

AN INITIAL ASSESSMENT OF  
BIODIