (based on industry survey data).
- The Forestry Skills Action Plan produced by the Scottish Forest and Timber Technologies Group in 2020 builds on the 2015 data to note that the 25,000 FTEs employed in forestry at this time represented a reduction of 16% since 2014, due to rising productivity and/or an increase in self-employment.
- The Action Plan notes the dominance of males amongst the forestry workforce (79%), and that the self-employment level is around 50%. It reports that the greatest number of forestry businesses are in the Highlands, the South of Scotland, Perthshire, Aberdeenshire and Argyll and Bute.

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[9] These include Forest and Land Scotland and Forest Research (who produce Forest Statistics), the Confederation of Forest Industries (CONFOR), the Forest and Timber Technologies Industry Leadership Group, or private forestry companies and land agents that collect data on the price of timber, etc.

[10] The definition of the forestry and timber processing sector in this study was "activity related to forestry, trees, woodland and primary timber processing (pulp mills, production of sawn wood, wood panels, fencing posts and woodfuel, including chips, briquettes, pellets, firewood and other woodfuel) in Scotland, and note that this includes forest management and primary timber processing, forestry civil engineering, haulage, agent, community groups with interests in woodlands, NGOs, local authorities with woodland activity, research and education, and those activities of the Forestry Commission and Forestry Commission Scotland, which are located in Scotland. this excludes secondary processing and paper production from imported pulp and most haulage from primary to secondary producers."

[11] This estimate is based on data from the CJC Consulting (2015) report yet takes a wider industry definition and further includes employment in tourism linked directly to forestry. Total employment is estimated as direct employment plus jobs indirectly supported within the wider supply chain plus those induced through spending of wages.

- The Action Plan notes that the average salary for forestry workers (forest craftspersons, harvesters, tractor drivers) is currently £22,880 and £30,680 for forestry managers, although skilled harvesters can earn as much as £50,000.

Table 3: Employment in forestry by employment measure and survey

Industry Definition	Employment Measure	Direct Employment	Total Employment	Source
Scottish Forestry	Full-time equivalent	-	25,0000[12]	Scotland's Forestry Strategy 2019 – 2029
Forestry and timber processing	Full-time equivalent	12,423	19,555	CJC Consulting (2015)
Forest recreation and tourism	Full-time equivalent		6,312	
Forestry related deer and game	Full-time equivalent		2,260	
02: Forestry and logging (Scotland)	Employment[13] Employees Full-time Part-time	6,000 4,500 4,500 450	-	Business Register and Employment Survey 2021, Nomis
02: Forestry and logging (UK)	Employment Employees Full-time Part-time	20,000 16,000 14,000 2,000	-	Business Register and Employment Survey 2021, Nomis
UK Primary wood processing	Full-time equivalent	7,443	-	Forest Research (2022), industry survey

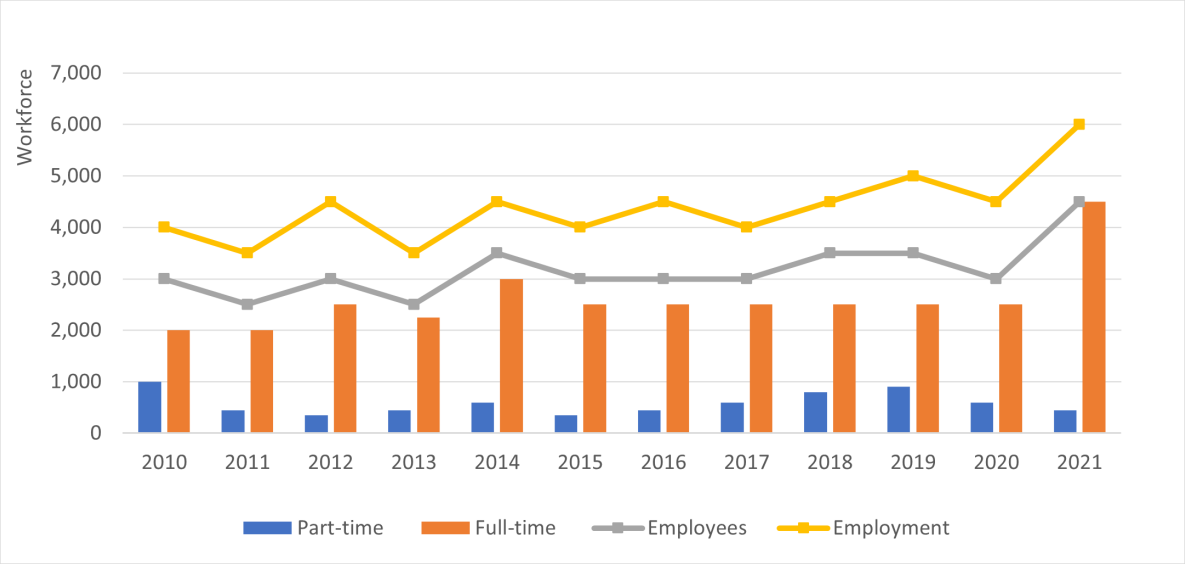
Using publicly available data from the BRES, Figure 4 below shows Scottish employment in the forestry sector between 2010 and 2021. For most of the period, the number of employees has ranged around 3,000, although between 2020 and 2021 there was a rapid increase to 4,500. The majority of employees were in full-time employment, which

[12] This figure is based on the CJC Consulting (2015) study and combines their values for the forestry and timber processing sector (19, 555) and forest related recreation and tourism (6, 312).

[13] The Employment statistic within the Business Register and Employment Survey further includes working owners.

increased from 2,500 in 2020 to 4,500 in 2021 (80%). The proportion of working owners within the workforce remained relatively stable and therefore total employment (employees and working owners) increased from 4,500 to 6,000 between 2020 and 2021 (50%)[14]. As this relates to a single year, more work would be required to be more confident of this trend.[15]

Figure 4: Employment in SIC two-digit code 02: Forestry and Logging 2010 to 2021, Scotland



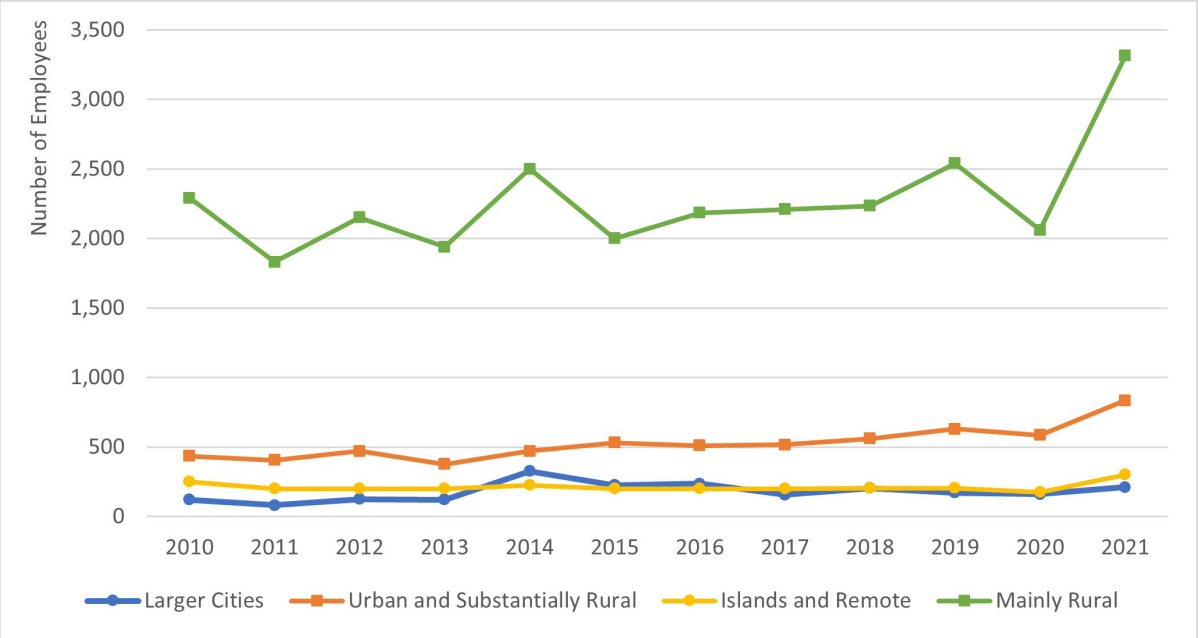
Source: Nomis (2023). Note: The information between 2010 and 2014 excludes units registered for PAYE. The Employment statistic further includes working owners.

Mirroring the situation for agriculture, Figure 5 shows the strong rurality of employment in forestry and depicts the total number employed in relation to rural and urban local authorities using the Scottish Government's RESAS 2018 Urban Rural Local Authority Classification. It demonstrates that the majority are in Mainly rural local authority areas, and that growth in employment has occurred in these areas where the number of employees increased by 44.75% between 2010 and 2021. Again, however, more work is needed to be confident that this represents a real trend.

[14] These figures from NOMIS suggest that all of the 4,500 workforce in 2021 were working full-time but the data breakdown confirms 450 part-time employees. There may be an error in how this data is listed in the open access file, or this is due to rounding of the data, but further interrogation is needed to check these totals.

[15] Forthcoming work by Frontline Consultants, Westbrook and Ralph to quantify the GVA impact of the forestry sector in the UK and sub-nations may provide further insight on this trend.

Figure 5: The number of employees in the forestry (and logging) sector by the RESAS local authority-level Rural-Urban classification between 2010 and 2021, Scotland



Source: Nomis (2023). Note: The information between 2010 and 2014 excludes units registered for PAYE.

6.3.3 Peatland restoration

Peatlands are a key part of the Scottish landscape, providing significant carbon storage potential, an internationally important habitat, a means of improving water quality and reducing flood risk, and highly attractive locations for tourism.

In contrast to agriculture and forestry, however, peatland restoration is not recognised as a discrete 'sector' in the way data is collected (i.e. the SIC codes used), nor does it have well-established representative sector organisations. It was not possible to find accurate and up-to-date data on the numbers of people currently employed in peatland restoration activities in Scotland. While there is growing academic work to understand the costs and effectiveness of peatland restoration (see for example, Glenk et al. 2022; Glenk and Martin-Ortega, 2018; Artz et al., 2019) and the motivations and experiences of actors (see for example Novo et al., (2021)) this work has yet to address current employment levels.[16]

The research team therefore sought to gather more qualitative information from short interviews with several individuals working in different capacities in the sector (see Appendix 1). The results emphasised that the restoration work itself involves a very wide

[16] A handful of estimates for peatland employment effects have been produced in the context of wider modelling studies where peatland employment was not the main focus. These are detailed in Appendix 12. Estimates of the future peatland restoration workforce are discussed in section 8.1.3.

range of occupations, knowledge, skills and equipment across different sites, partly dependent on their characteristics, location, altitude, topography, access, etc.

Peatland restoration work is primarily conducted by skilled machine operators. Most peatland restoration projects will require some form of designer as a main consultant, an ecologist and a project manager for the contractors who do the work. Some companies are exploring how to manage this work in-house but, in most circumstances, self-employed sub-contractors are used. Following initial restoration, maintenance and monitoring work may be required. Within the wider supply chain the skills/professions that are required include hydrologists, soil scientists, ecologists, conservationists, engineers, project managers, administrative staff, researchers, and manual workers of various kinds.

6.3.4 Nature-based activities

There is no single universally accepted definition of the nature-based sector. A report by Hirst and Lazarus in 2020 for NatureScot includes the following nature-based solutions in a broad definition of nature-based jobs:

- Peatland restoration
- Flood risk management
- Blue carbon
- Coastal ecosystems
- Woodland restoration
- Low carbon and regenerative land use including agriculture, forestry and wildlife management
- Sustainable marine management and fisheries
- Green finance
- Urban green infrastructure, including planning, ecological engineering, active travel networks
- Sectors highly dependent on natural capital (especially tourism and food and drink)

This broad definition is worth bearing in mind in relation to the CLBLR's recent report which recommended consideration of using this alternative 'label' for the land-based sector.

Despite a thorough search by the research team, NatureScot appears to be the only organisation generating evidence about the contribution of and labour requirements for this sector. The 2020 report for NatureScot by Hirst and Lazarus is the most comprehensive study of the nature-based sector that could be found and this estimates that:

- the sector makes a significant contribution to the Scottish economy, amounting to 195,000 jobs or 7.5% of Scotland's workforce in 2019.
- the number of jobs increased by 12,031 between 2015 and 2019 (a 7.5% increase), accounting for one-third (31.7%) of all job growth in Scotland during this period.
- this growth rate was more than five times the rate of all jobs in Scotland in the period 2015-19.
- this is also likely to be an under-estimate as some of the smallest businesses operating in the sector are likely to be unregistered. It is also difficult to separately identify the key nature-based sectors, and it is also possible that some nature-based activity is actually included in other sectors, such as construction (e.g. of water-based projects).
- the majority of these jobs are in rural local authority areas, with 9% being Island and remote, 46% being Mainly rural, 24% being Urban with substantial rural, and 21% within Larger cities.

As shown in Table 4 below, Hirst and Lazarus (2020) build on the work of two earlier studies. Various definitions for nature based activities have been used resulting in a range of estimates for employment in the nature based sector (see Appendix 11). Notably, Biggar Economics (2020) include employment in oil and gas extraction which is excluded from other studies on the basis that it is not assessed as sustainable.

Table 4: Nature Based Jobs in Scotland

Study	Employment estimate
Hirst and Lazarus (2020)	195,345 jobs 'nature based jobs' in Scotland in 2019, equivalent to 166,721 FTE
Biggar Economics (2020)	They estimate total employment in the natural sector as 290,100 in 2018, around 11% of Scottish employment.
RPA and Cambridge Econometrics (2008)	They estimate nature- based employment in Scotland in 2003 as 154,000 jobs directly supported by the natural environment or 242,000 when further considering direct, indirect and induced employment.

Looking ahead, Hirst and Lazarus (2020) argue that significant further growth is anticipated on the back of the expansion in activities – including peatland restoration, green infrastructure and green finance, woodland creation, and blue carbon – required to meet our net zero targets by 2030 and 2045. Several opportunities were identified for nature-based skills development by Hirst and Lazarus (2020), including a need to fill operational jobs more effectively, for which recruitment is often local and sometimes through sub-contracting arrangements. While graduate and post-graduate jobs were found to be relatively easy to fill, there were challenges with operational posts due to a lack of applicants, a lack of experienced candidates and competition for the same skills from other sectors.

6.4 Conclusion

While the evidence base for the agriculture and forestry workforce is relatively well developed, though not always consistent, that is not the case for the peatland restoration and nature-based sectors where the evidence base is limited.

This is mainly due to:

- data-related issues (not least that these two sectors do not map easily onto existing SIC codes) which mean that activities are hard to identify and define clearly, and therefore hard to analyse and understand.
- the nature of the workforce in many of these activities, again with a dominance of contractors and individuals working on a self-employed basis, who may travel around locations to access work opportunities.

There is potential for competition for individuals with relevant and transferable operational skills between sectors – for example between construction and some aspects of peatland restoration, and between peatland restoration and forestry, but it is difficult to ascertain the potential extent and impact of this competition from existing data. Moreover, the extent of this competition will also be affected by wage levels in different sectors, the geographical

and seasonal distribution of jobs, ease of access to and the cost of transport in rural communities, access to appropriate and affordable housing, access to training and re-/up-skilling initiatives, etc. In future, gathering both qualitative and quantitative data on these issues will be hugely valuable to improving our understanding of the complexities of the land-based labour market and the issues that affect it.

7 Modelling the likely future workforce

7.1 Introduction

This research included a requirement to design an appropriate scenario-based modelling approach to anticipate future workforce needs and skill sets associated with the land uses required to support Scotland's transition to net zero. The rationale for the modelling work was to identify the scale of future workforce needs required to deliver the policy targets set out in the CCPU 2020, particularly those relating to peatland restoration and woodland creation. Identifying these needs is critical in order to understand the potential for labour supply and demand to match (or not), thus leading to better labour utilisation and higher productivity. Information about the size and location of the future workforce is also critical to informing knowledge and evidence about the future of rural communities and decisions about infrastructure investments, in particular relating to demand for housing (of different types), transport and a range of vital services.

However, we were unable to find sufficiently reliable datasets on input costs to inform a robust approach. A detailed account of the research undertaken is set out in the Appendices, to initially assess existing research on the future of the labour market (both land-based and more generally) from the wider UK and Scotland (Appendix 12), to review approaches to scenario creation (Appendix 13) and to devise a sound approach to scenario-based modelling based on input cost information (Appendix 14). The approach is summarised here.

7.2 Scenario modelling work

7.2.1 Introduction

The research team set out to assess the effect on employment of the Scottish Government's policy targets in relation to peatland restoration, woodland creation and regenerative agriculture, based on our review of:

- the existing evidence about these activities, and
- parallel studies which have adopted a variety of different methodologies to estimate future employment requirements (see Appendices 12 and 13).

An early decision was taken to step back from assessing future employment in regenerative agriculture as it was considered that the Scottish Government's targets lacked sufficient specificity to be quantified in biophysical or monetary terms. In future, if a policy target is specified (e.g. a proportion of land area that should be under regenerative or low carbon agriculture, or a proportion of agricultural output which should be generated using these techniques, though such targets would be hard to agree, measure and monitor) then this modelling could be revisited using the approach proposed here.

The team began development of a model by focusing on the peatland restoration sector, where a search of the literature highlighted a particular knowledge gap.

7.2.2 Peatland restoration – overview of methodological approach

We examined the Scottish Government's target to restore 20,000ha peatlands per year to consider the impact on employment in upstream sectors. Step by step details of our approach are set out in Appendix 14. We searched the literature for information on peatland restoration costs, seeking to understand unit costs of different inputs, including labour and machinery requirements, and how these may vary between sites.

7.2.3 Data challenges encountered

While the quality and availability of data on peatland restoration costs is increasing, information remains partial, and we have been unable to find a reliable indication of the cost structure of peatland restoration work within the published literature (see Appendix 14 for further information on peatland restoration costs that the team was able to find).

Several factors lead to substantial variations in peatland restoration costs. These include:

- the condition of peatland to be restored, and then subsequently maintained.
- the type of existing land use.
- the restoration technique required.
- remoteness and accessibility of the site.
- the scale of work required (e.g. degree of drainage/number of dams required).
- material requirements dependent on the degree of degradation.

While these factors are becoming better understood, it is not straightforward to discern their relative influence on the overall costs which are largely summarised per hectare (ha). We were unable to find information on how labour or machinery requirements may vary by site conditions, and to add further complexity, the costs are changing all the time as the cost of materials and equipment changes. Technology advances (e.g. LiDAR) may lead to reduced labour requirements over time too, although in contrast to this, costs may rise as the 'easier to reach' sites are restored first.

Overall, it was not possible to determine a reliable estimate for the cost structure for peatland restoration. However, the detailed evidence gathering conducted for this study provides a strong basis from which to tackle these data challenges, and build indicative estimates of future jobs required in peatland restoration.

Approximately half of all peatland restoration projects in Scotland are supported by Peatland Action. This provides a wealth of existing data and an opportunity to collect more detailed figures for analysis of current and future employment requirements.

7.3 Woodland creation – overview of methodological approach

Having first focused on peatland restoration, the research team then examined the Scottish Government's 18,000ha per year afforestation target (from 2024/25), to consider the impact on employment of delivering this target. To inform this analysis we searched the literature for information on woodland creation costs, seeking to understand unit costs of inputs, such as labour and machinery requirements, and how these may vary between sites (for similar reasons to those outlined in Section 7.2.3 for peatland restoration sites).

We were similarly unable to find a reliable indication of cost structure for woodland creation within the published literature, and were unable to complete the planned analysis (see Appendix 14 for information that we did find on costs, including the useful work of Glaister in 2019).

There is potential to identify further detailed data sources which could inform a future analysis, if required. For example, the report published in March 2022 for Scottish Forestry, the Forestry Commission and the Welsh Government which explored the impact of investment in forestry on employment which may provide some useful insights, and we understand an update to work on the economic contribution of forestry to the Scottish economy is in preparation.

8 Net Zero and Land Based Employment

8.1 The impact of net zero on the land-based workforce

Although the team was unable to complete the modelling work, we reviewed prior studies that had considered the impact on employment of implementing net zero related land use change in the Scottish / UK context. We found:

- a relative lack of research examining the impact of net zero commitments on employment in the land-based sector. This is however a rapidly expanding field and a number of relevant studies have been published while our work was ongoing.
- the evidence base is entirely within the grey literature. The team is not aware of any peer reviewed academic literature that has sought to assess the magnitude of changes to employment relating to net zero commitments.[17]

Various studies have estimated changes to employment arising from specific activities within the land-based sector such as tree planting and peatland restoration. Some of these also assess the impact of particular policy targets. A report by WPI (2021) for Green Alliance provides an example of this and summarises marginal employment impacts (per 100 ha) identified by prior studies.

The recent Net Zero Workforce report by the Climate Change Committee (2023) seeks to evaluate the impact of net zero across the UK workforce. Within this they evaluate the impact on employment in Agriculture and Land Use, as one of six broad sectors of the economy. To our knowledge this is the only assessment of employment impacts across these sectors.

We also considered the evidence base for the likely impact on employment in specific sectors:

- Forestry
    - there is a wide range in the magnitude of estimates across studies.

[17] A search of Web of Science did not identify any relevant studies (Appendix 2)

    - Glaister (2019) provides an estimate of the number of workers required to deliver six forestry work programmes. This could be regarded as providing a lower range estimate of direct employment in the forestry sector.
    - we are hesitant to suggest an upper range estimate from the current literature. An impact assessment drawing upon Westbrook and Ralphs (forthcoming) could provide an upper range estimate for the sector, and further assess indirect employment that would be supported by an expansion of activity.
- Peatland restoration
    - there is a narrower evidence base for the likely impact of net-zero on employment, although the magnitude of estimates across studies is broadly consistent.
- Agriculture
    - This is a notable omission. Agriculture is the largest land-based sector by output and employment, yet there is a relative lack of evidence concerning the likely effect of net-zero commitments on employment in agriculture. The Climate Change Committee (2023) report is the only estimate that the team has been able to find in their extensive search.

Similarly we are not aware of any studies which have sought to quantify the impact of net-zero on employment in the game and wildlife sector.

8.1.1 The impact of net zero commitments across the land- based sector

To our knowledge, the report by the Climate Change Committee (2023) A Net Zero Workforce is the only source which has assessed changes in employment across the land-based sector as a whole.

The Climate Change Committee (2023) assessed the potential impact of net zero on the UK workforce. Taking as a reference the technological and behavioural changes described by the Climate Change Committee's Balanced Net Zero Pathway, they assessed the likely influence of such changes to key sectors of the UK economy.[18]

Following on from a review of the literature, the Committee defined specific scenarios to identify lower range and upper range estimates for changes to employment across the UK in the Agriculture and Land Use sector (detailed in Table 5 below). These scenarios do not necessarily reflect Scottish Government policy. Their estimates provide an indication of the likely direction and magnitude of changes to employment across the land-based sector,

[18] In the preface to the report, the Committee highlights the following key messages:

- while achieving net-zero targets will entail transformational change to the economy, the majority of workers will not see major impacts;
- there is potential for net zero transitions to create more jobs than are lost; and
- the transition could provide opportunities for job growth in areas of traditionally low employment, and support diversification of the workforce in net zero sectors.

Across the UK economy as whole they estimate that "the transition could bring 135,000 to 725,000 net new jobs, including 8,000 to 75,000 job losses."

though as highlighted in the report and through the wide extent of estimates they present, there is considerable uncertainty regarding employment impacts.

The Committee estimated that the greatest potential for job creation is in afforestation, followed by non-livestock agriculture, while livestock agriculture is at greatest risk of job losses. Employment in food processing could either be positively or negatively impacted, while employment in peatland restoration shows modest potential for job creation, when compared to afforestation and non-livestock agriculture.

Table 5: Change in number of jobs across agriculture and land use (United Kingdom), reproduced from Climate Change Committee (2023).

Sector	Sub-sector	Lower range (thousands)	Upper range (thousands)
Agriculture and land use	Peatland restoration	1	2
	Afforestation	7	39
	Non-livestock agriculture	3	7
	Livestock and mixed agriculture*	-42	-7
	Food processing	-17	10

Source – Climate Change Committee 2023
*Sector definitions are detailed in Climate Change Committee (2023) Annex 2. Livestock and mixed agriculture comprises the following SIC codes; Animal production; Mixed farming; Fishing; Aquaculture; Other crop and animal production; hunting and related services

8.1.2 The impact of net zero commitments in forestry

Estimates of the net- zero workforce in forestry are summarised in Table 6 below. There is a relatively wide extent in the magnitude of estimates across studies.

The upper range estimate provided by the Climate Change Committee (2023) is considerably greater than has been suggested by prior studies and we see some reason to be cautious of relying on the upper end of this range (the method applied in creating the estimates is not detailed). In addition to this, work commissioned by the Forestry sector in Scotland has produced a more conservative range of estimates (see Table 6).

Work by Westbrook and Ralphs (forthcoming) has estimated the marginal employment effect of ten forestry case studies in Scotland. They outline considerations for how this might be used to assess the impact on employment of implementing the Scottish Government's national target. The team believe that this approach offers a promising means to understand the net zero forestry workforce.

Glaister (2019) defined industry work programmes for key forestry activities, estimated work rates for each activity, then calculated the number of workers that would be required to fulfil those work programmes (see Appendix 5). A strength of this approach is that it gives an indication of the number of workers required in specific roles. For instance, estimating

the number of workers required to plant trees is 941 FTE or 2041 seasonal workers working 45% of the year.[19]

A drawback of this approach is that it does not fully assess the wider indirect impact of an increase in forestry activity on employment through the wider forestry supply chain, for instance in building roads or supplying machinery. Glaister also adopted a narrower definition of the forestry sector than the prior CJC (2015) report and does not consider employment in forestry sector organisations, forestry land agents, forest recreation and tourism or local authorities. For these reasons, Glaister's estimates might be regarded as a lower range estimate for the forestry sector. An impact assessment, drawing upon Westbrook and Ralphs could provide a robust upper range estimate for the sector.

Table 6: The impact of Net Zero Commitments on Employment in Forestry

	Per 100 ha	Assessed Scenario	Estimate	Direct/ Indirect
Climate Change Committee (2023)	-	Impact of implementing the Balanced Net Zero Pathway. 30,000 ha per year, rising to 50,000 ha per year from 2025.	7,000 - 39,000 Jobs created in addition to current UK employment.	Not detailed by the study, the upper range may further include indirect jobs.
WPI (2021)	22- 114 jobs with most rigorous/ applicable estimates clustering toward the lower end	Impact of an additional 20,000 ha tree planting per annum*	4,400 - 22,800 Jobs created in addition to current UK employment.	Not detailed by the study, the upper range may further include indirect jobs.
Glaister (2019)	-	Total workforce required to deliver 15,000 ha per annum tree planting, planned harvesting, haulage, timber processing and restocking.	4,806 Jobs required to deliver work programmes within six forestry sub-sectors**	Direct jobs
CJC (2015)		-	12,423 FTE jobs within the Scottish Forestry Sector	Direct jobs

[19] Establishment and Maintenance (775 FTE), Ground Preparation (166 FTE).

	Per 100 ha	Assessed Scenario	Estimate	Direct/ Indirect
Westbrook and Ralphs (forthcoming)	17 - 37*** FTE in Scotland	-	-	Direct plus indirect jobs.
*Moving from the UK Government's current ambition to the Committee on Climate Change's high ambition scenario implies an additional 20,000 ha per year. **See Appendix 5. Glaister (2019) adopts a narrower industry definition than was used by CJC (2015). ***Authors calculations based on Westbrook and Ralphs (forthcoming). Sum of Scotland FTE over first 5 years, i.e. excluding felling. See Appendix 5.				

8.1.3 The impact of net zero commitments in peatland restoration

Estimates of the net-zero workforce in peatland restoration are summarised in Table 7 below. While the evidence base is fairly small, the magnitude of estimates is broadly consistent across studies.

In the CCPU (2020) the Scottish Government estimated that 200 FTE direct contractor and delivery jobs would be created by their commitment to spend £25 million per annum on peatland restoration, though due to the seasonal nature of work this would likely require a greater number of workers each working part of the year. This is in line with the lower end of the range indicated by WPI (2021) and sits below that indicated by the Climate Change Committee (2023).

Further considering jobs supported indirectly through the wider supply chain, WPI (2021) estimate that as many as 800 jobs could be supported by 20,000 ha per year peatland restoration. This is broadly in line with the upper end of the range estimated by the Climate Change Committee (2023).

Table 7: The impact of net zero commitments on employment in peatland restoration

	Per 100 ha	Per £1M invested	Assessed Scenario	Estimate	Direct/ Indirect
Scottish Government (2020) Update to the Climate Change Plan	-	10 contractor jobs	Commitment to spend £25 million annually (Scotland). This investment seeks to support a commitment to restore 20,000 ha per annum.	200 FTE contractor and delivery jobs	Direct jobs
WPI (2021)	1-4 jobs with the higher end of the range reflecting indirectly created jobs	-	**20,000 hectares restored per year (Scotland) ***50,000 hectares restored per year	Would imply between 200 – 800 jobs. Would imply	Direct jobs, indirect jobs

	Per 100 ha	Per £1M invested	Assessed Scenario	Estimate	Direct/ Indirect
				between 500 – 2000 jobs.	
Climate Change Committee (2023)	-	-	*56,000 hectares per year by 2030 (p.46)	1,000 – 2,000	Not detailed by the study
Hirst and Lazarus (2020)	-	-	Not detailed by the study****	356	Not detailed by the study

* As specified on page 46. The Balanced Net Zero Pathway is further specified as, all upland peat restored by 2045. 40% lowland cropland rewetted & 35% sustainably managed. Committee on Climate Change (2020) The Sixth Carbon Budget The UK's path to Net Zero p.173.

**WPI (2021) assess the target of 50,000 ha per year as implying between 500- 2,000 jobs. For ease of comparison this has been rescaled to reflect the Scottish target of 20,000ha per year.

***The 50,000ha per annum scenario reflects a prior recommendation by the Committee on Climate Change to restore 55% of peatland to good status by 2050, WPI (2021) estimate that this implies around 50,000 hectares restored per year (UK). Glenk and Martin-Ortega (2018) estimate that this 55% equates to approximately 1.6m ha of peatlands across the UK (Dicks et al., 2020).

****Hirst and Lazurus (2020) suggest that a future trend for peatland restoration could see the sector grow by five times the level of current activity. They estimate this could create 356 new jobs.

8.2 Additional issues to consider

Alongside the need to continue work on establishing estimates of the future scale and composition of the workforce, the literature and our stakeholder interviews highlight some further issues, which are inter-related, that require consideration when attempting to generate quantitative assessments. This demonstrates the importance of gathering both quantitative and qualitative data when undertaking scenario planning work.

8.2.1 Skills

In 2020 Skills Development Scotland produced a Climate Emergency Skills Action Plan which set out an overall direction of travel for the labour market in response to Scotland's net zero commitments. This argues that reaching net zero by 2045 will require transformational change across the economy, including the emergence of new jobs and transitioning existing jobs to embed new green skills. Workers will require both hard and soft skills. The plan

further emphasises the importance of meta-skills such as self-management, social intelligence, innovation and an ability to communicate well.[20]

8.2.2 Seasonality

The issue of seasonality is key to understanding the scale, type and location of future jobs in the land-based sector, in particular the extent to which it is possible for individuals to move between land-based sectors to perform different activities at different times of the year, or indeed between the land-based and other sectors. The potential for workers to connect different seasonal activities and work across sectors may be important for workers ability to meet accommodation and living costs in rural areas, and therefore to attracting sufficient workers to fulfil these roles.[21]

Based on the sources that we have reviewed (Appendix 12), we suggest that the main tree planting period is October – March, excluding December and January and that the key busy period for peatland restoration is August – March (with interruptions due to winter weather). Due to having similar busy periods it seems unlikely that roles within tree planting and peatland restoration will be fulfilled by the same individuals.

To attract workers to fulfil seasonal roles in tree-planting, it may be important to consider the potential for complementary off-season work. In this respect hospitality (commonly the second largest employer in rural areas) may have a complementary calendar, though perhaps a differing skill profile.

8.2.3 Attracting Workers

It will be necessary to attract workers across the land-based sector both to fulfil targeted increases in activity (particularly in tree planting and peatland restoration), and to offset natural attrition due to retirement and other factors.

Research highlights factors which may make this more challenging. Recent workforce studies have indicated that many employers across Scotland are experiencing recruitment challenges in a tight labour market.[22] Within the nature-based sector, Hirst and Lazarus (2020) point to a divide between graduate posts (drawn from national labour pool) and

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[20] 'The Skills Imperative to 2035' programme of work notes a similar set of generic skills which will be in greater demand, including creativity, critical thinking, teamwork, problem solving and resilience.

21 Responsibilities towards existing seasonal employment may also constrain workers ability to seek other employment. For instance, The Women in Farming Report found that "women juggle off- farm work around the needs of the farm" and would take holidays from off-farm work during lambing (Shortall et al., 2017). It also found that responsibility for feeding and housing (seasonal) migrant workers tended to fall upon women.

[22] For instance, the Chartered Institute of Personnel and Development (2022) reported that employers are reporting labour shortages as a dominant issue across all sectors, with 47% employers reporting hard to fill vacancies. Fraser of Allander (2022) similarly reported a high proportion of businesses experiencing recruitment difficulties and problems filling roles, while Skills Development Scotland (2022) note that labour shortages remain a dominant issue for businesses in Scotland.

operational posts (drawn from local labour pool), with operational posts generally harder to fill and experiencing stiff competition from other sectors.

In future, increased competition for skills could serve to enhance wages. Westbrook and Ralph (forthcoming) suggest that wages in the forestry sector may have to rise to attract a sufficient supply of workers. They highlight that median pay for forestry workers (£20,590) is substantially less than the UK national average (£29,577) and less than in other skilled roles involving machinery operation, including agricultural machinery drivers (£28,062), road construction operatives (£28,460) and mechanical engineers (£37,050). Added to low wage rates, the nature of the work in terms of remoteness and isolation, its physical nature and level of potential danger, and the change in mindset needed for much of the activities (see the points made in stakeholder interviews for this project in Box 1), may also serve as further discouraging factors.

Anecdotally, it is said that wage rates in peatland restoration are often above the market rate. Despite this a shortage of local skilled peatland restoration contractors has been highlighted as a barrier to upscaling restoration efforts (Reed et al., forthcoming). This point was further reflected in stakeholder interviews (see Box 1).

8.2.4 Learning Pathways

A widely raised point is the need to attract learners to the land-based sector. Hirst and Lazarus (2020) report that low awareness of opportunities and the range of jobs available was cited as a challenge by stakeholders across the nature-based sector alongside the need to better engage young people and non-traditional groups.

This was further picked up in the CLBLR (2023) which recommended work to be taken to reframe the land-based sector as the 'nature-based sector' to be more inclusive of the range of activities within the sector.[23]

The CLBLR considered that a greater emphasis on sustainability and natural capital could enhance the perception of the sector, helping to attract learners. They further recommended supporting an increase in sector school/college partnership learning pathways (again see Box 1).

Considering the forestry sector more specifically, research by UHI, Lantra and the Institute of Chartered Foresters has pointed to a potential future skills shortage in the forestry sector if longstanding challenges around recruiting students and declining provision of higher education courses are not addressed.[24] They highlight a need to improve perceptions of the industry and make it more attractive to potential students.

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[23] such as aquaculture and urban greenspaces which neither fit well beneath 'land based' or 'rural'.

[24] They highlight that low levels of student enrolment in forestry courses, alongside declining provision of forestry courses, is leading to a critical skills shortage relative to the level of provision required to meet forestry sector targets. Following the closure of higher education courses at Edinburgh, Oxford, Aberdeen and Newton Rigg, much of the remaining higher education provision is in England (Bowditich et al, 2022).

8.2.5 Demographics, Housing and Employment

The Scottish Government's National Strategy for Economic Transformation (March 2022) recognises a number of structural economic challenges including deep-seated regional inequalities with post-industrial areas lagging behind and rural and island areas facing particular challenges such as a falling labour supply, poorer access to infrastructure and housing challenges which are holding back local businesses. The Strategy goes on to note that:

> "The transition to a net zero economy presents Scotland with the further challenge of achieving a just transition that delivers positive employment, revenue and community benefits, in contrast to the industrial transitions of the 1980s."

Elsewhere green land use change has been highlighted as an opportunity with potential to address labour market challenges. For instance an analysis by WPI for the Green Alliance found that across the UK, areas with the greatest potential for afforestation also faced greater than average labour market challenges. They take this to imply that an increase in tree planting showed potential to create jobs in these areas (WPI, 2021).

For this to be feasible however there must be attention to wider rural challenges such as demographic ageing and rural housing provision. Given that rural residents may already be less mobile than their urban counterparts due to structural challenges such as a lack of local childcare and affordable transport and housing, this may mean that they are less able to take advantage of new opportunities that arise.

Coupled with this are challenges around delivering and accessing training in rural locations which may mean that rural workers are not able to access the most up-to-date education and training options available. Hirst and Lazarus (2020) highlight the importance of small and micro-businesses across the nature-based sector, which could be a barrier to enhancing skills provision as smaller businesses often lack the ability to access formal training delivery. Alongside this, the remote location of work alongside seasonality of employment can make training more costly and challenging to organise (Scottish Forest and Timber Technologies, 2020).

The information in Box 1 is based on an interview with an individual working in the land-based sector in an island community. Many of the points discussed here are illustrated in the quotes taken from the conversation.

Box 1. Peatland restoration and green jobs – an island perspective

Local perspective on national policy priorities in peatland restoration

"What we really need locally here are more contractors to carry out the work and specifically digger drivers and appropriate training for plant operators. Existing restoration contractors have tried everything to recruit them but we're not getting anywhere. Without adequate numbers of machines and operators we can't do the work. Part of the issue is that it requires skilled operators. There are plenty of skilled operators in the islands but we're struggling to recruit them to work on peatland both because there is high demand for their skills and because the current funding model does not allow for land managers to restore their own peatland… Plenty of crofters have their own machinery and the skills to carry out the work but the current process requires the work to be tendered to contractors."

'Cathedral builder' mindset

"Operators have to work on land that they'd never normally take a machine out on and be really careful to avoid causing further damage. There is such an expanse of peat to be restored that it requires a 'cathedral builder' mindset. Workers need to be able to keep going while recognising that they may never get to see the final result or what they might consider as tangible benefits."

Tight labour market generally

"The local labour market is tight. Tight is not even the word – it's never been like this before. Knitwear, crab, and seafood processors have lost access to a large pool of foreign workers and this has had a knock on effect across all sectors. …. There's also the problem of housing, even where employers are able to attract workers from outside the isles, there's nowhere for them to live. Property prices have increased exponentially here in the past 4 years, new regulations have pushed people out of the private rental market and the number of second homes, retirement homes, and holiday lets is putting huge pressure on housing stocks. Although there is investment in social housing it is not coming fast enough for young people starting out now."

Encouraging young people into green jobs

"Local young people could be an asset. We have plenty of local young people and plenty of opportunities for them, but we are not matching the two at the moment. We need more engagement with schools so that people know that the full range of jobs that are there. In conservation programmes and citizen science programmes, for example, run by public and third sector organisations, recruits tend to be young graduates from outside the islands. This leads to a lack of local involvement and local knowledge in the development of conservation initiatives, which in turn compromises communication and ultimately the value of the results achieved."

Green skills – a core skill for the future is the ability to be flexible

"Career guidance tends to focus on getting young people into university. There's not enough recognition of the range of non-traditional work out there. Forget the idea that we don't know what future jobs will look like, our current problem is that many of those supporting young people to make career choices don't know what the employment market looks like right now."

9 Conclusions

This project has reviewed evidence relating to the composition and condition of the land-based labour market and its likely future trajectory given the Scottish Government's policy targets set out in the 2020 Climate Change Plan Update. We examined the potential for a methodological approach to model future labour requirements in the land-based sector in order to ensure that climate change and net zero targets are met.

9.1 The composition of the land-based workforce in Scotland

The research highlighted challenges in assessing the overall composition of the land-based workforce, with no commonly agreed definition, which in turn affects the way the required data is collected. The difficulty in identifying and clearly delineating some land based activities, such as peatland restoration, from the SIC system means that there is a lack of dedicated information on these activities within multi-sector labour market studies. The amount of information available varies between sectors, with much of it drawn from industry sponsored reports ..

. The research identified widely used estimates for key sectors, however due to differences in how employment is measured and how industry boundaries are defined, these are not directly comparable with one another. Industry groups in agriculture commonly depend on headcount figures which count part-time and full-time employment equally, while in forestry estimates are expressed as full-time equivalents (FTEs).

Differences in industry definitions also present a challenge. The agricultural sector within the June Census stops at the 'farm gate' (i.e. it refers to the total agricultural workforce on farms), whereas the forestry sector within the CJC (2015) study is broader and includes workers employed in timber haulage, forestry consulting, and local authorities. Employment statistics for the nature-based sector are also not directly comparable with those for agriculture or forestry because they already count part of agriculture and part of forestry and therefore combining figures for nature based employment with either forestry or agriculture would result in double-counting.

For all of these reasons it is not straightforward to determine how many people currently work in the land- based sector.

9.2 The current condition of the rural land-based labour market and key trends

Our analysis at local authority level using BRES data shows headline employment trends in agriculture and forestry over the last ten years, highlighting both similarities and differences between sectors.

A key area of similarity is that employment is strongly rural. Jobs in agriculture and forestry are predominantly located in rural areas. As such, the majority of employment growth since 2011 has occurred in *Mainly Rural* local authority areas.

Both agriculture and forestry have seen an expansion in *the number of employees* over the last decade, however they show differing trends in their *total workforce*. Within agriculture there has been a shift in workforce composition. A moderate increase in agricultural

employees has been offset by a similar decrease in working owners, thus the *total agricultural workforce* is roughly the same in 2021 as it was in 2011. New positions have predominantly been for part-time and casual staff.

Meanwhile *the total forestry workforce* has increased substantially over the last decade, by around 50% between 2011 and 2021. The majority of new positions have been for full time staff. The number of working owners has also increased, though overall working owners are less significant than for agriculture, accounting for less than a quarter of the workforce, as compared to around half in agriculture.

Current and potential workforce opportunities exist in woodland creation, peatland restoration, a shift to regenerative agriculture and a growth in nature-based activities due to the Scottish Government's climate change related targets. It is very difficult with current data to estimate how much and where opportunities are most likely to be concentrated, and the extent to which growth in employment in these sectors or in particular regions may result in decline in other sectors and regions.

Moreover, these opportunities are emerging at a time of 'tightness' in the current labour market where there are labour shortages being experienced in some regions and sectors. While this current 'tightness' may be primarily a result of labour market changes associated with the Covid-19 pandemic and Brexit, wider social trends, and in particular demographic ageing and an overall contraction in the population of working age, suggest that some tightness may continue. There are additional factors in rural areas which affect the size, shape and mobility of the workforce, including the availability of affordable housing, childcare and transport.

9.3 Modelling the future work force

The research identified a relatively limited evidence base examining the impact of net-zero commitments on employment in the land-based sector and the variations between sub-sectors. This project explored the potential for undertaking scenario modelling work but it was not possible to complete this using the approach proposed at the outset. There is potential to model future labour requirements and skills needs if detailed cost breakdown information for all of the policy target activities becomes available (i.e. woodland creation, peatland restoration, low-emission agriculture and nature-based activities).

A recent report by the Climate Change Committee (2023) gives an indication of the likely direction and magnitude of employment impacts within the land-based sector. While acknowledging considerable uncertainty around changes, the report indicates positive employment impacts in afforestation, non livestock agriculture and peatland restoration, alongside negative employment impacts in livestock agriculture, and a mixed picture for food processing.

The implied shift in sectoral composition raises important questions around the wider effects this may have on rural economies and communities. For example, how do the supply chains for those industries compare in terms of their size and geography and therefore the likely impacts of on rural economies? Will an expansion of tree-planting and peatland restoration activities and jobs support rural economies and communities in the same way as

agricultural activities and jobs? Will these new workers live in rural areas year-round, spend their wages in the local economy and contribute to school rolls?

It is also important to consider the viability of seasonal roles in tree planting and peatland restoration. The ability of workers to connect different forms of seasonal employment may be important their ability to take on seasonal roles. However, due to having similar busy periods it is unlikely that jobs in tree planting and peatland restoration will be fulfilled by the same individuals. More generally, upscaling jobs in rural areas requires attention to wider rural challenges such as housing provision, demographic ageing and the affordability and availability of services including transport.

There is clear value in exploring qualitative and quantitative data for scenario-based work, particularly in an area as complex as the land-based labour market where there will be trade-offs and regional differences. Qualitative ad hoc or tailored exercises can provide complementary insights to those provided by quantitative modelling approaches. A greater understanding of these issues is critical to promoting a just transition and enabling the sustainability of rural communities as Scotland transitions towards its net zero targets.

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11 Appendix 1: Project aim, objectives and outline methodological approach

The **aim** of this project was:

"To achieve a system-wide overview of the existing statistics and what they tell us about the current land-based labour market in the rural land use sector in Scotland."

There were three key **objectives** and the research team identified four **tasks to** undertake to achieve them:

Objective 1: To assess the existing data for the land-based labour market in the rural land use sector in Scotland in order to understand the composition of the workforce and associated skills and identify key gaps.

Task 1: The desk-based identification and review of key sources of quantitative, statistical data on Scotland's rural labour market, with a focus on understanding the composition of the rural workforce and associated skill requirements, and its resilience to change. The research team undertook an extensive search for publicly available and secure access only information relating to the labour market in the UK and Scotland. We also identified any gaps in our understanding, particularly relating to sectors/activities that may become more important in future.

Objective 2: To analyse the available evidence and report on the current condition of the rural land-based labour market, including trends of continuity and change since 2010.

Task 2: The desk-based identification and review of available academic and other relevant, non-quantitative evidence on the current condition of the rural land-based labour market and related skills issues, including trends of continuity and change since 2010.

Objective 3: Using a scenarios approach, to model likely future rural workforce needs and skill sets associated with the land uses anticipated as part of the transition to net zero. The scenarios were aligned with the policy targets set out in the Climate Change Plan Update, and focus on the key delivery dates of 2030 and 2045.

Task 3: Informed by a review of similar studies that have sought to model future workforce needs and skill sets associated with the land uses anticipated as part of the transition to net zero, and a review of how scenarios have been developed and used in similar studies, we designed a methodological approach to create a working model to explore likely future rural workforce needs and skillsets associated with the land uses anticipated as part of the transition to net zero.

Task 4: When the team was at the stage of having a draft report and a preferred methodology for the scenario modelling work, we undertook a small number of interviews with relevant stakeholder organisations and SRUC colleagues to sense-check our evidence review, scenarios and modelling work. Ethical approval for these interviews was obtained from SRUC's Social Science Ethics Committee. Interviewees were sent the draft report to read in advance of the conversation (where time permitted) and interviews were recorded (with permission). The interviews were relatively unstructured, allowing the interviewee

scope to raise issues of importance to them to inform the project. The data from these interviews is reported here anonymously with no individuals or organisations identified.

12 Appendix 2: Policy context for the land-based labour market

A2.1 Climate, environment, place-based and skills policies

The Scottish Government's Environment Strategy sets the overarching framework for Scotland's strategies and plans relating to the environment and climate change. The vision set out in this Strategy is:

> "By 2045 – By restoring nature and ending Scotland's contribution to climate change, our country is transformed for the better – helping to secure the wellbeing of our people and planet for generations to come."

The Scottish Government's climate change legislation sets a target date for net zero greenhouse gas emissions by 2045. Changes to climate change legislation and associated consumer behaviours to move towards greater sustainability will impact on the economy and society, including the labour market, in various ways.

The Government's Climate Change 2018-32 Plan, published in 2018, and its Climate Change Plan Update published in late 2020, describe the large-scale changes needed to help reach our statutory net zero targets. The third progress report on the Climate Change Plan Update was published in May 2023. In addition to this, the Scottish Government also has ambitious targets to end biodiversity loss by 2045, requiring simultaneous and significant improvements in nature restoration. A new Scottish Biodiversity Strategy to 2045 was published in December 2022.

Changes to Scotland's workforce will be required to meet these ambitious targets, with land-based activities having a key role to play, in particular in rural areas where much of this activity can be found; this includes agriculture, forestry, peatland restoration and nature-based activities. Recent policy documents set out the direction of travel in these sectors, including the Scottish Government's Agriculture Vision 'Sustainable and Regenerative Farming – next steps' (published in March 2022), the Scottish Government's Forestry Strategy 2019-2029 and its planned Circular Economy legislation and Route Map to 2025 and beyond. There have also been independent inquiries and reports, such as the Farming for 1.5º inquiry and the Commission for the Land-Based Learning Review which have contributed to thinking regarding the future shape of land-based activities. The independent review of Scotland's skills delivery landscape, chaired by James Withers reported in June 2023, having undertaken a call for evidence in Autumn/Winter 2022.

At the same time, some elements of the policy context are yet to be confirmed, including the future support regime for agriculture (though more information has been available on this since the speech by the Cabinet Secretary for Rural Affairs, Land Reform and Islands Mairi Gougeon at the Royal Highland Show in June 2023) and the shape and organisation of Scotland's agricultural knowledge and innovation system (AKIS) (a report by the James Hutton Institute published in May 2023 undertook an options appraisal for this), both of which are highly relevant to this project.

The work of the first Just Transition Commission between 2019 and 2021 and the second Commission which started in 2022, recognises the potential for people and places to be affected in different ways by these workforce changes. The Scottish Government recognises the scale of the transition required in its response to the first Commission's final report and has committed to setting out a series of just transition plans. A discussion paper to support engagement on a just transition in the land use and agriculture sectors was published in June 2023.

The Land and Agriculture Just Transition Plan (LAJTP) is due to be published in line with the future arrangements for agricultural support to replace the CAP following the UK's EU exit, and will focus on those who live and rely on Scotland's land for their livelihoods and wellbeing and on maintaining thriving rural and island communities. The LAJTP will look to demonstrate how Scottish Government policies to tackle and adapt to climate change and wider Scottish Government action will support:

- the creation of new or expanded economic opportunities in sectors such as nature-based solutions, natural capital investment and maintenance, green tourism, sustainable and regenerative food production and wood products.
- an increase in health and wellbeing for both people and the environment, and
- greater community empowerment as we look to ensure those already disadvantaged do not carry the burden, and that more benefits such as skills enhancement and employment opportunities flow to local communities.

In terms of its policies for specific places, Scotland does not have a distinct rural policy or strategy; the Scottish Government takes the approach of mainstreaming where rural issues are reflected in mainstream policy development. In late 2022, there was a new commitment for the projects which are funded as part of the National Strategy for Economic Transformation (NSET), to undertake checking using new 'Rural Lens' guidance to ensure that these projects take account of and meet the needs of Scotland's rural communities and people. In April 2023, in his vision for Scotland, First Minister Humza Yousaf announced that a Rural Delivery Plan would be published by 2026 and alongside this in the same timescale, a Remote, Rural and Islands Housing Action Plan. Since the Islands (Scotland) Act 2018, which exists to support and help meet the unique needs of Scotland's islands, the Scottish Government has committed to publish a National Islands Plan every five years with an annual review, and, alongside other relevant authorities as set out in the 2018 Act, a commitment to undertake Islands Community Impact Assessments.

The Scottish Government's Climate Emergency Skills Action Plan sets out the Government's plan to maximise the transition to net zero by 2045, ensuring that the workforce has the skills required to make the transition to net zero just, fair and inclusive to all. Demand for green jobs and associated green skills is expected to increase rapidly in response to these policy drivers and to wider consumer behaviour changes. Linked to this, fair work is an important policy driver for Scottish Government, particularly given that the Covid-19 pandemic has exacerbated existing socio-economic inequalities. The Government's Covid-19 Recovery Strategy focuses on a number of priority actions including upskilling and retraining opportunities for employees impacted by the pandemic and the transition to net zero, support for low-income families most at risk of poverty, and mental health and wellbeing support for children and young people.

A2.2 The National Strategy for Economic Transformation (NSET)

It is worth adding further information about the NSET, which was launched in March 2022 and demonstrates, amongst other things, how central natural capital and natural capital based sectors are to economic policy in Scotland.

The Strategy recognises a number of structural economic challenges which preceded the Covid-19 pandemic, including Scotland's ageing population and relatively high level of economic inactivity (one in five people in Scotland). Structural inequalities led to many households living in poverty and Scotland's productivity lags behind that of many advanced economies. There are also deep-seated regional inequalities with post-industrial areas lagging behind and rural and island areas facing particular challenges such as a falling labour supply, poorer access to infrastructure and housing challenges which are holding back local businesses. The Strategy goes on to note that:

"The transition to a net zero economy presents Scotland with the further challenge of achieving a just transition that delivers positive employment, revenue and community benefits, in contrast to the industrial transitions of the 1980s."

Nevertheless there are also notable strengths:

- Scotland is in the top quartile of OECD countries for higher education, research and development,
- the percentage of the population with tertiary education, and
- young people's participation in the labour market.

Looking to the future, the NSET notes the Scottish Government's aim in relation to achieving a more skilled workforce in Scotland, where there is a focus on the transition to net zero, the digital revolution and lifelong learning. Through three NSET projects funded on the skills theme, the focus is on adapting the education and skills system to make it more agile and responsive to economic needs and ambition. This includes supporting and incentivising people and employers to invest in skills and training throughout their working lives and expanding Scotland's available talent pool at all skill levels to give employers the skills pipeline they need to take advantage of opportunities.

Specific NSET actions around skills include implementing the next phase of the Green Workforce Academy and implementing a lifetime upskilling and retraining offer that is more straightforward for people and employers. Importance is also placed on the implementation of the Climate Emergency Skills Action Plan, the Green Jobs Skills Hub to share information on skills shortages and opportunities throughout the labour market, and the Commission for the Land Based Learning Review (CLBLR) which reported in January 2023 and offers an opportunity to link across existing work in the Skills Action Plan for Rural Scotland and the Climate Emergency Skills Action Plan. Closely linked to these developments, the new SkillSeeder web platform was set up in 2020 as a skill sharing marketplace funded through CivTech Challenge 5 where courses and training can be listed across all sectors and those seeking training can find information and sign up in one place.

The NSET also refers to the fair work agenda which is a key policy driver for the Scottish Government and also its Future Skills Action Plan which built on the recommendations of the Enterprise and Skills Board's Strategic Plan published in 2018. The Action Plan contains four themes:

- Increasing system agility and employer responsiveness;

- Enhancing access to upskilling and retraining opportunities;
- Ensuring sustainability across the skill system; and
- Accelerating the implementation of the learner journey review.

12.1.1 A2.3 The Climate Change Plan Update policy targets – further information

The work undertaken in this project is particularly aligned with the policy targets set out in the Climate Change Plan Update (CCPU).

The CCPU notes the Scottish Government's commitment to green recovery from the Covid-19 pandemic which captures the opportunities of our transition to net zero:

"That means creating green jobs, developing sustainable skills and nurturing wellbeing. This approach recognises climate change as a human rights issue and the transition to net zero as an opportunity to tackle inequalities."

Scotland has ambitious targets to end it's contribution to climate change by 2045: a commitment to reducing emissions by 75% by 2030 (compared to 1990) and to net zero by 2045.

The Update emphasises that:

"Scotland's natural capital is one of our greatest assets and is central to our future net zero economy, developing thriving rural economies based around woodland creation, peatland restoration and biodiversity, as well as sustainable tourism, food and drink and energy" (p9).

The Update also calls for a coordinated approach, a whole system view (as taken for example in the Third Land Use Strategy), across sectors and policy targets, though the document itself contains policies and targets for individual sectors.

At the centre of the Scottish Government's commitment to securing a just and green recovery, is a commitment to increase the number of good, green jobs, and to enable people to access these jobs through training and reskilling. To further align the skills system with the demand resulting from a green recovery and the transition to net zero, the Climate Emergency Skills Action Plan was also published alongside the Update.

The policies and targets in the Update can be summarised as follows:

- Land use, land use change and forestry:
    - The Update contains plans to significantly increase forestry and peatland restoration in particular to reduce greenhouse gases and other pollutants, and increase the levels of carbon dioxide being absorbed and locked up in timber products.
    - The Update sets out a plan to continue to expand forest cover in Scotland, with **an increase in new woodland creation from the current target level of 12,000 ha annually in 2020/21 to 18,000 ha in 2024/25**. Scottish Forestry and Forestry and Land Scotland will work with investors, carbon buyers, landowners and market intermediaries to increase private investment in new woodlands in order to increase the woodland carbon market by at least 50% by 2025.
    - As of March 2020, over 25,000 ha of peatland have been put on the road to restoration, and earlier this year we announced a £250 million ten-year

funding package to support the **restoration of 250,000 ha of degraded peat by 2030.** To deliver on the 2032 emissions reduction envelope annual peatland restoration needs to be far higher than the current 20,000 ha annual target and we will work closely with delivery partners, land owners, managers, farmers and crofters to continue to encourage more restoration of peatland, both traditional bog but also land that offers the highest emission savings per ha.

- Agriculture:
    - There is recognition in the Update of the need for agriculture to produce high quality food and deliver high environmental standards and emissions reductions going forward, as well as manage soils and grasslands appropriately and deploy technology innovatively to support all of these activities.
    - The Update provides a routemap for agricultural transformation, building on the work of the farmer led groups, and **including a shift towards low carbon sustainable farming**. The Agricultural Transformation Programme will be scaled up to enable farmer and crofters to purchase equipment to reduce emissions and support practice change. Options to **explore multi-faceted land use will also be followed**, including forestry, peatland restoration and management and biomass production, especially for those farmers wanting to step back from agricultural businesses.
- Electricity:
    - The CCPU announces further policies to continue the rapid growth in renewable energy generation over the past twenty years, moving from a low to a zero carbon electricity system, with the potential for NETs to deliver negative emissions
    - Renewable energy generation in Scotland accounts for the equivalent of 50% of our energy demand across electricity, heat and transport by 2030
    - Publish a bioenergy action plan in 2023
- Waste and circular economy plans/targets:
    - Continue to embed circular economy principles in wider green recovery
    - Increasing recycling, reducing food waste, reducing materials going to landfill

The Update contains a section which outlines what the policies mean in practice in terms of a pathway to 2032 (p18). This section of the report states:

"By 2032, the natural environment and landscapes around us will have undergone significant restoration, with a sustainable land use system that prioritises nature and biodiversity. 21% of our land will be covered by forest, following increased funding of £150 million as well as our target of planting 18,000 hectares per year by 2024/5. We will also have restored over 250,000 hectares of peatland with £250 million of investment over 10 years, protecting this significant carbon store, and restoring wetland habitats. The prioritisation of these "nature-based solutions" and restoration projects will deliver multiple benefits, not only in terms of carbon sequestration, but also enhanced biodiversity, improved air and water quality, and landscapes and ecosystems that are more resilient to climate change.

Meanwhile, the agricultural sector will have supported these changes in land use, through the use of appropriate land for afforestation, including further integration of woodlands on

farms, and peatland, while continuing the important role of food production. Farmers and crofters will continue to be supported for their key roles of producing high quality food and environmental stewardship while meeting conditionality for delivery of high environmental standards for emissions reduction and biodiversity. They will be adopting all available low-emission technologies and practices supported by the introduction of new approaches, alongside environmental conditionality. Through partnership working between government and industry, for example through the work of the farmer-led groups and realigned and enhanced advice, agricultural businesses will have the skills and tools they need to produce food more sustainably, while adopting new technologies and innovative approaches."

13 Appendix 3: Web of Science database search terms

The research team undertook a search of publications using Web of Science to assess the extent to which the impact of net zero and biodiversity commitments on the land-based labour market has been explored.

13.1.1.1 Table A1: Information on the research team's Web of Science database search terms

Population	Scotland	TS = (Scotland OR UK OR "United Kingdom")
Intervention	Land Use Transition relating to Net Zero and Biodiversity Commitments	TS = ("net- zero" OR "net zero" OR "climate- change" OR "climate change" OR climate OR "climate-aligned" OR carbon OR "low- carbon" OR diverse* OR "Just Transition" OR "just transition" OR green OR peat OR peatland OR "nature- based" OR "nature based" OR "natural- capital" OR "natural capital" OR rewilding OR renewable OR social OR ethical OR ESG OR NBS OR "land use" OR "land- use change" OR LULUC OR LULUCF OR bioenergy OR "animal health" OR "animal welfare") AND
Comparator	(absence of intervention)	
Outcome	Rural Labour Market	TS = (rural OR forestry OR planting OR farm* OR agri* OR land OR land- based OR "land use" OR "land use change" OR LULUC OR LULUCF OR bioenergy OR "animal health" OR "animal welfare") AND TS = (jobs OR employment)

Sources published 2010 and earlier were excluded.

TS stands for topic search, this means that the search is for the terms in four fields: Title, Abstract, Keywords and Keywords Plus. Sources are returned only if they include one (or more) term from each set of brackets.

14 Appendix 4: Defining the land-based sector

Lantra Scotland is the sector skills organisation for land-based activities in Scotland. The organisation's website has a wide range of information on pathways into jobs and qualifications. In their 2009 Environmental and Land Based Scottish Sector Profile report they define the sector as including a set of SIC (2003) codes[25] (see Box A1).

In its 2012 skills assessment report for the Agriculture, Forestry and Fishing sector, Lantra notes that the sector has a key role in feeding our nation and is indispensable for our current and future economic prosperity. Businesses in the sector safeguard the UK's natural environment and natural heritage and are on the front line in the drive for food security, sustainable development, growing the rural economy and adapting to climate change by reducing greenhouse gases and creating more renewable energy. More specifically in terms of the SIC codes (2007) included, Lantra include Code 01 (crop and animal production), 02 (forestry and logging), 03 fishing and aquaculture and 75 (veterinary activities). However, they note that the sector is broader than these categories, and includes farming, horticulture, viticulture and hunting and trapping, as well as aspects of animal health and welfare. Forestry and logging consists of silviculture (forest management), logging and coppicing. Fishing includes both fresh water and marine fishing, while aquaculture covers the farming of freshwater and marine plants and animals. Support services to these industries (such as agricultural consultants) and plant propagation are also included in the definition. Veterinary activities covers farm animals and domestic pets, and in terms of occupations, the sector includes veterinary surgeons and veterinary nurses as well as any other auxiliary personnel. Outside the scope of this skills assessment are research and development activities relating to the sector, such as plant trials and biotechnology.

SIC Code	Description
0100	DEFRA/Scottish Executive Agricultural Data
0111	Growing of cereals and other crops not elsewhere classified
0112	Growing of vegetables, horticultural specialities and nursery products
0113	Growing of fruit, nuts, beverage and spice crops
0121	Farming of cattle, dairy farming
0122	Farming of sheep, goats, horses, asses, mules and hinnies
0123	Farming of swine
0124	Farming of poultry
0125	Other farming of animals
0130	Growing of crops combined with farming of animals (mixed farming)
0141	Agricultural service activities
0142	Animal husbandry service activities, except veterinary activities
0150	Hunting, trapping and game propagation including related service activities
0201	Forestry and logging
0202	Forestry and logging related service activities
0502	Operation of fish hatcheries and fish farms
2010	Saw milling and planing of wood, impregnation of wood
5188	Wholesale of agricultural machinery and accessories and implements, including tractors
8520	Veterinary activities
9253	Botanical and zoological gardens and nature reserve activities

The (UK-wide) National Land Based College *('the one stop shop for land based careers and skills'*), refers to the UK Government's approach of regarding 'land based' careers as the:

[25] These are the Standard Industrial Classification (SIC) codes from 2003; this was updated in 2007 to adopt five digit codes.

"Agriculture, Environmental and Animal Care sector which offers a range of career opportunities[26]. The term 'land based' traditionally relates to farming and industries connected to the land and environment, including horticulture, food production, forestry, conservation, landscaping and equine (horses)…Land based careers are diverse and use a number of different skills. Many roles combine cutting edge science, engineering and IT with an understanding of the natural world and how it works. Skills within the more creative leisure sectors are also required, with opportunities in landscape design, floristry, tourism and recreation. Careers can also include working with animals, nature conservation and caring for our land and environment. Many of the careers span a number of the areas above, and skills gained are transferrable between these sectors."

The NLBC has worked with City and Guilds to design technical qualifications to increase skill levels in the land-based sector, including agriculture, animal management, environment, countryside and conservation, equine, forestry and arboriculture, horticulture and land-based engineering.

The research team also reviewed the remit of the Commission for the Land Based Learning Review (CLBLR) which was appointed by the Scottish Government to undertake a 'root and branch' review of learning in Scotland's land-based and aquaculture sectors, from early years to adulthood. The CLBLR provided independent, evidence-based advice to Scottish Ministers around the best ways to provide opportunities and qualifications through school, college, university, and work-based learning, including apprenticeships, for more people and specifically more women, to work with and on the land, particularly in green skills. The work of the CLBLR supports the Government's ambitions of delivering a just transition to net zero, by ensuring Scotland's learning system equips people with the skills and knowledge needed to work in the country's land-based sectors as well as any new and emerging green occupations in land-based sectors. The Scottish Government will respond to the CLBLR's report later in 2023.

The review considered the learning pipeline for the following sectors:

- agriculture
- aquaculture
- biodiversity
- environmental conservation
- equine
- fisheries management
- food and drink processing
- forestry, trees and timber
- game and wildlife
- horticulture
- peatland restoration

[26] The full list provided on the NLBC website is - Agriculture: crops, livestock, aquaculture and fisheries management, viticulture and oenology, land-based engineering and forestry; Environment: horticulture, landscaping, sports turf, countryside management, gamekeeping, forestry, aboriculture, floristry; Animal care: animal management, equine care and management.

The review did not include nature-based tourism, outdoor recreation and renewables (wind, hydro and solar)[27].

The Scottish Qualifications Authority (SQA) makes reference to the 'land-based and environment sector' which it argues makes up 6% of all UK businesses, employing 660,000 people. The SQA describes that its qualifications have been developed with Lantra and industry contacts (and they link to a variety of industry bodies[28]) to ensure they are relevant and provide people with the skills needed to work within this sector, and cover a wide variety of disciplines, including: animal care, aquaculture, environmental management, horticulture, forestry, landscape management, wildlife and conservation management, and much more.

Pearson, an awarding body offering academic and vocational qualifications, offers 'land-based studies' which includes agriculture, horticulture and land-based studies, with the latter including a range of subjects/courses, including plant and soil science, environmental and conservation management, wildlife ecology, developing a land-based enterprise, farm livestock husbandry, crop production, planting/care of plants, etc. which could support people going into a variety of jobs. The National Careers Service in its Environment and Land category includes a very wide range of occupations[29]. The Careermap website, in its sector spotlight on the land-based and environmental industries, splits the sector into three broad areas: land management, animal health and welfare, and environmental industries.

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[27] Members of the research advisory group wished to highlight that this omission could be significant. For instance, a study by CJC Consulting (2015) estimated that forest recreation and tourism alone supported 6,312 FTE.

[28] Organisations include: National Association of Agricultural Contractors; Horticulture Development Council Scottish Tenant Farmers' Association; The Institute of Fisheries Management; British Florist Association (BFA); National Gamekeepers Organisation; Association of Professional Landscapers; Institute of Groundsmanship (IOG); Institute of Horticulture (IOH); Landscape Institute (LI); Professional Gardeners Guild (PGG).

[29] Agricultural contractor, Agricultural engineer, Agricultural engineering technician, Agricultural inspector, Agronomist, Arboricultural officer, Archaeologist, Bin worker, Biologist, Building technician, Cartographer, Cemetery worker, Chemical engineer, Climate scientist, Commercial energy assessor, Corporate responsibility and sustainability practitioner, Countryside officer, Countryside ranger, Drone pilot, Ecologist, Energy engineer, Environmental consultant, Environmental health officer, Farm worker, Farmer, Fence installer, Fish farmer, Florist, Food manufacturing inspector, Forestry worker, Gamekeeper, Gardener, Geoscientist, Geospatial technician, Geotechnician, Groundsperson, Horticultural manager, Horticultural therapist, Horticultural worker, Hydrologist, Land surveyor, Geographic information systems (GIS) surveyor, geomatics surveyor, Landscape architect, Landscaper, Marine engineer, Meat hygiene inspector, Meteorologist, Nuclear engineer, Oceanographer, Oil and gas operations manager, Palaeontologist, Pest control technician, Quarry engineer, Recycled metals worker, Research scientist, Rural surveyor, Seismologist, Geophysicist, Thermal insulation engineer, Tractor driver, Tree surgeon, Water network operative, Water treatment worker, Wind turbine technician, Zoologist.

15 Appendix 5: Key data and evidence sources on the UK and Scottish labour markets

15.1.1.1 Table A2: Macro-level data on the UK and Scottish labour markets

Data	Details/Variables	Source/Website
Labour Force Survey 2007-2022 (ONS)	The Labour Force Survey (LFS) is a unique source of information using international definitions of employment and unemployment and economic inactivity, together with a wide range of related topics such as occupation, skills and training, hours of work and personal characteristics of household members aged 16 years and over. It is a household survey of the employment circumstances of the UK population. While most UK Government surveys contain some employment related questions, the LFS contains the widest range of employment and training questions.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=8959 Labour Force Survey – user guidance - Office for National Statistics (ons.gov.uk) Labour market in the regions of the UK - Office for National Statistics
Business Register and Employment Survey, 2009-2020: Secure Access	This data includes the key variables related to employment and employees, including totals, full/part-time, weighted and year-average estimates total working owners, legal status and public/private sector variables, geographical variables down to postcode level, Standard Industrial Classification codes 2003, 2007 & urban-rural indicators This is a very comprehensive source of employment data and is used as the basis for Oxford Economics' labour force modelling work with SDS for example.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=7463

Data	Details/Variables	Source/Website
Annual Population Survey	Combines data from the Labour Force Survey with a boost to provide a larger annual sample. A continuous household survey including topics such as employment and unemployment, education, training as well as housing, ethnicity, religion and health.	Annual population survey (APS) QMI - Office for National Statistics
Scotland's Census 2001, 2011, 2021	Census 2021 data for Scotland is not yet available so it has not been possible to access it for this project. A consultation on how the Census outputs should be made available closed in February 2023.	https://www.scotlandscensus.gov.uk/
Scottish Government	Labour Market Summary data (including information from the Labour Force Survey, the Annual Population Survey, the Annual Survey of Hours and Earnings, and including specific information on public sector employment, young people in the labour market, non-UK nationals in Scotland's workforce, etc.).	Labour market statistics - gov.scot (www.gov.scot) See additional information provided after this Table.
Skills Development Scotland	LMI (the Scottish Labour Market Information and Intelligence Framework) Regional Skills Assessment Data Matrix, including a rural cut of the data to support the Skills Action Plan for Rural Scotland 2019-21; data available at various spatial scales, including city regions, growth deals, local authorities. Sectoral Skills Assessments Covid-19 Labour Market Insights report	Scottish Labour Market Information and Intelligence Framework | Skills Development Scotland Regional Skills Assessments | Skills Development Scotland Sectoral Skills Assessments | Skills Development Scotland

Data	Details/Variables	Source/Website
Annual Survey of Hours and Earnings, 1997-2021: Secure Access	This data contains a small number of variables for each individual, relating to wages, hours of work, pension arrangements, and occupation and industrial classifications. There are also variables for age, gender and full/part-time status. Because the data are collected by the employer, there are also variables relating to the organisation employing the individual. These include employment size and legal status (e.g. public company). Various geography variables are included in the data files.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=6689
Office for National Statistics	Latest UK economy information Employment in the UK: monthly updates	UK economy latest - Office for National Statistics (ons.gov.uk) Employment in the UK - Office for National Statistics (ons.gov.uk)
Nomis (official census and labour market statistics) (2004-2022)	This data contains statistics related to population, society, employment, qualifications, economic (in)activity, workless household, earning, and the labour market at national, regional and local levels. These include data from current and previous censuses.	https://www.nomisweb.co.uk/reports/lmp/la/1946157405/report.aspx
CIPD (Chartered Institute for Professional Development)	Various data, updates, articles, guides etc. on labour market and employment issues, including labour market outlook summaries	CIPD The Professional Body for Human Resources and People Development See additional information provided after this Table.
Business Insights and Conditions Survey: Waves 1-61, 2020-2022: Secure Access	This data aims to deliver timely indicators to help understand the impact of the coronavirus pandemic (COVID-19). It captures businesses responses on how their turnover, workforce, prices, trade and business resilience have been affected during the crisis.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=8653

Data	Details/Variables	Source/Website
Business Structure Database, 1997-2021: Secure Access	The BSD data collects key information related to enterprises at national and local units, including employment (and employees), Turnover, Standard Industrial Classification (1992, 2003 and 2007 classifications are available), legal status (e.g. sole proprietor, partnership, public corporation, non-profit organisation etc), foreign ownership, birth (company start date), death (termination date of trading), various geographical variables, etc.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=6697
Longitudinal Inter-Departmental Business Register, 2007-2017: Secure Access	The IDBR covers businesses in all sectors of the UK economy, other than very small businesses (those without employees and with turnover below the tax threshold) and some non-profit making organisations. It includes key information on 2007 Standard Industrial Classification, Legal Status, Number of employees and Business growth.	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=8457
UK Innovation Survey, 1994-2020: Secure Access	The survey is based on a core questionnaire developed by Eurostat and Member States, and covers a broad range of policy interests including general business information, innovation activity, goods, services and process innovation context for innovation general economic information	https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=6699

15.1.1.2 Table A3: Micro-level data on the UK and Scottish labour markets

Data	Details	Website
Longitudinal Small Business Survey (LSBS) 2017	This data contains the information on business performance and growth including the environmental perspectives and goals of businesses, business activities, job training, technological use/skills, and other business characteristics at local, regional and national levels. In the LSBS-2017, information was collected for 1,042 SMEs in Scotland, of which 34.6% (361) were classified as rural businesses using postcodes.	Our team hold this dataset and it is also available upon request at: https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=7973
Scottish Business Monitor	Fraser of Allander Institute	Scottish Business Monitor | FAI (fraserofallander.org) See additional information provided after this Table.
Business Trends Survey	Scottish Enterprise	Scottish economy and global economic trends - Scottish Enterprise (scottish-enterprise.com)
SRUC's Rural Business Survey	Three years of data: 2017/18, 2018/19, 2019/20 including information on key challenges facing rural businesses (in Aberdeenshire, Tayside, Scottish Borders and Dumfries and Galloway); sample of 1,000-1,200 businesses in each of the three surveys	Impact of changes in the CAP regime on rural (non-agricultural) businesses — SRUC, Scotland's Rural College

As evident in Table A2, the team reviewed a range of sources of employment information and this final section of the Appendix provides a little more information from some of the key sources.

The Scottish Government produces secondary analysis of the latest labour market information from a range of sources, including the ONS' Labour Force Survey, the Annual Survey of Hours and Earnings and the Annual Population Survey in its Labour Market Summary. It also publishes an annual report on Scotland's Labour Market based on Annual Population Survey data with the most recent version published in 2020/21. This report contains information on a range of labour market issues, including employment rates (including by local authorities, sector and age), types of work (e.g. underemployment, contractually secure employment, gender segregation and job-related training) and skills. It also provides local authority level data on the proportions of people with low/no qualifications.

Skills Development Scotland (SDS) hosts a large amount of data on its website relating to Scottish employment, labour market and skills issues, including its regular Covid-19 Labour Market Insights reports. The Scottish Labour Market Information and Intelligence (LMI) Framework (involving SDS, Highlands and Islands Enterprise, Jobcentre Plus, Scottish Enterprise, Scottish Funding Council, Scottish Government, Scottish Qualifications Authority and the Improvement Service) encourages all organisations to work collaboratively to collate, analyse, publish, etc. labour market evidence. Through this framework, SDS provides Regional Skills Assessments (RSA) and Sectoral Skills Assessments (SSA, including information on job postings, employment forecasts and skill requirements, amongst other things). Both of these are built from existing datasets combined with regional/industry insights, and provide coherent, high-level evidence to inform future investment in skills. More information on these assessments is provided in the sector-specific sections later in the report. SDS also has a RSA Data Matrix Interactive Tool which provides data on over 80 indicators at Local Authority level, and for other sub-regional geographies.

SDS's Covid-19 Labour Market Insights Report from July 2022 notes the strong inflationary pressures, worker shortages, supply chain challenges, the cost of living crisis and the projection that the UK will enter a recession towards the end of this financial year as important issues impacting on the current Scottish (and UK) labour market. It goes on to note that the supply of people in the labour market has been impacted by high levels of economic activity, EU exit and demographic challenges. Labour shortages remain a dominant issue for businesses in Scotland, due to people being reluctant to change roles and challenges funding suitably skilled candidates and demand for workers remaining exceptionally high. The CIPD's Labour Market Outlook from Summer 2022 also reports that employers are reporting labour shortages as a dominant issue across all sectors. They are increasingly focused on upskilling existing workers (41%), followed by advertising more jobs as flexible (35%) to tackle recruitment challenges. In this Outlook, 47% of employers reported having hard-to-fill vacancies.

A Fraser of Allander Institute survey (the Scottish Business Monitor) from May 2022 also reports high numbers of businesses experiencing recruitment difficulties and problems filling roles. They note a variety of reasons, including candidates lacking skills/ experience, a lack of applications overall, and sometimes candidates' wage expectations being higher than businesses could offer. Some businesses also reported difficulties retaining staff, including due to increases in remote jobs in the labour market (such as people being offered highly

paid jobs in the London labour market but able to work in rural and island Scotland, for example).

16 Appendix 6: Green skills and green jobs

Terms such as 'green transition', 'green skills' and 'green jobs' have become more widely used in relation to the changes required in labour markets to meet climate and environmental goals (such as implementing circular economy practices, enhancing biodiversity, etc.), and to ensure a sustainable recovery from the Covid-19 pandemic. For example, as noted in SDS's February 2022 Sectoral Skills Assessment for the Agriculture, Forestry and Fishing sectors:

"green jobs are at the forefront of the Government's plans for recovery. Demand for green jobs (and green skills) is expected to increase rapidly as a result of policy and legislative drivers and consumer choice."

However, they remain poorly defined and there is no single agreed way to quantify them. The UK Government has not set out a definition of 'green jobs', nor how it will measure progress towards its ambitions –though a UK Green Taxonomy is under development and could provide this in future. The ONS estimates the number of UK green jobs in two ways:

(i) UK employment in the Environmental Goods and Services Sector (EGSS), defined as 'areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources'; and

(ii) Information collected from businesses through the Low Carbon and Renewable Energy Economy (LCREE) survey, focussing on (a different) 17 sectors[30] deemed low-carbon or related to renewable energy and defined as 'economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide'.

The International Labour Organisation (ILO) confirms the lack of an agreed definition of 'green jobs' (ILO 2018 p. 53, p135). They argue that a 'purist' definition takes a narrow approach defining them strictly in terms of green credentials – jobs that 'contribute substantially to preserving or restoring environmental quality'. However, the ILO tends to take a broader definition, arguing that green jobs are 'decent jobs that contribute to preserve or restore the environment, be they in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency'.

Contributors to the UK Government's House of Commons' Inquiry into 'Green jobs and the just transition' (p7-8) identified a range of other possible definitions, some of which included social care and the emergency services; others included all jobs because people across all jobs have an obligation to take action to protect the environment.

[30] These sectors are: alternative fuels; bioenergy; carbon capture and storage; energy efficient lighting; energy efficient products; energy monitoring, saving or control systems; fuel cells and energy storage systems; hydropower; low carbon financial and advisory services; low emission vehicles and infrastructure; nuclear power; offshore wind; onshore wind; other renewable electricity; renewable combined heat and power; renewable heat; and solar photovoltaic.

The ONS identify two further ways green jobs could be measured:

(i) the sectoral approach, which involves identifying relevant sectors, e.g. renewable energy, and either assuming all jobs in this sector are 'green' or deciding which jobs within the sector are 'green' and which are not; and
(ii) O*NET, a United States database, which sorts jobs in sectors that could make up a 'green economy' into three categories, based on the interaction between skills and the transition to a greener economy.

Following the UK Government's Green Jobs Taskforce definition of green jobs (p9), would encompass a wide variety of different sectors, including jobs in nature and habitat management, the circular economy, etc.:

employment in an activity that directly contributes to—or indirectly supports—the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks.

The UK Government's Green Jobs Taskforce report published in 2021, referred to the Government's Ten Point Plan for a Green Industrial Revolution published in 2020, and builds on an inclusive definition of green jobs and skills noting that every job has the potential to turn green and that there is a huge range of skills which will support the net zero transition.

Focusing on Scotland, increasing the number of green jobs has been a priority for the Scottish Government for several years, in order to reach ambitious environmental and net zero targets (see for example, the Programme for Government 2020-21, which announced £100m over the next five years for the Green Jobs Fund to support new and increased opportunities for green job creation across Scotland).

So, there is clear evidence both internationally and at UK level that green skills are regarded as increasingly important, but a lack of clarity over whether all jobs are potentially green, or only sectors related to environmental activity – or even certain jobs within certain sectors – should be included. However, without a clear definition it is impossible to quantify where these new jobs are, what type they are, what pay levels they offer and what skill levels they require, in order to inform the future skills and training plans of education and training institute and businesses themselves.

The Green Jobs in Scotland report, commissioned by the Implementation Steering Group behind Scotland's Climate Emergency Skills Action Plan and supported by the Scottish Government and Skills Development Scotland was published in November 2022. The report argues that, in order to ensure that everyone benefits from the net zero transition, it is crucial to have a clear understanding of what constitutes a green job and to determine the future jobs and skills needs. It goes on to argue that the definition should be inclusive to take account of the impact that the net zero transition will have on a broader range of jobs.

This recently published Green Jobs in Scotland report defined three different categories of green jobs:

1. **New and Emerging**: The impact of green economy activities and technologies creates the need for unique work and worker requirements, which results in the generation of new occupations. These new occupations can be entirely novel or 'born' from an existing occupation. An example is solar system technicians who must

be able not only to install new technology but also to determine how this technology can best be used on a specific site.

2. **Enhanced Skills and Knowledge**: The impact of green economy activities and technologies can result in significant change to the work and worker requirements of existing occupations. This impact may result in an increase in demand for these occupations. The essential purposes of the occupation remain the same but tasks, skills, knowledge and external elements, such as credentials, have been altered. An example is architects, an occupation in which greening has increased knowledge requirements pertaining to energy efficient materials and construction, as well as skills associated with integrating green technology into the aesthetic design of buildings.
3. **Increased Demand**: The impact of green economy activities and technologies can increase employment demand for some existing occupations. However, this impact does not entail significant changes in the work and worker requirements of the occupation. The work context may change but the tasks do not. An example is the increased demand for electrical power line installers and repairers related to energy efficiency and infrastructure upgrades.

The Green Jobs in Scotland research has developed a new green occupational definition, or a 'GreenSoc'. The GreenSoc is based on an adaption of the three types of green occupations, and then applied to Labour Force Survey (LFS) data and data scraped from job vacancy websites. The report includes an analysis of green jobs by industry, occupation and demographics, and in terms of the latter, identifies eastern Scotland and south west Scotland as where demand for new and emerging green jobs is highest.

The report highlights a number of limitations in developing GreenSoc for Scotland which are relevant for the work being carried out in this project. These limitations include a lack of sensitivity in both the Standard Industrial Classification (SIC) and the Standard Occupational Classification (SOC), where the classification at four digital level (which is standard for the SOC; the SIC codes were updated to five digits in 2007 to provide more nuance) is blunt in terms of providing detailed information on the exact tasks, skills and knowledge of any occupation. The problem of being unable to disaggregate larger occupational or sectoral codes is a challenge that is important in this research. The report argues that what is ideally required to better inform and drive awareness and action to support reskilling and upskilling is data disaggregated at the 5-digit or even 6-digit level within the SOC.

The Green Jobs Workforce Academy notes that the Scottish Government has prioritised six sectors in Scotland's journey to net zero (they are important to the economy and to net zero too): construction and the built environment; transport; nature; energy; engineering; and life and chemical sciences. In terms of the nature sector, the 'My World of Work' website notes plans for a five-fold increase in peatland restoration, a doubling of tree planting and more investment in the Woodland Carbon Code. It notes the need for 9,900 new workers in the agriculture, forestry and fishing sectors over the next three years (in contrast to the decline in jobs in agricultural production and the food sector predicted by the Climate Emergency Skills Action Plan 2020-2025, CESAP) and that it is expected by 2031 there will be around 18,200 new job opportunities in: crop and animal production; fishing and aquaculture; agriculture; finance; urban green infrastructure; tourism; forestry, trees and timber; peatland restoration; sustainable tourism; green finance; urban greenscaping; and integrated land management.

The research team identified a number of other reports exploring 'green jobs'. For example, the Greening the Giants Report produced by Onward in 2021 notes that there are 12 sectors where it will be challenging to decarbonise, including agriculture. It notes that this sector is geographically concentrated which will result in spatially uneven consequences (see also WWF's 2022 Land of Plenty report and the Carbon Brief 2022 report), though there is no detailed discussion of future jobs/skills requirements (see also the NFU's [2019] report on Achieving Net Zero). The Onward Report recommends implementing a gradually rising regulatory baseline for soil and animal husbandry within the Environmental Land Management (ELM) scheme, and including agriculture in the emissions trading system and introducing innovation grants for vertical farming and cultured meat projects. The Economy 2030 report from the Resolution Foundation with the Centre for Economic Performance at LSE focuses on the theme of 'green vs brown jobs' and the regional differences in terms of the geographical distribution of each, but there is little discussion of the land-based sector specifically.

A report to the European Commission by Bowen and Hanke in 2019 estimated green jobs by industry and found that some low emitting industries (such as real estate activities) had a greater proportion of people in potentially green jobs than some high emitting industries (such as agriculture, forestry and fishing). The report argues that the journey to net zero may involve pervasive changes to the composition of jobs, much of which will be achieved by labour market turnover, where employees switch the industry in which they work.

17 Appendix 7: Information on the rural labour market

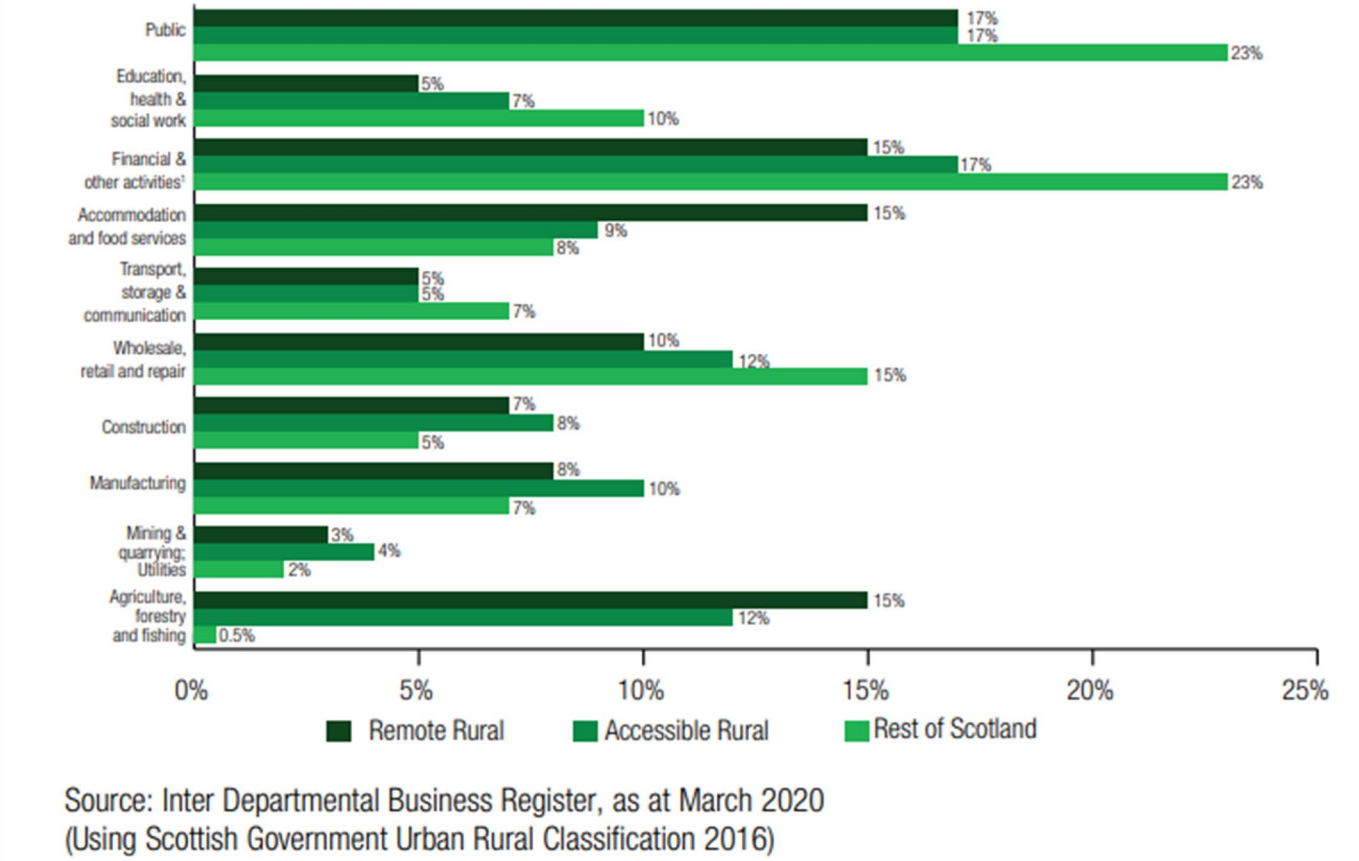
17.1.1.1 Table A4: Occupational breakdown of the labour market by the Scottish Government's Urban Rural Classification (2016)

	Remote Rural	Accessible Rural	Rest of Scotland
Higher managerial and professional occupations	12%	19%	16%
Lower managerial and professional occupations	25%	26%	29%
Intermediate occupations	10%	12%	14%
Small employers and own account workers	19%	13%	8%
Lower supervisory and technical occupations	10%	8%	9%
Semi- routine occupations	15%	12%	14%
Routine occupations	10%	10%	11%
Total	100%	100%	100%

Table A4 (Table 27 reproduced from Rural Scotland Key Facts 2021) shows the breakdown of the labour market in rural areas by SOC. This shows that across Scotland, the highest proportion of workers is in the lower managerial and professional occupations classification (with the rural proportions lower than in the rest of Scotland, though still accounting for one in four workers). While remote rural areas have a lower proportion of people in the higher managerial and professional occupations classification (12%), the proportion of workers in this category is highest in accessible rural areas (the data tables that accompany this report can be found online here).

Figure A1 below shows the sectoral breakdown of employment in rural Scotland. This is also taken from Rural Scotland Key Facts 2021 (Figure 12 in Rural Scotland Key Facts 2021). This shows that the agriculture, forestry and fishing sector accounted for 15% of employment in remote rural Scotland in 2020, compared to 12% in accessible rural Scotland (and only 0.5% in the rest of Scotland). This sector accounts for the highest proportion of private sector employment in remote rural areas; only the public sector accounts for a higher proportion (17% in both accessible and remote rural Scotland).

17.1.1.2 Figure A1: Employment by industry sectors and the public sector (2020)



Source: Inter Departmental Business Register, as at March 2020
(Using Scottish Government Urban Rural Classification 2016)

It is also worth providing some detail here on the Skills Action Plan for Rural Scotland 2019-21 which contains further discussion on some of the challenges of rural labour markets. The Plan notes the need to understand various key features of rural areas which underpin any action, including:

- where they are,
- their diversity,
- the diversification of the rural economy away from the primary sector in recent years,
- the need for a robust evidence base,
- the need to understand how rural-specific and national policies and practices play out in rural locations, and
- the need to understand how jobs and skills interventions play out in relation to wider economic and social issues as mentioned above, including the availability of affordable housing, transport infrastructure, etc.

The Plan sets out the relatively complex policy context for skills and jobs interventions, which includes Skills Investment Plans for specific areas (including the Highlands and Islands and the South of Scotland, for example) and sectors (including several of relevance to rural Scotland such as food and drink, tourism, aquaculture and the timber and forest industries), plus City Region and Growth Deals such as the Borderlands, sector strategies (including for agriculture, tourism and food and drink) and organisational strategies, including for HIE and SOSE.

The Plan identifies some of the particular challenges of delivering training and skills provision in rural areas where learners and employers are dispersed, demographic ageing is occurring at a faster rate than is the case in the rest of Scotland and employment rates are generally high, with lots of people working part-time, from home and often in multiple jobs, but with low productivity levels. It notes that over the period 2018-28, total requirement (the number of people required to fill employment demand, including expansion and replacement demand) in Scotland's rural areas is forecast as 256,000 jobs, accounting for almost one quarter of the total requirement for Scotland. 90% of this will be in Mainly Rural areas. In terms of sector, total requirement will be greatest within:

- wholesale & retail (51,800 jobs),
- agriculture, forestry and fishing (33,500 jobs – which represents 76% of the total requirement for the sector across Scotland) and
- administrative and support services (32,500 jobs).

In relation to the land-based sector specifically, the Plan notes the long-standing issue of the under-representation of women and their contributions in this sector with many roles un- or under-paid, and the need to address this in future to bring about positive recruitment change.

A key point is the higher tendencies for employers to report hard-to-fill vacancies in rural areas, and that rurality tends to exacerbate skills shortages, due to wider challenges around talent, attraction and retention, connectivity and training, and education provision[31]. Technical skills shortages were often reported, including in forestry and engineering, where there are national shortages, and in a range of core business skills, including management and leadership, mentoring and customer services.

The Plan outlines five priorities for future action, including:

1. achieving a better understanding of the sills that employers need and aligning provision to support this
2. providing individuals with accessible education and skills provision
3. developing the current rural workforce through upskilling and reskilling
4. building a secure pipeline for the future, and
5. taking a strategic coordinated approach to tackling skills in rural areas.

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[31] It is likely that word of mouth is important in terms of recruitment into many jobs in rural areas, including in the land-based sector. As such, employers may be more likely to mention job opportunities informally (e.g. at marts or at social events) or on social media and so they may not appear in official job vacancy statistics. There is also a bigger risk for small employers if they take on a new, unknown member of staff. It is also worth noting that it can be difficult for those individuals who find themselves outside these local networks for whatever reason (e.g. because they are new to the local area) to find work (for more information on informal networks in the rural labour market, see this paper published in 2003: Unemployment duration and employability in remote rural labour markets - ScienceDirect.

18 Appendix 8: Background information on the agricultural sector

The most recent statistics on the agricultural sector are reported in the main body of this report and this Appendix provides some additional background information about the sector.

Some 80% of Scotland's land mass is under agricultural production, with 85% of Scotland's land being designated as Less Favoured Area (LFA), meaning that there are challenges for agricultural production relating to soils, climate, topography, etc..

It is worth noting that, like businesses operating in many other sectors, agriculture, forestry and fishing sector businesses are experiencing significant challenges currently relating to the cost of living (or cost of doing business) crisis, including increased costs for fuel, fertiliser and food. More positively, businesses in general across the sector are adopting new technology and innovation, which is resulting in a demand for higher skills, including digital.

The UKCES (2016) report noted some of the wider drivers of change in the agricultural sector, including productivity improvement (including through investment in technologies) which will lead to decreased future labour demand and rising cost pressures – which have been exacerbated recently – which will encourage long-term efficiency savings and likely further reduce labour demand. Changes in consumption patterns were noted as an important driver of changing demand for agricultural outputs, including a shift towards substituting domestic and indeed 'local' products for imported foods, and a growing trend for eating out (though this may have been impacted longer-term by the Covid-19 pandemic). Overall however it was projected that the UK would remain a net importer of food and beverages. On balance therefore, modest growth in agricultural and fishery activity was expected to increase demand for domestically-produced foods and drinks, stimulating activity in agriculture and fishing industries.

Although now over a decade old, Lantra's 2012 report is still relevant, noting the high levels of self-employment in agriculture, forestry and fishing (around 50% of the workforce in 2012), and the importance of seasonal working and unpaid family members (3% of the workforce, higher than the national average of 0.3%). The Lantra report also confirmed the dominance of male employees who significantly outnumber female employees (though it is worth noting that many females engaged in this sector may not be formally recognised as employees). It also confirmed that the workforce is ageing with a dominance of individuals from the white ethnic group (99%), a prevalence of skilled trades, elementary and managerial occupations, and a dominance of full-time workers (80%), with 19% part-time across the sector.

In terms of skill levels, the Lantra report noted that those working in the sector are on average highly skilled but poorly qualified and more likely to have no formal qualifications when compared to the rest of the economy. Around 53% of employers in this sector provided some form of on/off job training in 2011, compared to 59% across the rest of the economy but the sector is the third lowest in terms of employers providing training. This can be explained by a range of factors including high capital intensity, simple product market strategy, high levels of risk and uncertainty, high levels of variability of income, lack of regulated entry into jobs, high travel costs due to remoteness and lack of ICT infrastructure.

The Lantra (2012) report made a series of recommendations regarding priority areas for action relating to upskilling and entry, progression and sector careers, some of which were defined as 'crucial' and some as 'other high priority'. The areas defined as 'crucial' included:

- a need to 'professionalise' the sector (including to change perceptions and make it more attractive and to increase the number of people working in it with formal qualifications)
- improved succession planning
- environmental management
- risk management
- scientific knowledge and technology transfer, and
- ICT to aid technological change.

It is interesting to see environmental management included in the crucial areas for upskilling more than a decade ago. Other areas included in the 'other high priority list' also showed recognition of the changing role of farmers encompassing activities beyond food production, including woodland management, practical conservation, marketing and market analysis, negotiation and influencing and public engagement in agriculture, forestry and fishing. The report concludes that the future workforce in agriculture, forestry and fishing would need to ensure a balance between high level technical and high level business management skills; this is particularly interesting when it is noted that agriculture is usually perceived as a low tech sector. It is not, however, clear is the extent to which these recommendations have been implemented as data is not available to evaluate the changing skills levels amongst the agricultural workforce. This is partly due to a lack of empirical data collected on this, but also due to the challenges mentioned previously, for example, the difficulty of collecting information from the many small businesses and self-employed contractors who operate across the sector.

Skills Development Scotland's Sectoral Skills Assessments (SSA) provide detailed skills-related information for sectors across the economy. They are part of a wider suite of labour market information published by SDS. The most recent SSA for agriculture, forestry and fishing was published in November 2022. The SSA includes forecast data produced by Oxford Economics, about which SDS notes the following caveats:

- forecasted data are based on what we know now and include past and present trends projected into the future.
- the more disaggregated forecasts become, the less reliable they are likely to be.
- their value is in identifying likely direction of travel rather than predicting exact figures.

Information from the most recent SSA is included in the main body of this report.

SDS's Climate Emergency Skills Action Plan 2020-25 discusses the opportunities and skills implications of the climate emergency, including in relation to agriculture where emissions need to be reduced (agriculture and related land use in Scotland are the second largest source of net emissions after transport, although forestry makes a net contribution to reducing carbon emissions – the Climate Change Plan sets out a target of 24% emissions reduction from agriculture from 2020-2032), more peatland restored (250,000 ha of degraded peatland restored by 2030), trees planted (an increase in annual woodland creation to 18,000 ha a year by 2024) and biodiversity enhanced. In contrast to the SDS and

Oxford Economics forecasts (and likely mainly due to the use of different definitions), the projection in the CESAP is for a decline in employment in the sector in future (by 5%, 4,600 jobs by 2029) but rising levels of productivity of 17% over the same period.

The CESAP notes a set of skills implications of these changes, including:

- structural change and managing change to low carbon and regenerative farming will require management and technical competencies. Farmers and agricultural managers need the skills to undertake or commission the technical tasks required to reduce emissions.
- precision agriculture will increase the demand for digital skills
- upskilling and reskilling the workforce is critical
- raising awareness of GHG emissions and skills required for their reduction is vitally important to ensure a sector-wide contribution to the net zero target. Such a 'culture change' in Scottish agriculture will form part of a 'transformation pathway' through which the sector can support the transition to net zero, as outlined by the independent inquiry on farming and climate change in Scotland.

Finally it is worth noting, as this is important later on for the scenario analysis, that the Scottish (and UK) Government has been criticised (see for example, the 2021 report on Towards Net Zero in UK agriculture, commissioned by HSBC, and WWF's 2022 Land of Plenty report) for not doing enough in terms of a detailed future strategy for decarbonisation and net zero for agriculture, and indeed for wider land use activities, and for not having specific targets and associated investment plans for cutting emissions, the amount of land in low carbon/regenerative farming, etc. This lack of specific targets means that detailed and accurate forecasting work to identify likely future jobs and associated skills needs is challenging.

Box A2 provides some information, taken from the November 2022 SDS SSA, about recent developments across the sector to tackle skills issues.

Box A2: Examples of current skills provision for agriculture (taken from SDS SSA for Agriculture, Forestry and Fishing)

A range of organisations working in the agriculture sector are focused on improving skills and training across the sector. For example, the Skills for Farming Group is developing and delivering a range of interventions that are focused on supporting the skills needs of the industry and better articulating pathways into the sector. One project has focused on developing a Net Zero Toolkit to support the farming community towards net zero, signposting to areas of support and showcasing best practice. The Land-based Pre-Apprenticeship programme continues to build on its success by creating work placement opportunities for young people and the ambition to progress to Modern Apprenticeships. The Agriculture and Horticulture Development Board (AHDB) also has an Agriculture and Horticulture Skills Leadership Group.

SRUC is working closely with providers and staff to identify new opportunities for regional skills provision (e.g. in horticulture and net zero) across the land-based sector. It is bringing together its provision into a 'Skills Academy for the Rural and Natural Economy' which brings together all short course and CPD provision. It is also focusing on encouraging students to develop their entrepreneurial thinking and knowledge through its Enterprise Academy.

18.1.1 Additional Data Sources

- In terms of numbers of businesses, again drawing on data in Rural Scotland Key Facts 2021, 35% of SMEs in remote rural Scotland operated in the agriculture, forestry and fishing sector and 26% in accessible rural areas (2% in the rest of Scotland).
- 56% of the agricultural workforce are farm occupiers who own or rent their farm and work on it; 40% of farm occupiers are female (2021 Agricultural Census). Ownership status (with over half of the current workforce strongly linked to ownership or rental of their land), and the opportunities for new people to take on the ownership or lease of farms, impacts on the ability of individuals to move in and out of the sector. Equally, the movement of people out of (and indeed into) the sector therefore has implications for land sales and ownership in rural Scotland.
- According to the 2021 Agricultural Census, the average age of farm occupiers and the agricultural workforce is high, with 40% of male occupiers aged 64 or older (32% of females) and only 10% of working occupiers aged 41 or under. This demographic profile is important to understand when considering sector-specific interventions to address succession planning, upskilling initiatives, etc. Regular staff make up 31% of the total agricultural workforce, with the majority of these people working full-time.
- By way of comparison, the Scottish Government's 2020/21 report on Scotland's Labour Market notes that 50% of the workforce in the agriculture, forestry and fishing sector is within the 50 and over cohort.
- Work by SRUC in 2018 (conservatively) estimated that there were 9,255 seasonal migrant workers in Scottish agriculture in 2017; this number has reduced in recent years due to Brexit and other factors (which has likely had a knock on impact on production, in the fruit and vegetable sector, for example). Skills Development

Scotland's most recent Sector Skills Assessment for agriculture, forestry and fishing (published in November 2022) reported that, in 2021/22, the number of EU migrants working in the sector declined by 37.8 per cent compared to the previous year*

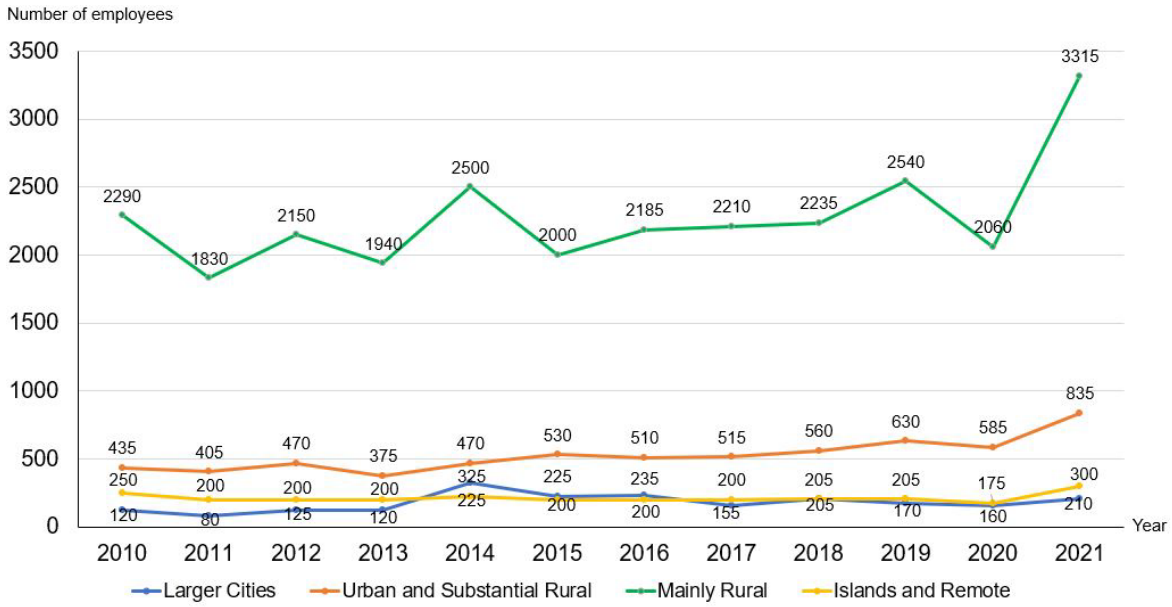
- Data from the ONS for the whole of the UK reports that the agriculture sector had 129,000 self-employed people in 2022, accounting for approximately 3% of the total number of those in self-employment in the UK.
- Data from the Scottish Government's Agriculture Facts and Figures publication in 2019 shows that average weekly earnings in agriculture in 2018 were £460.98 (for regular full-time workers) with an average working week of 44.5 hours.
- Despite the disparities in these data sources, data from the Agricultural Census suggests that the size of the agricultural workforce has been relatively steady over the past ten years (Figure 1).

- The GVA from agriculture in 2020 was estimated to be c£1.4 billion (before support payments, and costs such as labour, rent, taxes and interest are taken into account), accounting for approximately 1% of Scotland's total GVA. This is slightly higher than the equivalent figures for 2018 which estimated total income from farming in Scotland was £672million and the sector accounted for 0.8% of GVA in Scotland.
- The sector had a forecasted GVA of £2,592 million in 2022, 1.7% of Scotland's total economic output.

19 Appendix 9: Background information on the Forestry sector

As is the case with agriculture, the forestry sector is also reasonably well served in terms of sector bodies of different kinds, though perhaps not to the same extent as agriculture[32]. To reiterate, forestry is often grouped with agriculture (and fishing) for data purposes. Separating out these sectors in future would be useful in order to ensure we have a detailed understanding of them individually and together to inform future labour market needs.

19.1.1.1 Figure A2: The number of employees (total) in the forestry (and logging) sector by the RESAS local authority-level Rural-Urban classification between 2010 and 2021



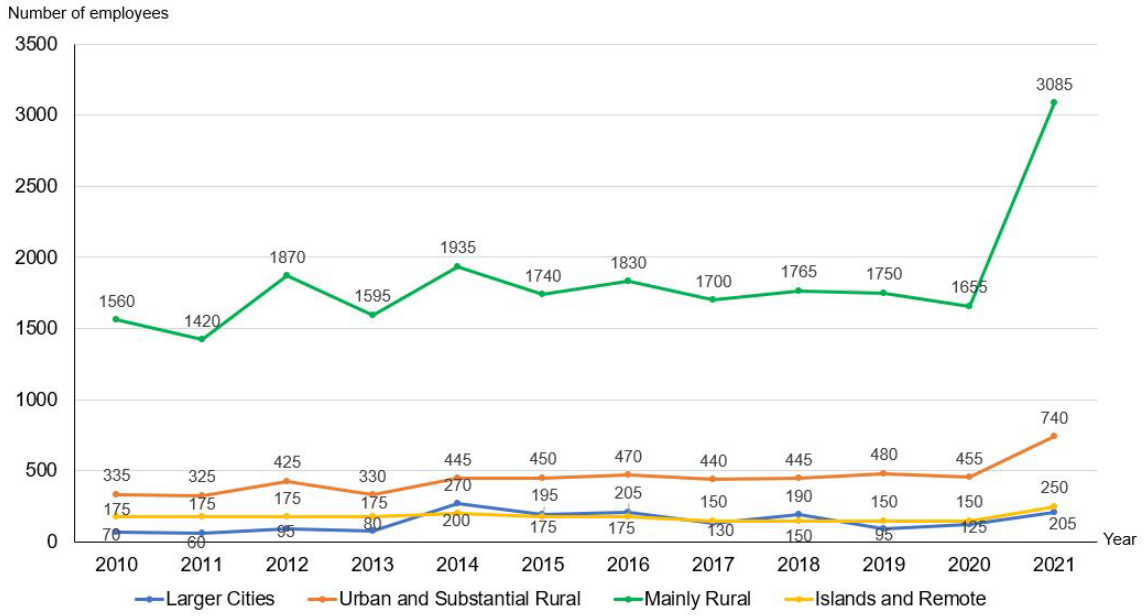
Source: Nomis (2023). Note: The information between 2010 and 2014 excludes units registered for PAYE.

As with agriculture, the research team undertook some additional analysis using publicly available data from the BRES to consider employment change in the forestry sector over the last 10 years. Figure A2 and A3 report the number of employees (total and full-time only) in the forestry sector by the RESAS Rural Urban Local Authority Classification between 2010 and 2021, respectively. Mainly rural local authority areas have the highest number of all employees and full-time employees in the forestry sector, and are responsible for most of the significant increase from 2020-21, followed by Urban with substantial rural areas. The

[32] These include Forest and Land Scotland and Forest Research (who produce Forest Statistics), the Confederation of Forest Industries (CONFOR), the Forest and Timber Technologies Industry Leadership Group, or private forestry companies and land agents that collect data on the price of timber, etc.

number of all employees in Mainly rural areas increased by 44.75% between 2010 and 2021 (Figure A2) and the number of full-time employees also increased by 97.75% during the same period (Figure A3). In particular, the number of full-time employees in the forestry sector has significantly increased from 1,655 to 3,085 people between 2020 and 2021 in Mainly rural local authority areas. More work is needed to check whether or not this is a data anomaly or due to a specific and significant change in circumstance in the sector.

19.1.1.2 Figure A3: The number of full-time employees in the forestry (and logging) sector by the RESAS local authority-level Rural-Urban classification between 2010 and 2021



Source: Nomis (2023)

Note: The information between 2010 and 2014 excludes units registered for PAYE.

Approximately 18.5% of Scotland is currently under woodland and forest cover (1.4 million ha), an increase from around 5% 100 years ago (the EU average is 43%). Forestry values have been rising since 2000 (see for example, Forest Research 2022; Clegg and Tilhill 2021; Savills 2019), with Savills (2019) reporting that forestry investments have significantly outperformed other asset classes over the last decade achieving an average return of 15.8% compared to 5.6% for equities. McMorran et al. (2022) noted the sharp rise in land values which has resulted from the increase in forestry investment recently. This has resulted from a number of factors, including institutional investors and financial institutions entering the market looking for new environmental investments (including amenity, recreational and rewilding projects), global timber shortages (but the ongoing need for timber to meet house-building targets), and global policy drivers to reduce reliance on fossil fuels and achieve net zero, including through tree planting and woodland creation (see also McMorran et al. 2022). McMorran et al. (2022) noted that 2021 saw the largest ever annual investment in commercial forestry land with total investment in commercial forestry land in both 2020 and 2021 reaching just over £200 million, around double the levels seen in

preceding years. Similar work by Knight Frank shows UK farmland values peaking in the mid-2010s and plateauing since (Knight Frank 2021).

The forestry sector is also characterised by a high proportion of workers with no formal qualifications and there is a prevalence of lower level qualifications (though skills are not always related to formal qualifications). The Forestry Skills Action Plan also notes confusion regarding industry standards for training as licenses can be obtained from different providers. The sector is somewhat fragmented with:

- many diverse microbusinesses operating.
- the high proportion of self-employed workers (which are not always measurable in key indicators).
- the predominance of males over the age of 45 in the workforce.
- the increasing use of tech.
- increasing productivity.
- lack of promotion of a wide range of careers and development opportunities in the sector.

More positively, the sector is becoming recognised as one which can provide a range of 'green jobs' within an expanding green economy, and the Action Plan assesses future skill needs within the industry, highlighting the need for technical, operational and strategic leadership skills, more support for new entrants to ensure a more diverse workforce, improving perceptions of the industry among young people, and ensuring succession planning and upskilling. What is not clear from the analysis undertaken here, however, is the levels of skills and qualifications amongst the (large number of) people joining the sector recently as reported earlier, nor where those people are coming from i.e. are they newly qualified young people for example, and/or are they older people/more experienced workers who moving into the sector from other sectors (either land-based sectors or other activities) who can draw on existing skills and/or need training in new skills.

Looking to the future, the Scottish Forest and Timber Technologies Group report from 2019 (Roots for Further Growth) sets out the scale of the future growth in the forestry sector, in particular relating to net zero and carbon sequestration and storage targets, the emergence of new products, including in textiles and biotech, and enhanced digitalisation and mechanisation.

Further considering future workforce requirements, Glaister (2019) was commissioned by Lantra and the Scottish Forest and Timber Technologies Skills Group to review the potential gap between the current trees and timber sector workforce and the capacity required to deliver its key target for woodland creation and forecasted increases in production and associated restocking. The report forecast growth across the sector to 2027 in order to undertake planned/forecast harvesting, restocking and new woodland creation programmes, and estimated an overall increase in employment required from 2017 to 2027 of 32% (or a total recruitment need of 72% if retirement and other factors are considered).

Glaister (2019) estimated the number of workers required to fulfil key roles in forestry, necessary to meet the target of 15,000ha woodland creation per annum in 2027 (the target has since been raised to 18,000ha). Firstly, industry work programmes for harvesting, restocking; new woodland creation; and primary processing were defined. Secondly, the level of resourcing that would be required to fulfil those work programmes (assessed as

worker year equivalents) were estimated. Lastly those estimates were mapped to six forestry sub-sectors. Estimated employment requirements per sub-sector are given in table A5 below. Applying Glaister's (2019) methodology, work by RDI Associates et al. (2021) on behalf of the Forestry Skills Forum for England and Wales, estimated a 51% increase in employment across all roles in the forestry workforce to 2025 and an 86% increase to 2030 on 2019 employment levels for England, and equivalent 72% and 63% increases for Wales respectively. Comparing the number of positions advertised annually on the ICF vacancy service they note a 441% increase from 2016 to 2021.

We further note a prior study by CJC Consulting (2015) which sought to quantify the economic contribution of the forestry sector in Scotland. Taking a relatively wide perspective[33] CJC Consulting (2015) estimate GVA and employment for three broad categories of forest industries; forestry and timber processing; forestry related recreation and tourism; and forestry related deer and game. They further estimate total employment arising from forestry related recreation and tourism as 6,312 FTE and GVA from this sub sector as £182.8 million. They note however that such figures may not be fully representative of the net contribution of the sector, as forestry related recreation may be expected to displace some proportion of other recreation possibilities. Adjusting for displacement they suggest a range of 4, 270 to 5, 840 FTE jobs created by forestry recreation and £120 to 164m GVA. These authors further estimate total employment arising from forestry related deer and game, with their definition including deer management for forestry, as well as sport shooting within a woodland habitat. Values for both are drawn from PACEC's (2014) The Value of Shooting report. They assume that 25% of the total activity defined in the PACEC study can be attributed to forestry related deer and game. Applying this multiplier to the PACEC values they estimate total employment to be 2,260 and GVA from this sub-sector to be £68 million.

[33] They define the forestry and timber processing sector as "activity related to forestry, trees, woodland and primary timber processing (pulp mills, production of sawn wood, wood panels, fencing posts and woodfuel, including chips, briquettes, pellets, firewood and other woodfuel) in Scotland' and note that this includes "forest management and primary timber processing, forestry civil engineering, haulage, agents, community groups with interests in woodland, NGOs, local authorities with woodland activity, research and education, and those activities of the Forestry Commission (FC) and Forestry Commission Scotland (FCS) which are located in Scotland." Notably this excludes secondary processing.

Table A5. Forecast Employment in Forestry By Sub Sector (reproduced from Glaister, 2019)

Activity sub- sectors	2017 (derived)	2022 (forecast)	2027 (forecast)	Increase of WYE* to 2027	Percentage increase of WYE* to 2027
Harvesting	488	582	628	140	29%
Establishment & maintenance	514	680	775	261	51%
Ground preparation	120	150	166	46	38%
Haulage	339	404	436	97	29%
Management & supervision	142	168	182	40	28%
Primary processing	2032	2426	2619	587	29%
Combined activity for all sub sectors	3,635	4,410	4,806	1,171	32%

*worker year equivalent

Westbrook and Ralph (forthcoming) develop a series of ten case studies in order to assess employment impacts from marginal investments in forestry (results summarised in table A6 below).

Discussing the nature of future job creation, they highlight that targets to increase forest cover "will potentially create substantial additional employment through [various forestry sub-sectors] planting, maintenance, felling, primary and secondary processing, and leisure and recreation forest usage."

Following from their analysis they suggest that employment impacts will depend on:

- Site characteristics; size of planted area, terrain, type and density of planting, whether new planting or restocking, whether access is improved, whether public access is encouraged, fencing needs;
- Whether nursery stock is domestic or imported;
- Share of tree cover achieved through rewilding as compared to conventional planting;
- Investment in materials, machinery and equipment – whether this is labour productivity enhancing and whether sourced domestically;
- Potential trade off with agricultural production – and scope for transfer of working time from agriculture to forestry

They further suggest that supply of workers wishing to enter the industry will be a constraint. To surmount this they suggest (i) increasing rates of pay, potentially through skill development and (ii) providing more multi- occupational opportunities, including farm diversification and encouraging community based forest ownership.

They highlight that median pay for forestry workers (£20,590) is substantially less than the UK national average (£29,577) and less than in other skilled roles involving machinery operation, including agricultural machinery drivers (£28,062), road construction operatives (£28,460) and mechanical engineers (£37,050).

Table (A6) Marginal Employment Impacts from Forestry Investment (Reproduced from Westbrook and Ralph, forthcoming)

Case Study 1 Planting Mainly Conifers with Periodic Thinning (50ha)	Total Cost	FTEs (Scotland)
Initial Costs	£191,500	5.09
Costs Prior to felling (Total of first 5 years)	£101,938	3.22
Main felling Costs	£125,300	2.87
Case Study 2 Planting Predominantly Conifers without Thinning (50ha)	Total Cost	FTEs (Scotland)
Initial Costs	£191,500	5.09
Costs Prior to felling (Total of first 5 years)	£83,050	2.69
Main felling Costs	£125,300	2.87
Case Study 3 Agroforestry Planting (10ha)	Total Cost	FTEs (Scotland)
Initial Costs	£37,900	1.07
Total Costs over first 10 years	£78,500	2.59
Case Study 4 Extensive Broadleaf Planting (20ha)	Total Cost	FTEs (Scotland)
Initial Costs	£148,060	2.9
Costs over first 5 years	£29,300	1.1
Case Study 5 Bioenergy Crop Planting (10ha)	Total Cost	FTEs (Scotland)
Initial Costs	£65,100	1.93
Costs Prior to felling (Total of first 5 years)	£36,600	1.03
Main felling Costs	£106,075	2.66
Case Study 6 Felling of a Conifer Stand (100m3)	Total Cost	FTEs (Scotland)
Case Study 6a: Regular Conifer Stand	£6,384	0.13
Irregular/CCF/Extensive Conifer Stand	£9,504	0.21
Case Study 7 Large Scale Nursery Production (Government-funded nursery sited in Scotland. Flat terrain, producing conifer species 7 million trees produced per annum.)	Total Cost	FTEs (Scotland)
Nursery Employees	£900,556	26
Supplies and Services	£567,000	8.37
Total	£1,467,556	34.37
Case Study 8 Visitor Facilities within and/ or adjacent to a forest (30ha)	Total Cost	FTEs (Scotland)
Initial Costs	£232,400	5.5
Average annual costs	£16,500	0.36
Case Study 9 Forest Lodges (70 cabins in Delamere Cheshire with bar, restaurant, café and shop)	Total Cost	FTEs (Scotland)
Construction	£12,000,000	22.5
Annual Costs	£250,800	33.73

Case Study 10 Large Scale Log Line	Total Cost	FTEs (Scotland)
Development phase impacts in Scotland*	£413,000	5
Development phase impacts in GB*	£1,240,000	
Annual Costs	£3,240,000	64.9

20 Appendix 10: Background information on the game and wildlife management sector

This Appendix provides some background information on the game and wildlife management sector which is an important land use and employment sector in rural Scotland.

According to Lantra (2018), the game and wildlife management sector has two main purposes: protecting habitats and promoting biodiversity, as well as supporting tourism and recreation. Employees can work with a range of species; however, in Scotland they mainly focus on deer, rabbits and hares, and birds such as grouse, pheasant and partridge. There are three main types of gamekeeper: lowland, upland and highland, and although some principles of their work are the same they work in different ways and with different species. Gamekeepers could also be involved in deer and game rearing (with approximately 40 million game birds released each year in the UK). These two areas of work involve similar basic knowledge but have specific specialities.

A variety of organisations have undertaken work on the sector to explore its value in terms of contribution to the economy, and the number of employees and businesses in the sector, though as is the case with many of the other land-based sectors, the figures provided are different as a result of different approaches to data collection and to defining the sector.

Research carried out by Lantra in 2010 (reported in Lantra 2018) shows that the game and wildlife management industry played an important role in the environmental and land-based sector at this time, representing 9% (2,300) of businesses and 4% (5,300) of employees.

The industry employment base is mainly made up of seasonal or part-time jobs, meaning that it is very difficult to provide clear statistics on business size. It is known, however, that generally businesses are small across the sector. Work by SDS found that microbusinesses dominated the sector in Scotland, with 83% of the sector employing 0-4 people.

As the majority of businesses and employees are in remote locations, there is a reliance on staff being qualified with up-to-date technologies and practices.

A report by Lantra in 2011 on behalf of Scottish Natural Heritage (SNH) explored skills requirements in the game and wildlife management sector in Scotland. The sector was defined as involving the management of upland, lowland, woodland and wetland game and wildlife species, including partridge, grouse, pheasant and deer. Workers in the sector are focused on protecting habitats, promoting biodiversity, supporting tourism and recreation and providing a source of high quality meat. Game and wildlife makes a significant contribution to the Scottish economy, as well as contributing to the maintenance of Scottish moorland, which is a huge tourist attraction. SNH estimates that wildlife tourism has a value

of £67 million to the Scottish economy. The British Association for Shooting Conservation (BASC) Scotland estimate shooting, stalking and angling to have a value of £136 million.

The Lantra report provides a range of information about the sector's labour market in 2012 (more than ten years ago):

- The game and wildlife sector workforce was male dominated (97.6%), with three quarters (75.8%) aged 45 or over.
- The self-employed (39.4%) were slightly more prevalent than fulltime employees (31.4%) and part-time employees (29.2%).
- Almost a third (29.2%) of survey respondents involved in the game and wildlife sector were found to be self-employed. Just over a third (31.4%) had a full-time involvement in the sector, and the majority (39.4%) stated that they worked part-time within the sector, mainly in a voluntary capacity.
- Some 6.9% of respondents defined their involvement as 'other' which, when explored further, meant that these people had a small involvement in the game and wildlife area.
- A substantial volunteer workforce (20%) supplemented the paid workforce within the game and wildlife sector.
- Another 60% was made up of involvement in game and wildlife estates (24.9%), tenant farmers (12.7%), commercial forestry (11.8%), and private woodlands (10.6%).
- Whilst there were 164 job titles listed by respondents, the sector was dominated by four key roles; those job titles with the word 'keeper/deer manager/stalker' made up nearly half of the respondents (48.3%).
- Survey respondents were highly qualified, with 95.5% stating that they possessed a relevant qualification citing both accredited and non-accredited courses. Exploring this further found that almost 70% of respondents cited non-accredited but industry-recognised practical certificates of knowledge and competence. From this, it can be concluded that the sector's workforce is highly skilled, but this is often developed through non-accredited training methods and knowledge transfer activities than full-accredited qualifications.
- The majority of respondents (86.1%) recognised the importance of qualifications, and this was more prominent amongst the workforce who were full-time and in more senior roles.
- Skills gaps were identified in the areas of IT, raising public awareness of the game and wildlife sector, and the higher-level skills related to conservation and ecological issues, such as habitat management.

The report put forward a series of recommendations related to the future workforce in this sector in Scotland (remembering that this work was undertaken in 2011-2012), including improving signposting and access to information on opportunities for training and CPD for those working in the sector, work to determine future skills priorities and where there are gaps, improved communication between those operating in the sector, more transparency about training on offer and accreditations, more courses that include the areas of conservation and technological change, support for the voluntary sector to keep up with the demands for greater professionalism, and greater promotion of the sector to young entrants, career changers and women.

A survey carried out by Public and Corporate Economic Consultants in 2014 on behalf of 17 organisations involved in shooting and conservation revealed that shooters spend an estimated £2.5 billion a year in the UK on goods and services. This produces a direct financial benefit to the UK – defined as gross value added (GVA) – of £2 billion a year. This survey indicated a need to ensure there are trained individuals to support this sector to maintain its influence on the economy.

The report also indicated that there were around 35,000 jobs directly supporting shooting and conservation in the UK. The industry also directly supports around 5,200 full-time jobs in the food and accommodation sector which helps to sustain rural communities in the autumn and winter when conventional income from tourism is likely to be reduced.

Work by Glass et al (2015) explored the socio-economic impacts of grouse shooting in two remote rural areas of Scotland, including the number of jobs (permanent and seasonal) and amount of spend and revenue linked to this activity in the two areas and wider community-level benefits, such as attendance at local schools by children of gamekeepers and their local spending in shops. Although most people answering the project survey in both areas felt positively about the impacts of grouse shooting in their area, the research highlighted that more work was needed to improve estate-community relationships. Some concerns were raised in both areas about the increased number of hilltracks that had been constructed and about illegal raptor persecution.

Thomson et al. (2018) reviewed the socio-economic impacts of driven grouse moors in Scotland and cite a range of estimates for employment linked to grouse moors.

They highlight that direct employment associated with grouse moors includes gamekeepers, shoot managers, other estate staff and seasonal and casual employees, while the industry further creates indirect employment in both upstream sectors which provide inputs and services, and downstream sectors such as game processing.

The key findings of their report note caveats which must be borne in mind when interpreting these estimates, and which bear repeating in full:

- There is a narrow base of evidence that specifically focuses on the socio-economic impacts of grouse shooting, with some additional evidence relating to the wider game shooting or estate sectors. The dated nature of much of this research means that the social and economic impacts of more recent intensification of driven grouse moor management, on some estates, are missing from the evidence base. Therefore, industry-collated and reported data is often cited in contemporary discourse regarding grouse moor management.
- Much of the commissioned research and industry-collated socio-economic evidence suffers from self-selection and self-reporting bias. The lack of a definitive dataset that includes all estates engaged in grouse moor management means that it is impossible to assess how representative research and industry data is of the whole sector.
- The narrow evidence base and inconsistency in data collection approaches mean that evidence on socio-economic impacts is open to criticism. As most of the research has been commissioned by representatives of the grouse or wider estate sector, the objectives of the research have been criticised, by some, as only focusing on demonstrating the positive aspects of grouse moor management. However,

despite the limitations, the existing evidence base does provide some context relating to the social and economic contributions of grouse moor management (see Table A7 for a summary of the employment impacts predicted by a number of studies of activities linked to grouse shooting and grouse moor management).

20.1.1.1

Scale and Focus	Source	Direct Employment	Indirect Employment
All sporting shooting	McGilvray et al. (1990)	2,171 FTE jobs directly dependent (at least 1,500 keepers/stalkers).	5,041 FTE jobs supported indirectly through supply chain.
	PACEC (2006)	5,300 FTE jobs directly dependent.	5,700 further indirect and induced jobs
	Hindle et al. (2014)	Estimated 733 FTE jobs in sporting land uses (based on a sample of 186 estates)	1,134 FTE jobs supported indirectly by sporting land uses
	PACEC (2014)	8,800 combined direct and indirect FTE jobs and a further 2,000 FTE jobs related to conservation/wildlife management in moorland habitats.	
Scotland - grouse shooting	McGilvray (1995)	Estimated 940 FTE jobs directly linked to industry supporting £14.7m in wage spend.	
	Fraser of Allander Institute (2010)	Estimated 1,072 jobs directly dependent based on a grossed up sample of 93 estates.	Estimated 1,286 jobs supported indirectly through supply chain.
	Scottish Moorland Group Unpublished	Grouse shooting (2011/12) estimated to support 2,640 FTE jobs (direct and indirect) and generated wage spend of £30.1 million.	

Building on work by Thomson et al. (2018) which noted a lack of evidence of the socio-economic impacts of grouse shooting and alternative moorland land uses, McMorran et al. 2020 explored the socio-economic impacts of moorland activities in Scotland using financial data from case studies to generate information on direct and indirect expenditure and employment impacts. The study explored the potential impacts of moorland for grouse shooting being transferred to other uses, including forestry and woodland. The approach taken in this report is useful in informing the modelling work in this study.

21 Appendix 11: Background information on the nature-based activities sector

As noted in the main report, there is no single universally accepted definition of the nature-based sector. A report by Hirst and Lazarus in 2020 for NatureScot includes a defined set of nature-based solutions in a broad definition of nature-based jobs, including peatland restoration, woodland restoration, green finance, coastal ecosystems and sectors highly dependent on natural capital (the full text is provided in the main report).

- Green finance
- Urban green infrastructure, including planning, ecological engineering, active travel networks
- Sectors highly dependent on natural capital (especially tourism and food and drink).

This broad definition is worth bearing in mind in relation to the CLBLR's recent report which recommended consideration of using this 'label' for the land-based sector. The term nature-based sector is therefore a term that encompasses all of the activities we describe in this section of the report.

Despite a thorough search by the research team, NatureScot appears to be the only organisation generating evidence about the contribution of and labour requirements for the nature-based sector as a whole, and there are no representative organisations. The 2020 report for NatureScot by Hirst and Lazarus is the most comprehensive study of the nature-based sector that could be found and again the key points from this report are included in the main text.

Looking ahead to the future, Hirst and Lazarus (2020) argue that significant further growth is anticipated on the back of expansion in activities – including peatland restoration, green infrastructure and green finance, woodland creation, and blue carbon – required to meet our net zero targets by 2030 and 2045. They note that action needs to be taken now to ensure that we thoroughly understand and are aware of the skills and capacity needed for the nature-based sector in future. This is because there is a time lag before increased workforce capacity and upskilling works through the system. They argue that skills needs for this specific sector should be mainstreamed and aligned with skills policy, planning and delivery partners. NatureScot's skills action plan for 2022-23 addresses some of these concerns about the future workforce and skills levels in the sector.

Several opportunities were identified for nature-based skills development by Hirst and Lazarus (2020), including a need to fill operational jobs more effectively, for which recruitment is often local and sometimes through sub-contracting arrangements. It was also noted that many businesses operating in this sector are micro or small with seasonal labour demands where costs and availability of training can be challenging. Workforce-sharing initiatives may be one potential solution to explore, where the costs of training and upskilling are shared amongst employers and jobs are created which are viable, year round jobs, also thereby reducing the potential for loss of employees to other sectors.

The location of many of these jobs in remote rural areas is potentially hugely beneficial for these communities, although many are experiencing shrinkage in their working age population (and have done so for decades), making the attraction of new people all the

more important[34]. Finally, the report suggests that higher education institutes need to be engaged in ensuring that young people entering the sector have an appropriate blend of technical, digital and multi-disciplinary skills, including climate literacy and an understanding of natural capital.

[34] The Rural Visa Pilot Scheme is an interesting development in this regard, to facilitated tailored migration to remote and rural communities.

22 Appendix 12: Seasonality

This section discusses the seasonality of employment in tree planting and peatland restoration. A significant expansion of activity in tree planting, and peatland restoration activity is required in order to meet net zero land use targets. In order for workers to fulfil these roles they must be able to secure sufficient income to cover housing and living costs. Whether this is through taking on a range of roles in the land-based sector, or within the wider economy, it is important to understand the seasonal working patterns as these pose a constraint to taking on further employment

Based on the sources that we have reviewed, we suggest that the main tree planting period in Scotland is October- March, excluding December and January and that the key busy period for peatland restoration is August to March (with interruptions due to winter weather). Due to having similar busy periods it seems unlikely that roles within tree planting and peatland restoration will be fulfilled by the same individuals.

Seasonality is a key aspect of many job roles within the land- based sector. Seasonal patterns in labour demand arise from various factors, including agricultural production cycles (e.g. lambing and fruit picking), seasonal increases in demand (e.g. tourism and hospitality), and seasonal restrictions on activities (for instance due to bird nesting restrictions).

The seasonal and part time nature of activities within the land based sector have been highlighted as a potential constraint to upscaling the labour force to meet net zero land use targets (Hirst and Lazarus, 2020).

While seasonal increases in labour demand can be important to rural economies, seasonality of employment can also create challenges. A reliance on insecure seasonal employment can exacerbate problems surrounding the affordability of rural housing. Responsibilities towards existing seasonal employment may also constrain workers ability to seek other employment, particularly affecting women.[35]

Seasonality of Peatland Restoration

The need to avoid disturbance to ground nesting birds is perhaps the key constraint to work in upland environments. NatureScot have issued the following guidance for managers and contractors working on peatland restoration;

“To reduce the risk of disturbance, it is recommended that, as a default approach, restoration work should be programmed to occur outside the main bird breeding season (April - July). Despite the recommended default approach, a blanket exclusion for restoration work undertaken during the bird breeding season [was not deemed] necessary and there will be circumstances where restoration work should be possible. This should only

[35] e.g. The Women in Farming Report found that “women juggle off- farm work around the needs of the farm” and would take holidays from off- farm work during lambing (Shortall et al., 2017). It also found that responsibility for feeding and housing (seasonal) migrant workers tended to fall upon women.

be done when active consideration of the likely consequences for breeding birds has been undertaken and can be demonstrated that work will avoid affecting sensitive species." (Douse and Artz, 2022)

To this end NatureScot have developed a ten- point checklist. While there is no outright restriction on work during bird breeding season, meeting the conditions of the checklist entails further costs to contractors. It is unclear to what extent contractors are willing to bear these costs, or whether the April – July period is viewed as a de facto restriction.

Winter weather is another factor that will influence the number of days in the year on which restoration can be carried out. The arrival of winter weather, snow, ice and strong winds makes restoration work more challenging, while snow lying on the ground may necessitate site closures causing costly delays to contractors (Novo et al., 2021). [36] Sites at elevation in upland environments are most at risk of closure due to snow.

Peatland restoration must also be accommodated within wider estate management activities such as lambing, muirburn, deer stalking and grouse shooting which further follow seasonal patterns.

22.1.1.1 Table A8 Wider Seasonal Influences on Upland Work

Activity	Open Season	Source
Lambing	The start of lambing varies depending on breed and farm management system. Commonly, mid- March or early April. For early finished lamb production, lambing may commence as early as mid-December.	SAC (2023) The Farm Management Handbook 2023/24
Grouse Shooting	12th August to 10th December	Thomson et al. (2018)
Deer Stalking Male deer Red (female) Sika (female) Fallow (female) Roe (female)	 Year Round* 21st October to 15th February 21st October to 15th February 21st October to 15th February 21st October to 31st March	NatureScot (2023) Deer Management in Scotland FAQs
Muirburn	The standard muirburn season runs from 1st October to 15th April inclusive in Scotland	NatureScot (2023) The Muirburn Code

[36] Recognising that work closures due to snow place additional costs on contractors and that this may adversely affect the perception of industry security, Peatland ACTION have introduced snow day payments to encourage retention of machinery at site where work is disrupted by snow for short periods of time. The policy will pay £300 per machine per day, up to maximum of 10 days and is currently scheduled to remain in place until March 2026.

*as of 31st October, 2023

Seasonality of Tree Planting

Tree planting typically takes place over the winter when trees are dormant and less likely to be damaged. Winter planting when the ground is moist also allows the best chance of establishment before spring, though it is also important to avoid planting when the ground is frozen or too wet (The Tree Council, 2021).

Scottish Forestry (no date) indicate that trees are typically planted between October and March. Morgan (1999) meanwhile indicates that due to ground conditions planting should generally avoid December and January.[37] A range of estimates for the tree planting season are shown in Table 9 below.

The planting season is further constrained by the availability of seedling stock. Bare root stock is only available in the winter when trees are dormant. Container grown trees meanwhile may be planted all year round (The Tree Council, 2021).

22.1.1.2 Table A9 Estimates of the Tree Planting Season

Source	Planting Season
Scottish Forestry (no date)	October to March
Morgan (1999)	Mid- October to Mid- April, avoiding December and January, though extending to Mid- May in Cold Climatic Zone.
Woodland Trust (no date)	November to March
Addland (2021)	October to April
Scottish Agroforesty Forum (no date)	Late Autumn (lowland sites) Early Spring (upland sites)
Glaister (2019)	45% of the year (planting and beating up) 55% of the year (ground preparation)

[37] Morgan (1999) outlines various constraints on planting date including tree species, type of seedstock, climatic zone and soil type, then goes on to suggest indicative planting dates by species and climatic zone. Overall, it is recommended that trees are planted into warm soils (>6°C) allowing four weeks of root growth before winter. Due to this planting during December and January is only recommended for a limited range of species in milder, sheltered areas. High elevation sites may be planted from mid- March onwards once soil temperatures have increased.

23 Appendix 13: Summary of existing research work exploring future labour market and skills requirements

In this Appendix we review a number of research projects and programmes that the research team found that are exploring the size and shape of the current and future labour market and the current and future economic contributions of different activities. This review helped to inform the team's thinking about the modelling approach to be used in this work.

23.1 A13.1 The UK Commission for Employment and Skills

The UK Government's Commission for Employment and Skills (UKCES) Working Futures 2021-24 was a publicly funded, industry-led organisation providing leadership on skills and employment issues across the UK until it closed 2017. The UKCES undertook a programme of research including producing and updating robust labour market intelligence, through a number of 'core' products, including the Working Futures Series (see for example Wilson et al. 2020).

The Working Futures series from the UKCES was a quantitative labour market model that provided detailed projections of the size and shape of UK employment by industry, occupation (to SOC 2010 4 digit occupational categories), qualification level, gender and employment status for the UK, its constituent nations and for the English regions in the medium to long-term (up to 2024). The modelling of what the future might be like was based on past trends (see Wilson et al. 2016 for more detail on the technical approach, including the data used from the Labour Force Survey and the Census). One major advantage of the Working Futures forecasts is that they were based on a common and consistent economy wide overview of skill needs (as measured by occupation and formal qualifications), allowing detailed comparisons across sectors. This is based on a transparent, specific set of macroeconomic assumptions and economic relationships, affecting the whole economy and its structure.

The focus of Working Futures was on demand for skills as measured by employment, occupation and qualification, recognising that different jobs require different skillsets. Sectoral change is one of the drivers of changing demand for skills, and the projections are based on the use of a multi-sectoral, regional macroeconomic model, combined with occupational, replacement demand and qualifications modules. However, projections should not just be based on changing levels of employment by occupation which provide only part of the story about how the demand for skills is changing, but also on replacement demands. The latter recognises the significant outflows of those retiring from the labour market, or leaving for other reasons, such as for family formation, mortality, net occupational mobility and net geographical mobility. The model shows that, despite projected declines in employment for many occupations, there will be significant demand for the skills concerned to replace those leaving the current workforce (i.e. total replacement demand outweighs expansion demand).

As with all projections, the Working Futures analysis should be regarded as being indicative of likely trends and orders of magnitude, given a continuation of past patterns of behaviour

and performance, rather than precise predictions of the future. The projections in Working Futures are based on econometric models and judgement, including with reference to a range of exogenous factors, including global economic trends, productivity levels, UK house prices, etc. and the results should be used in conjunction with other sources of intelligence about the labour market. The rationale for predicting future skills requirements is about better matching of labour supply and demand, in order to achieve better labour utilisation and higher labour productivity. The information produced from analysis like this is critical to policy-makers but also to individuals, education and training providers, and employers to inform policy development and strategy around skills, careers and employment.

Wilson et al. 2020's recent work provided a benchmark for debate and thinking about the employment future given a continuation of past patterns of behaviour and performance. The overall outlook for changing employment levels and patterns by sector, occupation, qualification and geographical area show many similarities to those set out in the previous set of Working Futures projections. Thus, despite the uncertainties associated with EU exit many of the underlying trends regarding skills remain unchanged.

Working Futures was based on Cambridge Econometrics (CE)'s multi-sectoral dynamic macroeconomic model (MDM-E3) based on the UK government's official data to provide a comprehensive and detailed picture as well as projections of the UK labour market, focusing on employment prospects for up to 75 industries, 369 occupations, 6 broad qualification levels, gender and employment status as well as economic contribution, including results for the devolved nations and the English regions. This model is normally used to analyse changes in economic structure and assesses energy-environment-economy (E3) issues and other policies. In MDM-E3, the key indicators are modelled separately for each industry sector and (sub)region, yielding results for the UK as a whole. It also disaggregates the UK into twelve regions, including Scotland. Due to the limitations of available data, currently in the MDM-E3 database there are 87 main employing activities distinguished at the UK level (and 46 for the regions), defined using the Standard Industrial Classification 2007 (SIC2007). It can be used for annual comprehensive forecasts to the year 2030 by sector, an in-depth treatment of changes in the input-output structure of the economy, detailed treatment of the interactions between energy generation, environmental emissions and economic development, scenario analysis, to inform the investigation of alternative economic futures and the analysis of policy for the UK as a whole and its regions, and so on (there is more information about MDM-E3 in the Technical report on sources and methods).

23.2 A13.2 SDS and Oxford Economics

While the Working Futures modelling work using Cambridge Econometric's MDM-E3 model provided a common and consistent approach to analyse changes in different sectors, it is worth noting that there are other (similar) models available which will also do this. Skills Development Scotland (SDS) appointed Oxford Economics to provide labour market, sectoral, occupational and skills forecasts for Scotland, both nationally and regionally over the period to 2027. The forecasts provided are produced by Oxford Economics Local Authority District Forecasting Model. Results have been provided for Regional Outcome Agreement areas (ROAs), City Region Deal areas, local authorities as well as Scotland and the UK. The model is based on employment data from the Business Register and Employment Survey and six variables are provided:

- Employment,

- Occupational change,
- Broad industry and sectoral change,
- Total requirement including expansion and replacement demand,
- Employment by gender and status, and
- Demand for qualifications.

Oxford Economics Local Authority District Forecasting Model sits within the Oxford suite of forecasting models. This structure ensures that global and national factors (such as developments in the Eurozone and UK Government fiscal policy) have an appropriate impact on the forecasts at a local authority level. This empirical framework (or set of 'controls') is critical in ensuring that the forecasts are much more than just an extrapolation of historical trends. Rather, the trends in their global, national and sectoral forecasts have an impact on the local area forecasts. In the current economic climate this means most, if not all, local areas will face challenges in the short-term, irrespective of how they have performed over the past 15 years. The Oxford approach depends on three factors: global and national outlooks, historical trends in an area, and fundamental economic relationships which interlink various elements of the outlook. Importantly in the context of this work where the scenarios are guided by the policy targets, Oxford's model provides projections on a 'policy neutral' basis. Unconfirmed, aspirational or policies at planning/development stage are not included. Though forecasts are built primarily around the economic relationships above, the use of local knowledge and published material on local development is required to augment the results of the formal modelling process.

SDS, based on the Oxford Economics model, provides a large quantity of information on future skills requirements by sector and by various geographies in their RSAs and SSAs.

Having reviewed these existing models which have been applied to the labour market in general, the appendix now turns to review employment and labour market work which has been undertaken for specific sectors. This is described in the text in the remainder of Appendix 12, and summarised in Table A6 at the end.

Studies of the current and future contributions of peatland restoration activities

A handful of modelling studies which have sought to provide an indication of employment effects from peatland restoration.

23.2.1.1 Table (A10) Modelled Peatland Restoration Employment Effects

Study	Method	Modelled Result
WSP (2022)	Input Output Analysis	11 direct jobs or 15 (direct plus indirect) jobs, relating to one case study 110 ha restoration project
Rayment (2021)	Results extrapolated from a prior study of EU LIFE and HLF funded habitat restoration projects	One direct FTE job and one further indirect FTE job created for each £70,000 invested.

Study	Method	Modelled Result
Dicks et al. (2020)	Input Output Analysis	3 temporary jobs during restoration and 7 job years during ongoing operation and maintenance, per 100 ha. restored.

Studies of the current and future contributions of the nature-based sectors

The research team identified a number of studies which have sought to determine the contribution of nature-based sectors to the Scottish economy and to quantify nature-based jobs. Each have employed a similar approach, first identifying nature-based sectors within national statistics, then applying a weighting which reflects either the contribution of natural capital to the sector and/ or the proportion of activity which is assessed as sustainable. The studies have adopted varying conceptual definitions of nature-based activity, and varying approaches to weighting. This has resulted in differing sectoral compositions and a range of estimates for nature-based employment, although most are around 160,000 FTE (direct) jobs in nature-based sectors (c6% of Scottish employment), with further estimates of jobs in the wider supply chain (of 240,000 and 290,000).

Hirst and Lazarus (2020) note that jobs in the nature-based sectors are growing much faster than in the rest of the economy – up to five times the rate of all jobs in Scotland – and accounting for one third of total job growth from 2015-2019. Their work also looks at regional differences, noting that in remote and rural areas, the primary sector dominates in terms of nature-based activities, while in urban areas, nature dependent sectors, tourism and food and drink account for the majority of nature-based employment.

A study commissioned by NatureScot (then SNH) by RPA and Cambridge Econometrics employed IO modelling to assess the Economic Impact of Scotland's Natural Environment (EISNE)**.** Their approach started from the 128 level two industrial sectors identified in the Office for National Statistics (ONS) 2003 Standard Industrial Classification system (SIC). Employing various techniques they estimate the contribution of the environment to each sector resulting in a list of 26 sectors judged to have significant links to the environment (where they have assigned a greater than 20% weighting), which together comprise the nature-based sector.

They estimated the sectoral GVA by modelling a hypothetical closure of the nature- based sector. They estimate the direct contribution to intermediate demand as £3.9 billion excluding and £8.6 billion including wages in 2003. Further considering the indirect effect of such a shock through inter-industry purchasing (the Type 1 effect) they estimate the contribution of the sector to be £5.9 billion.

Further considering the induced effect of such a shock through changes to wages and household consumption (the Type 2 effect) they estimate the contribution of the sector to be £17.2 billion. From this latter value they estimate GVA per head at around £3,400 per resident per year. They note that these estimates are somewhat sensitive to their weightings (weightings reflect percentage reliance on the environment), acknowledging this they have sought to apply conservative weightings and as such they believe their estimates may under-estimate the real contribution of the sector. They estimate employment in 2003

as 154,000 jobs directly supported by the natural environment or 242,000 when further considering direct, indirect and induced employment.

Building on the EISNE study, in work commissioned by NatureScot, Hirst and Lazarus (2020) sought to make an assessment of nature-based jobs and skills in Scotland. After first updating to 2007 SICS these authors employed a new conceptual definition of nature-based activities provided by NatureScot, then reviewed and updated the weightings assigned in the EISNE report. Applying this new conceptual definition resulted in a number of sectors being excluded that had appeared in the prior EISNE report; namely, construction, membership organisations, sewerage and refuse disposal, and water supply.

Hirst and Lazarus (2020) obtained sectoral employment data from the Business Register and Employment Survey (BRES) and augmented this to account for 'missing' unregistered zero employee businesses, as the BRES excludes jobs in businesses not registered for VAT or PAYE. From their analysis they estimated that there were 166,721 FTE 'nature based jobs' in Scotland in 2019. They further estimated that jobs within the sector have grown by 12,031 (7.5%) since 2015, five times the rate of increase of all jobs (1.5%) and accounting for one third (31.7%) of all job growth during that period.

In research commissioned by SRUC, Biggar Economics (2020) define and quantify the scale of the natural economy. Conceptually they define the natural economy as those sectors in the economy that:

- Use natural resources,
- Conserve/ preserve natural resources, and
- Rely on natural resources or on the natural environment.

To operationalise their definition, they start from industrial categories at level 2 as defined in the Office for National Statistics (ONS) 2007 SIC. As a first step they identify those sectors that comprise the primary sector:

- agriculture,
- forestry and logging (SIC 02),
- fishing and aquaculture (SIC 03),
- mining of coal and lignite (SIC 05),
- extraction of crude petroleum and natural gas (SIC 06),
- mining of metal ores (SIC 07),
- other mining and quarrying (SIC 08), and
- mining support service activities (SIC 09).

Then with reference to the Scottish Government IO Tables combined use table they identify those sectors which are particularly reliant on inputs from the primary sectors:

- manufacture of food products (SIC 10),
- manufacture of beverages (SIC 11), and
- manufacture of wood and of products of wood and cork except furniture manufacture of articles of straw and plaiting materials (SIC 16).

As a last step they augment their definition to include broader sectors that would not necessarily be captured by a single sector:

- tourism, and
- energy (including renewable).

For purposes of reporting they remap to six sub-sectors:

- tourism,
- food and drink,
- fishing and aquaculture,
- agriculture,
- energy (including renewables), and
- forestry, logging and manufacture of wood.

Having identified relevant sectors they consider whether a weighting should be applied, deciding to apply a 40% weighting to the tourism sector. Their analysis finds that GVA within the sector is dominated by energy. They estimate that in 2018 the Scottish Natural Economy generated £29.1 billion GVA, more than a fifth of total Scottish GVA, while the Scottish Natural Economy *excluding energy* generated £8.3 billion GVA in 2018, around 6% of Scottish GVA.

They further find that the trend in GVA is dominated by changes within the energy sector. Including energy, they find that the natural economy shrunk by 18% between 2008 and 2018, while excluding energy GVA within the sector grew by 25% over the period, with the value of tourism increasing by 60% and agriculture increasing by 39%.

Considering employment, their analysis find that the contribution of the energy sector remains significant, though less stark. They find tourism to be the largest employer, employing 87,200 followed by the energy sector and agricultural sector both tied at 67,000. They estimate total employment in the natural sector as 290,100 in 2018, around 11% of Scottish employment, but with regional variations across the six sectors.

RSPB-commissioned work, undertaken by Dicks et al. (2020) assessed the economic costs and benefits of nature-based solutions to mitigate climate change. The study makes a cost-benefit analysis of nationwide implementation of three forms of nature-based solutions: peatlands, saltmarshes and afforestation. Alongside direct monetary costs and benefits, their analysis estimates changes to jobs and sectoral GVA, and these values are presented as additional indicators alongside the primary indicators of their cost-benefit analysis (net-benefit and benefit cost ratio).

Although the report does not explain how the scenarios were designed, the assessment of them within the analysis reflect the authors' interpretation of the potential scale for nature-based activities across the UK. Changes to jobs and sectoral GVA are estimated by input-output modelling and are described here in the text and in Table A5.

Peatlands

The authors note that peatland restoration projects may be expected to have a positive effect on employment, through the creation of additional jobs both during the restoration phase itself, and in ongoing future operation and maintenance of the habitat. Furthermore, when considering upland peatland areas, jobs can be created in economically vulnerable and remote areas (Committee on Climate Change 2018).

Meanwhile, due to restoration projects jobs may be displaced from activities such as animal raising and agriculture. They consider that such job losses will be typically small for restored upland peatlands, as these are not generally used for intensive and profitable economic activities (Committee on Climate Change 2018). Table A4 below sets out the estimates for jobs created, which include jobs that are created as a direct result of the restoration project and ongoing operation and maintenance of the restored peatland, as well as within supporting industries (i.e. jobs within associated supply chains), and further jobs resulting from increased household incomes and consequent increased household spending.

They note that as part of its recommendations on how to improve the UK's use of land to meet climate goals, the Committee on Climate Change has recommended that at least 55% of peatland are restored to good status by 2050 (Committee on Climate Change 2020a). Work by Glenk and Martin-Ortega (2018) found that this 55% equates to approximately 1.6m ha of peatlands across the UK, thereby potentially generating approximately 48,000 temporary jobs in the restoration phase and 112,000 job-years during a period of 100 years. The value of the increased job opportunities should be considered alongside the benefit-cost ratio described above.

Saltmarshes

They note that temporary jobs will be created to carry out the restoration activities (as set out in Table A4). These estimates include jobs that are created as a direct result of the restoration project, as well as jobs within supporting industries (i.e. jobs within associated supply chains), and further jobs created as a result of increased household incomes and consequent increased household spending.

Considering an estimate provided by (Adnitt et al. 2007), they note that in the UK, total salt marsh habitat is expected to shrink by 4.5% in the next twenty years due to climate change. If these habitats were to be restored, an additional 308 temporary jobs could be created in a low restoration cost scenario, 660 in a medium restoration cost scenario and 1,628 in a high restoration cost scenario.

Woodland creation

Woodland creation and restoration projects have a positive effect on employment, through the creation of additional jobs both in the restoration phase itself, and in ongoing operation and maintenance of the habitat. It should be noted that job losses may arise as a result of afforestation, typically associated with economic activities originally carried out on the habitat. Job losses are not directly counted in their analysis.

The IO modelling carried out within their analysis estimates that the upfront capital investment for afforestation can generate the estimates set out in Table A11 below. These estimates include job-years that are created as a direct result of afforestation and ongoing operation and maintenance of the woodland, as well as jobs within supporting industries (i.e. jobs within associated supply chains), and further jobs that result as a result of increased household incomes and consequent increased household spending**.**

Table A11 below summarises the employment related results to the work by Cambridge Econometrics in 2020.

23.2.1.2 Table A11: Job Creation (Jobs Supported) Within Nature Based Solutions Scenarios Assessed by Cambridge Econometrics (2020)

	Jobs created (per 100 ha.)	Assessed Scenario	Job creation within Assessed Scenario
Peatland Restoration	3 temporary jobs during restoration 7 job years during ongoing operation and maintenance	The Committee on Climate Change (2018) recommends that at least 55% of peatlands are restored to good status by 2050. This has been estimated as comprising 1.6m ha (Glenk and Martina- Ortega, 2018).	48,000 temporary jobs during restoration 112,000 job years over a period of 100 years
Saltmarsh Restoration	14 temporary jobs during restoration in a low-cost scenario 30 temporary jobs during restoration in a medium cost scenario 74 temporary jobs during restoration in a high cost scenario	The spatial extent of salt marshes in the UK has been projected to shrink by 4.5% over the next twenty years due to climate change (Adnitt et al. 2007). The scenario considers if this habitat were instead to be restored.	308 temporary jobs during restoration in low restoration cost scenario 660 temporary jobs during restoration in a medium cost scenario 1,628 temporary jobs during restoration in a high cost scenario.
Woodland creation	25 temporary jobs to carry out plantation activities 6 job years during ongoing operation and maintenance	The Committee on Climate Change (2020) recommends the creation of 30,000 ha of new woodland in the UK.	7,500 temporary jobs during planting 1,800 job years over a period of 100 years
Summarised from Cambridge Econometrics (2020). Employment outcomes are expressed variously as the number of temporary jobs, and the number of job-years. The duration of temporary employment is not defined within the study. In each case job estimates reflect total jobs supported, and include both indirect jobs created in the wider supply chain and the induced effect on employment through re-spending of wages			

The Scottish Government (2022) in collaboration with NatureScot examined the economic analysis of how local investment in natural capital can impact local economies, measured as output effect and jobs created in Scotland. Given the limitations of the Scottish Government's the Input-Output (I-O) tables on the full local economic impacts and the

Standard Industrial Classification (SIC) of natural capital sectors, the research team applied the I-O model to conduct the new I-O tables and create new multipliers using from the investment information from literature review and the online stakeholder engagement (e.g., labour cost, material cost, etc.). The multipliers were then calculated by using for direct, indirect, and induced effects for the output effect and job creation and for use in economic appraisal of four different types of local natural capital investments: the restoration of upland and lowland peatland, woodland creation and restoration, regenerative agriculture, and coastal habitat restoration. The results suggested that if the four natural capital investments could be achieved, this should enable the increased inclusion of local economic impacts in business cases, including output and job creation, and investment strategies as well as providing better policy decisions in the future for Scotland.

- Estimates relating to net zero land use scenarios

Work undertaken by Vivid Economics (2020) explored the economic impacts of net zero land use scenarios. This work involved a social cost-benefit analysis of the Climate Change Committees net zero land use greenhouse gas (GHG) mitigation measures in the UK. Their analysis estimates the net benefit of fifteen land use options within forestry, bioenergy, agroforestry, peatlands, and agricultural practices. Net benefit is assessed on both a private (excluding non- market impacts) and social (including non-market impacts, such as avoided emissions) basis.

The analysis does not consider changes to employment, it does however provide a methodology for evaluating costs resulting from different land use activities such as peatland restoration. Alongside this it provides a detailed schedule of costs and an estimate of the level of work required to deliver the Climate Change Committee's recommendations (15 in total). For peatland restoration, the report also includes an estimate of how much work is required.

- Estimates relating to low carbon and renewable activities

It is also worth referring to a number of reports which have focused on defining and measuring low carbon and renewable activities. Allan et al. (2017) for example note that this presents conceptual (i.e. what's included and what's excluded), methodological and operational challenges (i.e. accuracy). The authors review three recent studies in Scotland which have sought to estimate jobs in the low-carbon and renewables sector, and to assess their relatively strengths and weaknesses, and propose that these jobs should be added to the IO tables. The 'Low Carbon Strategy for Scotland' projects the number of low carbon sector jobs required in future. Consoli et al. (2016, p1056) argue that "better estimating of green job numbers and identifying patterns of growth (or indeed decline) is important to ensure effective local responses – such as adapting regional skills policies and provisions".

Markaki et al (2013) applied I-O analysis to estimate clean energy investments by industrial sector and to calculate the macro-economic impacts of these green investments on production and employment in the Greek economy between 2010 and 2020. They produced the I-O table to compute the direct, indirect and induced production and employment effects associated with the selected energy conservation measures (e.g., the promotion of renewable energy technology, etc.). Their results demonstrated that the investments required for energy conservation projects would total €47.9 billion between 2010 and 2020. These investments resulted in an annual average gain of €9.4 billion in the national output

with a creation of 108,000 full-time equivalent employment during the same period. The result also showed that the employment produced per €1 million investment in energy saving initiatives in buildings and transportation is considerably greater compared to the development of renewable energy sources in the power generation sector.

23.2.1.3 Table A12: Summary of findings of existing studies of future economic and employment impacts across a range of land-based activities (to enable more direct comparison)

Study name	Conceptual Definition	Methodology	Results
RPA and Cambridge Econometrics (2008) The Economic Impact of Scotland's Natural Environment NatureScot Commissioned RPA and Cambridge Econometrics to determine the current value of **economic activity generated by the natural environment**, at national and regional	Nature Based Activity ▪ activities concerned with the protection, restoration and enhancement of the environment; ▪ activities that make sustainable use of one or more elements of the environment as a primary resource; (note on this basis they exclude quarrying and mining) ▪ activities which are dependent upon the quality of the environment, in particular tourism and recreation and supporting industries; and	They consider each of the 128 industries at level 3 in the 2003 SICS. They estimate the extent to which activity within that industry depends on sustainable use of the environment. They further define an environment sector, and attribute to it those flows deemed sustainable. They model a hypothetical closure of the environment sector. For each of the 128 industry groups in the 2003 Standard Industrial Classification (SIC), an estimate has been made of the extent to which each sector relies on and/or utilises the natural environment. In particular, consideration has been given to the need for a high quality environment, rather than exploitation of the environment. Thus, industry sectors such as mining and quarrying, although they use the natural environment for their primary resource, are assigned a dependence/link of zero per cent, since they do not rely on, or contribute to (in the short-term at least), a high quality environment." They identify 26 industry sectors that have significant links to the environment (where a significant link is defined as 20% or more of a sector's activities being environmentally-related). These sectors include food and drink production, water use, timber production and use, tourism and recreation. In full, these 26 sectors are: agricultural/forestry machinery, agriculture and hunting,	Direct contribution to intermediate demand: £3.9 billion excluding wages and £8.6 billion including wages. Further considering the indirect effect (the Type 1 effect) they estimate the contribution of the sector to be £5.9 billion. Further considering the induced effect (the Type 2 effect) they estimate the contribution of the sector to be £17.2 billion. They estimate nature-based employment in 2003 as 154,000 jobs directly supported by the natural environment or 242,000 when further considering direct, indirect and induced employment.

Study name	Conceptual Definition	Methodology	Results
level, and associated employment both direct and indirect.	▪ activities indirectly dependent on each of the above.	beers and ales, bread, rusks and biscuit, construction, fish and fish products, fishing and fish farming, footwear, forestry harvesting, forestry planting, fruit and vegetables, grain mill products, hotels and restaurants, meat and meat products, membership organisations, other food products, prepared animal feeds, recreational activities, sewage and refuse disposal, soft drinks and mineral water, spirits and wines, tanning and leather, tour operators, travel agents, vegetable/animal oils and fats, water supply, and wood and wood products.	
Biggar Economics (2020) Scotland's Natural Economy Sustainable Growth Potential SRUC commissioned Biggar Economics to define and quantify the scale of **the**	"The natural economy" They note that if broadly defined could encompass all economic activity, they seek a narrower definition on basis of activities that: Use natural resources Conserve/ preserve natural resources Rely on natural resources/ the natural environment	Biggar Economics does not apply a sustainability weighting, except to tourism. The natural economy is the primary sectors plus those sectors that are particularly reliant on inputs from the primary sectors. They start from industrial categories at level 2 as defined in the Office for National Statistics (ONS) 2007 Standard Industrial Classification System (SICS). As a first step they identify those sectors that comprise the primary sector: • agriculture; • forestry and logging (SIC 02); • fishing and aquaculture (SIC 03); • mining of coal and lignite (SIC 05); • extraction of crude petroleum and natural gas (SIC 06);	Their analysis finds that GVA within the sector is dominated by energy. They estimate that in 2018 the Scottish Natural Economy generated £29.1 billion GVA, more than a fifth of total Scottish GVA, while the Scottish Natural Economy *excluding energy* generated £8.3 billion GVA in 2018, around 6% of Scottish GVA. Considering employment, their analysis find that the contribution of the energy

Study name	Conceptual Definition	Methodology	Results
natural economy.		• mining of metal ores (SIC 07); • other mining and quarrying (SIC 08); and • mining support service activities (SIC 09). Then with reference to the Scottish Government Input-Output Tables combined use table they identify those sectors which are particularly reliant on inputs from the primary sectors: • manufacture of food products (SIC 10); • manufacture of beverages (SIC 11); and • manufacture of wood and of products of wood and cork except furniture manufacture of articles of straw and plaiting materials (SIC 16). As a last step they augment their definition to include broader sectors that would not necessarily be captured by a single sector: • tourism; and • energy (including renewable). For purposes of reporting they remap to six sub- sectors: • tourism; • food and drink; • fishing and aquaculture; • agriculture; • energy (including renewables); and • forestry, logging and manufacture of wood.	sector remains significant, though less stark. They find tourism to be the largest employer, employing 87,200 followed by the energy sector and agricultural sector both tied at 67,000, food and drink 46,900, logging forestry and manufacture of wood 12, 900, fishing and aquaculture 6,700, and mining 2,400. They further find substantial regional variation in employment across the six sectors.

Study name	Conceptual Definition	Methodology	Results
Hirst and Lazarus (2020) Supporting a Green Recovery: An initial assessment of nature- based jobs and skills. NatureScot commissioned Hirst and Lazarus (2020) to provide an evidence base and short initial **assessment of future employment opportunities related to investment in natural capital** and the skills	They define the **nature-based sector** as including: • **Nature-based activities**, such as nature-based solutions, land use, marine management & fisheries, green finance, urban green infrastructure, as well as • sectors highly dependent on natural capital, such as tourism and food and drink (also called **nature-dependent sectors**). Renewable energy generation was excluded from this assessment.	Hirst and Lazarus update the prior RPA and Cambridge Econometrics report. Start with 2007 SICS. Review sectors included in EISNE report, make adjustments on basis of NatureScot definition of nature- based activities. • nature-based solutions; (peatland restoration, flood risk management, blue carbon and the restoration / management of coastal ecosystems, woodland restoration, management of invasive non-native species - INNS); • low carbon and regenerative land use (including agriculture, forestry, wildlife management) • sustainable marine management and fisheries • environmental green finance (that excludes renewable energy generation) • urban green infrastructure, including planning, ecological engineering, active travel networks, • sectors highly dependent on natural capital (especially tourism and food & drink) They obtain sectoral employment data from the Business Register and Employment Survey (BRES) and augment this	They estimate that there were 166,721 FTE 'nature based jobs' in Scotland in 2019. They further estimate that jobs within the sector have grown by 12,031 (7.5%) since 2015, five times the rate of increase of all jobs (1.5%) and accounting for one third (31.7%) of all job growth during that period.

Study name	Conceptual Definition	Methodology	Results
required to do them as part of the green recovery and transition towards a net zero economy.		to account for 'missing' unregistered zero employee businesses, as BRES excludes jobs in businesses not registered for VAT or PAYE. They adjust and apply the sustainability weightings from EISNE report.	

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24 Appendix 13: Reviewing approaches to scenario creation

24.1 A13.1 Scenario Planning

Scenario planning (or scenario analysis, scenario prediction or scenario method) is a technique used in many contexts, usually as a means of strategic planning using a systems-based approach to make flexible long-term plans. It can take into account the often complex relationships between factors, but has been criticised for its inability to take account of disruptions to the plans and for too often being regarded as making predictions rather than as a means of envisaging and thinking through the potential impacts of various plausible futures. However, scenario planning is widely regarded as a useful technique to help a range of different stakeholders – including policy-makers, businesses, communities, etc. – to anticipate change and prepare more robust strategies to respond. It can be used at different stages of the policy cycle from agenda setting to policy design, policy implementation and policy review. Scenarios can be developed based on expert judgements or wider participatory approaches involving stakeholders.

It is important to remember that scenarios are descriptions of potential plausible future conditions. They are not forecasts but rather images of how the future can unfold (Mahmoud et al. 2009).

Dunkerley et al's (2022) work on *'Labour market and skills demand, adopting a horizon scanning and scenarios approach'* contains some useful reflections on the value of scenarios work in the context of labour market studies, and the need to include both quantitative and qualitative data in this work. The objective of their work was to scan the horizon of the labour market over the next 15-20 years, to identify the drivers and emerging trends and to create five different scenarios of what the labour market could look like in future. They acknowledge that, while quantitative projections are available (see for example the Working Futures modelling by Wilson et al. [2020]), even if they are robust, they have limitations and are not sufficient alone. For one thing, they do not adequately take into account the many external factors that shape the labour market, which are often characterised by great uncertainty and disruption. This can make planning effective policy intervention aimed at supporting skill development, for example through the right investments in education and training, challenging. Qualitative scenarios can complement these assessments as they can draw on a wider range of factors than can easily be considered in a quantitative framework (see also Störmer et al. 2014 for a qualitative approach to scenario planning).

In their work, Dunkerley et al. (2022) take a mixed method approach including an evidence review, stakeholder interviews, qualitative scenario development and a scenario workshop. From a structured process of examining the most important variables that influence the labour market and skills demand, they developed five qualitative, high-level scenarios for the labour market using a structured approach to reflect uncertainties in the economy, the

environment, technology and the wider societal, political and legal landscape, looking 15-20 years into the future. The five scenarios, which are not focused on specific sectors but provide a high level view of the labour market, with the implications for specific sectors drawn out, are:

- Digital greening,
- Living locally,
- Protectionist slowdown,
- Continued disparity,
- Generating generalists.

In terms of the importance of undertaking scenarios work, the authors argue that the purpose of scenarios is not to predict – they are not forecasts or likely predictions - but rather it is to help decision-makers envisage different possible, plausible futures and to support them in assessing which policy levers might be useful under which circumstance. Accordingly, scenario building can be a useful policy planning tool as policymakers can envision different kinds of possible futures and consider different policy levers to address these possible futures. Their development is reliant on the existing evidence base, expert opinion and current thinking on what is plausible.

From their research, Dunkerley et al. (2022) draw a number of implications which are useful context information for the scenarios in this project:

- ICT/digital skills are critical to the future of most jobs.
- Any future vocational education and training system needs to provide clear and more flexible pathways so that workers are well aware of training options and can make informed decisions about what to do and how to do it.
- More flexible, portable training with corresponding micro-credentials could be accompanied by accreditation and licensing of providers to mitigate the risk in quality of qualifications obtained in this way.
- A broad range of stakeholders should be involved in developing courses and training to meet local labour market demand.
- Education and training system also need to teach broad concepts and foundation skills (for example communication, networking, problem-solving, literacy and numeracy skills).
- Employer investment in training will be increasingly important, but employer unwillingness to train their workers will continue to be a barrier. Incentives for life-long learning, both for the employer and employee, will be increasingly important, as will information on the benefits and options outlined.

Dunkerley et al. (2022) also argue that scenario development is not free from, and indeed heavily relies on, expert knowledge and judgements made by the researchers involved. As such in their work, they combined researchers with labour market and skills expertise and scenario specialists. In their work they had a structured six-step process and a ‘systematic framework’ (Gausemeier et al. 1998) which identifies critical factors and combines cross-impact analysis, consistency analysis and cluster analysis to identify scenarios.

Bishop et al. (2007) also review approaches to scenario development. While recognising the popularity of the Royal Dutch Shell method (which they note has been described as the gold

standard) they urge practitioners to look beyond this and consider the applicability of a wider suite of approaches. They describe the following broad scenario planning techniques:

- Judgment (genius forecasting, visualisation, role- playing, Coates and Jarratt)
    - Analytically looser process relying primarily on the judgment of the practitioners, lacks the methodological structure of other approaches.
- Baseline / expected trend extrapolation
    - Defines one and only one scenario, the expected trend or baseline which is then extrapolated.
- Elaboration of fixed scenarios
    - Starts from pre- determined scenarios. Practitioners then elaborate the implications.
- Event sequence and probability trees
    - Considers the probability of key events occurring, highlights contingent events and maps as a probability tree.
- Backcasting
    - Retrospective analysis.
- Dimensions of uncertainty
    - Develops a matrix based on different dimensions of uncertainty. Scenarios are built from each element.
- Cross impact analysis
    - Develops matrix of potential outcomes and specifies individual and conditional probabilities. By setting threshold value (for event to be said to occur) and iterating the model many times probability distributions can be estimated.
- Modelling
    - Scenarios are determined based on differing combinations of model parameters and then implemented in the model.

Fergani (2021) discusses three prominent methods of scenario development (see Table A13).

24.1.1.1 Table A13: Summary of prominent methods of scenario development (adapted from Fergani (2021)

Method	Applicability
Royal Dutch Shell Method • Step 1: Identify Driving Forces of Change • Step 2: Distinguish "Predetermined Elements" and "Critical Uncertainties" • Step 3: Create 2- 4 Scenario Narratives through Dialogue. Asking how would the driving forces, predetermined elements and critical uncertainties behave in this or that scenario? • A key feature is iteration.	Historically the most popular method for scenario development, an open ended, loose process involving iterative discussion, can be time intensive.
4 Archetypes Method • Utilises 4 Archetypes: Continued Growth, Collapse, Discipline, Transformation • Step 1: Identify Driving forces of Change • Step 2: Specify Direction of Change • Step 3: Considering 4 predetermined Archetypes ask: How would the driving forces behave together in this narrative? • Step 4: Based on these interpretations develop scenario narratives. • Need to think of counter intuitive behaviour of driving forces and support this with references.	Quick. Necessary to consider whether archetypes are all relevant to the study context. Similar to the three horizon's method developed by Sharpe et al. (2016)
2 by 2 Matrix • Step 1: Identify Driving Forces of Change • Step 2: Driving forces clustered based on degree of mutual influence • Step 3: Identify Extreme Limits for clusters (factors) • Step 4: Rank factors based on impact and uncertainty • Step 5: Identify two most significant factors • Step 6: Create 2 by 2 Matrix	Structured process. Requires that uncertainty be reduced to two key factors, may be challenging to justify choice.
Dunkerley et al. (2022) • Step 1: Identify Driving forces of Change • Step 2: Cross Impact Analysis • Step 3: Future Projections • Step 4: Consistency Analysis • Step 5: Cluster Analysis • Step 6: Scenario Narratives	Structured process. Several stages of analysis, may be time intensive. Bishop et al. (2007) question the reliability cross impact analysis based on practitioner judgement.

24.2 A13.2 Identifying drivers of change and sources of uncertainty

As identified here, there are various approaches to designing scenarios, but all start with the same first step: identifying drivers of change/key sources of uncertainty in the system.

We can identify some of these drivers/sources of uncertainty affecting the wider UK and Scottish economies here:

- Demographic ageing,
- Digitalisation,
- National and international politics and economics (e.g. the war in Ukraine),
- Lifestyle and working changes associated with the Covid-19 pandemic,
- Climate change mitigation/adaption,
- Energy transition,
- Shift to a service based economy,
- Increasing inequality,
- Brexit,
- Trade with Europe and the rest of the world,
- The cost of living crisis,
- War in Ukraine,
- Government decisions and policy e.g. on inflation, interest rates, monetary policy and fiscal policy.

It is also possible to identify a list of drivers/uncertainties more specifically related to the land-based sector, which may result in unexpected/unintended consequences in terms of land use and land management and which may make achieving these ambitions more difficult, including:

- Policy changes e.g. in terms of the replacement for CAP support, land reform, changes to agricultural tenancies, circular economy ambitions, etc.,
- Mechanisation and digitalisation,
- Land ownership and succession issues,
- Rising Land Values, impacted by:
    - Fiscal incentives: IHT/ CGT reliefs,
    - Emerging Carbon and Natural Capital Markets,
    - High timber and forestry values,
    - Demand for plantable land,
    - Demand for peat,
    - Green Lairds/ Rewilding/ ESG,
- Rising demand (and support) for (bio)energy crops,
- Nutrition and diet transitions,
- Changes to agricultural advice arrangements and associated research activities.

24.3 A.13.3 Other issues considered by the research team in developing the scenarios

There are a number of other issues which need to be considered when designing scenarios for the future of the land-based sector and these were discussed int his project with the Steering Group and also on a one-to-one basis with individual stakeholders.

First of all, the likely trade-offs between sectors as Scotland moves towards achieving the CCPU targets, which will require assessments of the net effects on jobs in different sectors.

- Scottish Government tree planting targets may involve trade-offs with jobs in agriculture:
    - Woodland creation targets seek to increase woodland cover from 18% (as at 2019) to 21% by 2032, through a tiered increase in the planting rate reaching 18,000ha per annum from 2024.
    - Around 80% of land in Scotland is used by agriculture.
    - There may be capacity to increase woodlands on farms without displacing agricultural production. Agroforestry, shelter belts and other forms of on farm woodlands are actively encouraged. The recent Land Reform Consultation proposed a Land Use Tenancy which seeks to reduce barriers to tenants wishing to diversify from agriculture.
    - However, recent SRUC research has highlighted that larger scale conversion of agricultural land to forestry is already a feature of the market, as current high forestry and timber values have enabled forestry buyers to outbid for marginal hill land and increasingly for lower quality arable land (McMorran et al., 2022). This may result in jobs being displaced from sheep farms (agriculture) or grouse moors (sporting estates which employ game keepers) for example.
- Increasing management of uplands for peatland carbon (a key policy priority for Scottish Government) may involve trade-offs with jobs on sporting estates and in sheep farming:
    - The Rural Land Markets Insights Report 2022 highlighted shifting motivations for estate acquisition, a decline in sporting motivations, linked to legislative changes and negative social perceptions of driven grouse shooting that exist among some stakeholders, alongside a parallel increase in landscape scale rewilding motivations and peatland carbon as an investment prospect.
    - There is uncertainty around the extent to which a change in upland management in line with such motivations could coexist with / displace traditional sporting jobs.
    - Meanwhile land management for peatland carbon requires control/ exclusion of grazing and can be expected to impact on revenues in sheep farming with knock on implications for employment (Aitkenhead et al., 2021). The degree to which revenues are likely to be influenced depends on stocking densities which vary across the country.
- Scotland may evolve towards a more multifunctional vision of land use as many activities are seasonal:
    - For example, tree planting is seasonal, usually from October-March, and predominantly from January to March.
    - Some peatland restoration tasks are seasonal (due to bird restrictions), and heavy machinery tasks may not be feasible where there is snow cover.
    - Seasonality may result in more job churn if workers seek to transition to more secure year-round employment across different sectors.
    - One vision is that former sectoral distinctions become less pronounced and a general pool of land-based workers transition between roles as seasonal demands require.
    - This would require a significant shift in work cultures not least to incorporate more dynamism and flexibility and there may be cultural/ social barriers to

this, as well as limitations in terms of generic v specific skills. For example, can one individual hold the range of skills required to undertake peatland restoration, tree planting and wind turbine installation and maintenance (and what is the range of skills required)?

A second broader issue worth considering is the extent to which Scottish Government targets will create jobs in rural areas and/or in urban areas. Some of the jobs created in the renewable energy sector for example are more likely to be in urban centres than in rural locations. Moreover, the structural challenges in rural communities (such as lack of affordable housing and poor transport connectivity) highlighted by this work as potentially providing barriers to people taking up new opportunities in rural communities also mean that people may need to live in urban locations to undertake rural-based work. This means that the value generated by this employment, if a residence-based approach is taken, may be recorded in urban rather than rural locations.

- Sector-based or holistic scenarios?

It is possible to formulate scenarios which are holistic, i.e. involve targets relating to more than one sector, which are more likely to represent reality in terms of the inter-relationships between different sectors. However, this may not be specific enough to implement using an I-O model. For example, while the CCPU includes specific policy targets for forestry and peatland restoration activities, the ambitions regarding low emission agriculture and nature restoration activities are not clearly specified.

For example, rather than having a simple scenario based only on the target for woodland planting, the scenario could include multiple land use changes, such as an increase in woodland planting, peatland restoration, low emission farming and nature restoration activities. The latter might be described as more of a narrative based scenario (see for example Dunkerley et al. 2022).

An example of a narrow, specific scenario would be:

- “An increase in woodland creation is required as per the Climate Change Plan Update to deliver 18000 ha per annum by 2024/5, rather than the current level of 12,000 ha per annum. This will require an increase in the number of people employed in the forestry sector.”
- “An increase in peatland restoration work is required as per the Climate Change Plan Update to achieve a target of 250,000 ha of degraded peat restored by 2030. This will require an increase in the number of people employed in activities related to peatland restoration.”

An example of a more holistic, narrative scenario with or without targets could be:

- “By 2030/2045, Scotland aims to be planting 18,000 ha of woodland per annum, restoring 250,000 ha of degraded peatland, having X% of its agricultural activity/X% of its agricultural land following low emission and regenerative farming practices, and to have X people involved/£X invested in nature restoration activities.
- “Future landscapes in Scotland’s rural areas will comprise more peatland restoration, woodland expansion and nature restoration, with an increase in low emission agriculture. Creating and maintaining such a multifaceted land use system requires a

workforce which includes individuals with a range of land use and land management skills."

- "Future rural economies in Scotland will be thriving and based around woodland creation, peatland restoration and biodiversity, sustainable tourism, energy and food and drink".

We also considered whether the scenarios – irrespective of whether they are based on one or many sectors – could have three 'levels' i.e. achieving the CCPU policy target by 2030/2045, not/under-achieving the target, or going beyond the target.

The team also considered the potential to have regionally-focused scenarios, for example:

- "Dumfries and Galloway already has X ha of woodland and forestry and local provision (e.g. through SRUC) for training and skills development in this sector. This area could deliver ?% of Scotland's future woodland/forestry land use, but this would require an increase in employment in the sector of X people across the region, with a focus on X, Y, Z skills."

The decision on the approach to take was informed by discussion with Scottish Government research analysts and policy officials and the availability of appropriate data, and whether or not they could be implemented using the IO modelling approach. The team also reviewed scenario-based approaches used in other similar studies. One example is the 2020 Vivid Economics report which identifies 15 options across five different land use options (forestry, bioenergy, agroforestry, peatlands and agricultural practices and technology) and four scenarios (business as usual, net zero, high mitigation uptake and technology push).

Focusing on future possible land use changes rather than changes in employment, Thomson et al. (2018) identified five scenarios that they argued are technically feasible up until 2050:

- **Business as Usual (BAU):** Current trends in human diet, land use and management continue to 2050.
- **High Mitigation Uptake**: Agricultural land is spared as a result of a reduction in food waste, changes in diet away from red meat and dairy products, increased yields and improved agricultural practices: this land, is converted to forestry, energy crops and agroforestry. Some peatlands which are currently used for agricultural purposes are either permanently rewetted or partly rewetted by raising the water table. Wholly rewetted peatlands are partly restored to semi-natural vegetation.
- **Technology Push:** There is high uptake of mitigation practices and technological development in agriculture together with high levels of change in diet away from animal products, which are replaced with plant-derived food and other protein sources (e.g. synthetic and cultured meats) as well as large reductions in food waste. The land spared is afforested and used for biomass fuel crops, and there is some peatland restoration. This scenario also includes some multifunctional land use, e.g. agroforestry and re-instatement of hedges around field boundaries.
- **Multifunctional Land Use:** Reduction in food waste and dietary change away from red meats and dairy products combined with improved agricultural practices allows higher uptake for agroforestry and medium levels of afforestation, along with some increase in the area of biomass fuel crops.
- **Maximum food production:** Human diet retains current intake of meat and dairy products. Improvements on agricultural practices and yields increase food

production per ha, but land remains in agricultural use rather than being re-purposed.

Further comments from the Project Steering Group on the scenarios

A number of other comments were also received from the Project Steering Group at the interim meeting and at meetings before and since this, to inform the team's scenario-related work and these are summarised here. Overall, they demonstrate the complexity of work which aims to predict future employment change when (a) there are gaps in existing data and (b) there are a number of inter-related issues that will affect future employment, including levels of pay, seasonality of activities, the potential for multiple job holding, etc.:

- It may be valuable to have reference to specific numbers rather than generic as this could be useful to determine the likely requirement for training and development of the skills and skill provision in these sectors, such as peatland restoration and woodland restoration/creation. On the other hand, steering more towards generic scenarios would be more useful as there are still significant unknowns as to the specific trajectories but we do know that the 'more' and 'change to existing jobs' projections will be highly likely.
- It may be useful for the scenarios to include upland and lowland deer management - it's still early days but there may some labour market effects as a result of the recommendations from the Deer Working Group report in relation to the sector, and of course this is likely to have implications for the woodland and peatland restoration aspirations. The team considered that to meet woodland creation targets would require some assumptions about deer control, either through significant fencing requirements or through reducing deer numbers, both of which would have implications for jobs.
- The option of targeting one (or more) scenarios to specific regions (e.g. Dumfries and Galloway) on the basis of their existing land use pattern (e.g. a large amount of land already under forestry and woodland) was considered. However there was a concern that as scenarios are often (mistakenly) understood to be predictions, the work could take a more regional/micro look at the changes, which would then help to expose difficulties around the geographic location of workers and low rates of movement within the country. If there was a focus on one region, it would be useful if the model could be 're-used' for another region. Any model would need to take into account wider factors/characteristics of the region including housing, infrastructure, differing land uses/qualities, etc.
- It was suggested that having one or two sector specific scenarios might be helpful for 2030 and 2045 (e.g. relating to forestry and woodland creation and peatland restoration) plus two or three more general scenarios (e.g. high timber production, natural capital focused scenario). It was also noted that the latter may be a more appropriate reflection of the future labour market where people will need to deliver to a range of land uses and land management with a range of skills. At the same time, it was commented that data still tends to be sectoral in nature which is a key limitation in terms of calculating the future workforce needs and skill sets through the scenario analysis.
- How will modelling take into account changes in the types or 'quality' of jobs available, gender and age differences (note the high average age of farmers and the

often unrecognised role of women in agriculture) and also the role of the unpaid – and therefore mainly unmeasured and unresearched - workforce.

Based on reviewing all of this information, the research team concluded that several forms of scenarios were possible with the ultimate aim of modelling the impact of net zero and biodiversity commitments, particularly those for forestry planting and peatland restoration (and acknowledging that there is considerable potential for land use trade-offs):

- Technically oriented scenarios, following closely Scotland's commitments in the update to the Climate Change Plan and Biodiversity Strategy; these could be single sector focused, or include multiple sectors, e.g. productive forestry vs natural capital driven land use priorities.
- Broad narrative-based scenarios reflecting societal level drivers of change as for instance used in the Working Futures study.
- Geographically defined scenarios to highlight regional level drivers and outcomes.

24.4 A13.4 Expert input

The team sought further advice from several individuals in different stakeholder organisations across the land-based sector to inform the approach. Undertaking additional qualitative data collection to inform the quantitative work in scenario-based modelling is an approach advocated by researchers involved in the Working Futures programme (see for example, Dunkerley et al. 2022):

- There are potentially huge variations in the cost of peatland restoration (in particular) as the restoration work is dependent on such a wide range of factors, including altitude, previous/existing land use, access, etc. One of our interviewees commented on the potentially substantial input requirements:

"Easy lowland sites can be around £1,500 per hectare; more complex and more remote upland sites can be in the region of £5,000 per hectare. However, in the Peak District they are looking in the region of £25,000- £40,000 per hectare. The numbers and types of machines vary too, depending on access (i.e. some hill tracks and bridges can't take 14 tonne diggers which may be most useful for most damming work) and helicopter requirements. If material, such as coir logs, stones for dams, mulch and liming are required, then the price varies hugely."

- Some large education and training providers can be slow to respond to market changes due to the time needed to recruit new staff and progress new courses through validation programmes. However, developing new short courses in areas where there is existing in-house expertise may be quicker (SRUC and NatureScot's recently launched accredited peatland restoration course is a good example). Smaller, local training providers will also have flexibility to respond to changing needs in different locations from different groups (e.g. women seeking to enter the labour force), especially if they are able to deliver remotely.
- Further work on the future labour market must be informed by those working in the sector, whether that be contractors, project consultants, etc. This was the case for Glaister's (2019) work on the future employment requirements in the forestry sector for example. Their knowledge of 'on the ground employment-related issues' such as the extent to which people working in peatland restoration may switch to undertake

woodland creation (or vice versa), or those working in other parts of the construction industry may switch to peatland restoration is crucial to ensuring that future modelling work truly reflects the situation on the ground. In terms of the latter switch, the short window in which peatland restoration is possible (for example in some locations only once snow cover is gone and before ground nesting birds arrive) means that this may be unlikely.

- The need for more granular data relating specifically to skills requirements in particular sectors. One example is conservation-related activities where specific data is currently hard to find, but these activities are of increasing importance given the biodiversity and climate change crises. Underlying this again is the need to ensure that there is clarity about what is meant by conservation-related activities, i.e. a clearly defined set of SIC codes.
- It is extremely difficult to anticipate the geographical impacts of future labour requirements as this depends on individual worker mobility (which may be reduced when the cost of fuel is high for example, making travel uneconomic) but also a range of other factors. The labour market in the south of Scotland, for example, will be affected by developments south of the border with England relating to forestry planting or peatland restoration targets, wage levels, etc.
- Specific questions about the future of the labour market and the number of jobs in peatland restoration, woodland creation, tourism and hospitality etc. are tied up with wider debates about the future of Scotland's land and landscapes, and indeed its rural communities. If the labour market continues to be 'tight' as Scotland recovers from the Covid-19 pandemic, there will be competition between sectors for workers, and prioritisation may need to occur.
- Several interviewees emphasised the importance of place-based solutions co-created with communities that live locally and informed by local priorities and needs, and delivered locally. The latter may involve larger education and training providers shaping their provision to fit the requirements of their region/locality, and smaller training providers also making a substantial contribution. The current work being led by Scottish Rural Action to strengthen Scotland's rural movement may help to provide a forum for further discussion on this[38].

[38] For more information, please see: Birnam hosts Rural Movement Event | Scottish Rural Network

25 Appendix 14: Our approach to the scenario-based modelling for peatland restoration and woodland creation

This Appendix sets out more detail about our proposed methodological approach to estimating future labour requirements in peatland restoration and woodland creation activities.

25.1 A14.1 Peatland restoration - overview of methodological approach

The research team effectively sought to perform an economic impact assessment of the Scottish Government's target to restore 20,000ha peatlands per year in order to consider the impact on employment in upstream sectors. The team searched the literature for information on peatland restoration costs, seeking to understand unit costs of different inputs, including labour and machinery requirements, and how these may vary between sites.

From this we proposed to estimate the typical cost structure of peatland restoration work and apply this to estimate changes to final demand in upstream sectors (those supplying inputs, e.g. materials, machinery and consulting services) arising from the Scottish Government's planned £25 million per year investment in peatland restoration. The resulting effects on employment in upstream sectors may then be estimated using the multipliers from the Scottish Government's Supply and Use Tables (or the Scottish Government's Input-Output (I-O) tables). We acknowledge that these I-O tables cannot provide full and accurate information on the local and/or regional non-market benefits (such as social and environmental impacts) of peatland restoration (or woodland creation) because the I-O analysis only includes information on monetary values.

25.2 A14.2 Peatland restoration – data on input costs

We searched the literature for information on peatland restoration costs, seeking to understand unit costs of inputs, labour and machinery requirements and how requirement for these may vary between sites.

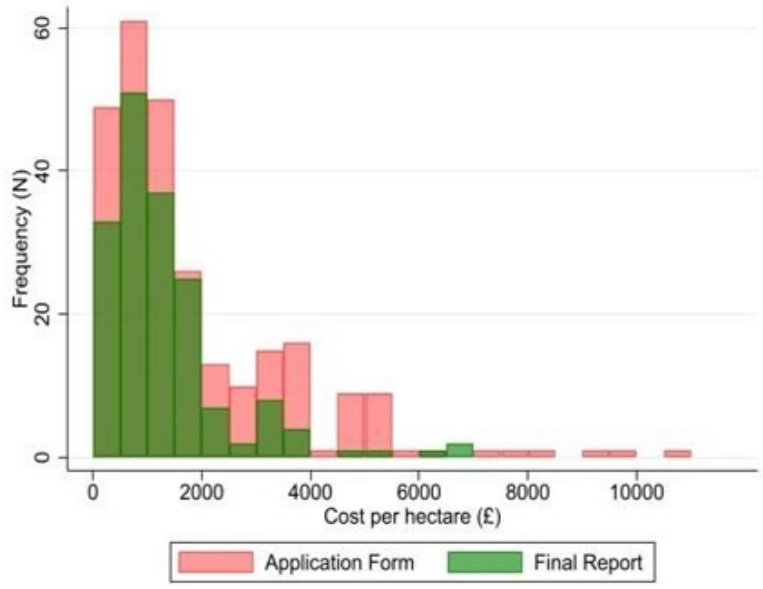
Per ha restoration costs

Glenk et al. (2022; 2021; 2020) analyse peatland cost data from monitoring forms submitted to the Peatland Action Programme. This provides the most recent and comprehensive overview of per ha. restoration costs in the published literature. The authors report that to their knowledge no other comparable dataset exists.

Their most recent (2022) analysis reports median restoration costs to be £1,026 per ha and mean to be £1,712 per ha., n = 174 observations across all projects submitted 2016/17 to 2020/21, based on final reported costs. They further highlight variation in per ha. costs by restoration technique and initial site condition. As indicated in Figure A4 below the

distribution of restoration costs is somewhat skewed. Due to this they consider that median is a more informative than mean, as mean estimate is distorted by a few large observations.

25.2.1.1 Figure A4: Histogram of Peatland Restoration Cost Per ha. reproduced from (Glenk et al. 2022)



Relevant literature Reviews

We further note a series of literature reviews which provide additional data, including several commissioned by CXC.

Table A14: Summaries of additional information sources on peatland restoration input costs

Source	Relevance
Okumah et al. (2019) How much does peatland restoration cost? Insights from the UK.	In a review funded by NERC, RESAS and the University of Leeds Climate Research Bursary, Okumah et al. (2019) provide an overview of per ha. peatland restoration costs within the published literature. **While their review does not detail unit costs, they highlight additional (limited) data which indicates that per ha. costs vary significantly by materials required.** (See Table A8 for the specific data from this work.)
Artz et al. (2019) The State of UK Peatlands: an Update	In a review commissioned by the IUCN UK Peatland Programme's Commission of Inquiry on Peatlands, Artz et al. (2019) provide an updated schedule of per ha. restoration costs within the published literature. **They further report unit costs for a small number of materials and methods.** (See Table A9 for the specific data from this work.)
Artz et al. (2018) Peatland restoration – a comparative analysis of the costs and merits of different restoration methods	In a review commissioned by CXC, Artz et al. (2018) review 70 publications and report per ha. restoration costs within the published literature. They further present results from a survey administered to a representative sample of 30 case study sites (twenty three responses, eighteen included) from 150 peatland action projects completed until April 2017. From this they note challenges in obtaining data on unit costs and the cost structure of peatland restoration. While they receive data from 18 sites, many of the surveys contained inconsistencies between total reported costs and cost breakdowns and they received invoiced costs for only 10 of the surveys. "Only a very few survey returns specified the breakdown of the costs to capital expenditure (6), labour costs (10), operating costs such as fuel and materials (2), and unforeseen costs (2). This was because the grantees and Peatland Action officers generally did not have access to this level of information on the actual spend, it was the contractors that would have held this information, but we did not receive sufficient responses from this community. It was not possible to carry out in-depth analysis on these sparse data, and hence only some preliminary observations on labour costs can be included here." pp.17 They report that ten surveys contained partial data on staff time and day rates. "A total of 241 paid staff days, ranging

	from 5 to 60 days between these ten projects, were required at an average cost of £220 per day. In addition, two of these projects specified a total of 82 days of unpaid workers at an estimated day rate of £100, although the cost estimate was only given for one of these projects." Overall, due to the relative lack of data they are unable to conclude whether labour is a significant component of total costs.
Artz et al. (2017) Data from the peatland action program and their use for evaluations of ecosystem benefits	In a review commissioned by CXC, Artz. et al. (2017) give an overview of monitoring form data submitted to the Peatland Action Program, and provide per ha cost estimates.

The team also identified a number of other relevant studies containing some information on peatland restoration costs:

- Moxey and Morling (2018) Funding for peatland restoration and management
- Moxey (2016) Assessing the opportunity costs associated with peatland restoration
- Grand Clement et al. (2015) New approaches to the restoration of shallow marginal peatlands
- Campbell et al (2019) Peatlands and Forestry

Table A15: Okumah et al. (2019) Datatables

Activity	Artz et al. 2018	Their Study	Their Study	Their Study	Their Study
	Median (£/ha)	Median (£/ha)	Minimum (£/ha)	Maximum (£/ha)	Mean (£/ha)
Normal-age forestry harvesting	1480	4306*	4306*	4306*	4306*
Whole-tree harvesting	No data	5630*	5630*	5630*	5630*
Felling to waste	No data	1993	437	3548	1993
Whole-tree mulching	2425	3565	2500	3840	3470
Ground smoothing/ stump flipping	No data	720	111	1250	700
Brash crushing	No data	894	125	1664	894
Damming plough furrows	No data	296	280	683	425
Damming drains with peat	No data	105	103	447	285
Damming drains with timber	No data	5612*	5612*	5612*	5612*

Damming drains with plastic	No data	366	74	886	398
Damming drains with rock	No data	5883*	5883*	5883*	5883*
Reprofiling hags/peat banks	688	1000	951	1143	1031
Introducing Sphagnum spp. plug plants	No data	802	473	1213	845
Cutting with chainsaws/clearing saws for regen	No data	499	242	756	499
Drain blocking (ha)	517	No data	No data	No data	No data
All restoration types combined	880 or 1500 (including land purchase)	1009	74	5883	1166

Table A16: Artz et al (2019) Datatables

Type of restoration activity	Average (£ per ha)	Median (£ per ha)	Range (£ per ha)	Cost per unit (unit in brackets)	References
All restoration types combined	£830	880 or 1500 (including land purchase)	200-10,0000	-	See Artz et al. (2019)
Drain blocking (ha)	879	517	-	-	See Artz et al. (2019)
Grip/gully blocking	-	-	-	25.32 (heather bale); 28.57 (peat); 95.30 (plastic); 120 (timber);162.98 (stone)	See Artz et al. (2019)
Hag Reprofiling	704	688	-	-	See Artz et al. (2019)
Restoring cutaway peat	300-5000	No data	-	-	See Artz et al. (2019)
Living mulch on bare peat	2976	1487	-	-	See Artz et al. (2019)
Brash application	-	-	-	61.90 (bag, 49m2)	See Artz et al. (2019)
Geotextiles application	-	-	-	1.40 (m2)	See Artz et al. (2019)
Lime, seed and initial fertiliser	1,082.18;	-	-	-	See Artz et al. (2019)
Plug plants	2575	-	-	-	See Artz et al. (2019)
Sphagnum plugs	690 (or 419.75 at half density)	-	-	-	See Artz et al. (2019)
Sphagnum clumps	612.5	-	-	-	See Artz et al. (2019)
Sphagnum translocation	462.5	-	-	-	See Artz et al. (2019)

Forestry mulching	2425	2425	-	-	See Artz et al. (2019)
Reprofiling	-	-	-	1.36 (m)	See Artz et al. (2019)
Peat dams and reprofiling (km)	1000	1000	-	-	See Artz et al. (2019)
Hag Reprofiling (km)	99.3	66.6	-	-	See Artz et al. (2019)
Cutting for diversity	742	-	-	-	See Artz et al. (2019)

25.3 A14.3 Peatland restoration - Data challenges encountered

While the quality and availability of data on per ha peatland restoration costs is increasing, specific and accurate information on unit costs is sparse and we have been unable to find a reliable indication of the cost structure of peatland restoration and woodland creation work within the published literature.

Various important factors have been highlighted in the literature as contributing to substantial variations in peatland restoration (and woodland creation) costs. These include forest to bog conversion (Glenk et al. 2022), the restoration technique required (Glenk et al. 2022), remoteness and accessibility (Artz et al. 2018), degree of drainage/number of dams required on lowland peat (Grand Clement et al. 2015) and increases in material requirements relating to the degree of degradation (stakeholder interview).

While there is increasing understanding of these factors, the marginal influence of specific factors is not easily discernible from existing cost data which largely summarises per ha and does not control for variation in degradation or magnitude of work required when reporting per ha values for restoration techniques. We were unable to find information on how labour or machinery requirements may vary by site conditions.

Overall, we did not consider that we could achieve a reliable estimate for cost structure and accordingly we have not performed the preferred modelling approach.

However, based on our work, the research team offers recommendations for future work to tackle these data challenges, and indicative estimates of jobs in peatland restoration and woodland creation based on extrapolation of estimates from prior studies.

25.4 A14.4 Peatland restoration - Recommendations for future work

Approximately half of all peatland restoration projects in Scotland are supported by Peatland Action. The Peatland Action data, analysed by Glenk et al. (2022; 2021; 2020) and Artz et al. (2017) is the most comprehensive overview of restoration costs in Scotland. The research team believes that it would be worth considering how the collection of data on unit costs and cost structure of works could be enhanced, without raising the burden of data

collection for those running and managing projects unnecessarily. The work by Glenk et al. (no date) provides a literature review and highlights wider considerations for the collection of peatland restoration data in future.

In addition to our suggestion of increasing data collection through funded projects, it is worth considering potential future primary research to generate additional data. Given the lack of data on unit costs in the published literature, an alternative approach to understanding future employment and skill requirements in peatland restoration (and woodland creation) may be to design a survey/qualitative study targeting peatland restoration (and woodland creation) consultants, contractors and training providers in order to better understand peatland restoration (and woodland creation) capital budgeting and workflow, as well as factors that may increase the cost/ difficulty of restoration work.

Should the aim of this work be to estimate workforce requirements at the national level, then in scoping such work it would be beneficial also to consider what distributional data exists at the national level that may inform understanding of distribution of sites in relation to factors that may increase cost/difficulty of restoration. Relevant factors may include those mentioned above that contribute to the substantial variations in cost estimates for different peatland restoration sites.

25.5 A14.5 Woodland creation - overview of methodological approach

Having first focused on peatland restoration, the research team then sought to perform an economic impact assessment of the Scottish Government's 18,000ha per year afforestation target (from 2024/25), again in order to consider the impact on employment in upstream sectors. To inform this analysis we searched the literature for information on woodland creation costs, seeking to understand unit costs of inputs, e.g. labour and machinery requirements, and how these may vary between sites.

We were similarly unable to find a reliable indication of cost structure within the published literature, and so again the intended analysis could not be performed.

25.6 A14.6 Woodland creation – information on input costs

The costs of woodland creation depend on a number of factors, particularly depending on whether the site requires clearing, draining, weeding, and fertilising. Typically, tree-planting programmes have high upfront costs, as the cost of acquiring the land can be elevated. Using the information from the report by Vivid Economics (2020), Dicks et al (2020) reveal that the costs of woodland creation can be classified into capital costs, operational costs, and opportunity costs.

Capital costs usually refers to the one-off upfront cost of converting land from its previous use, which include the cost of finance incurred by borrowing to pay for initial investments, planting trees and building fences, and acquiring machinery (the Scottish Government, 2022).

Operational costs are the recurring costs associated with tree planting such as maintenance costs for fence repairs, pest control, fire protection, payment of wages, contracts fees and

expenses for project monitoring (Dicks et al., 2020). While the opportunity costs associated with woodland creation often refer to foregone agricultural income, loss in open ground habitats and related reduction in recreational activities, cost of land acquisition and compensation payments for forgone income (Dicks et al., 2020). Table A10 summarises different types of costs related to the woodland creation activities.

25.6.1.1 Table A17: Costs of woodland creation

Cost type	£/ha	Total (£/ha)
Capital costs* (Dicks et al., 2020) - Coniferous planting and establishment costs - Coniferous financing costs	 4,637 6,749	 11,386
Capital costs* (Dicks et al., 2020) - Broadleaved planting and establishment costs - Broadleaved financing costs	 6,182 7,347	 13,529
Capital costs (the Scottish Government, 2022) - Labour - Transport/Machinery - Materials	3965.3 100 950	 5,015.3
Capital costs (McMorran et al, 2020) - Total establishment costs (e.g. wildlife management, fertiliser and labour, new plants, etc.) - 15 year running costs	 2,272 1,832	 4,105
Operational costs* (Dicks et al., 2020) - Coniferous planting and establishment costs - Coniferous financing costs	 2,576 82	 2,658
Operational costs* (Dicks et al., 2020) - Broadleaved planting and establishment costs - Broadleaved financing costs	 2,576 10	 2,586
Operational (management) costs* (Dicks et al., 2020) - Broadleaved management maintenance costs - Broadleaved management production costs	 4,688 742	 5,430

Opportunity costs* (Dicks et al., 2020)		
- Coniferous	12,715	25,430
- Broadleaved	12,715	

Note: * is calculated at the UK level.

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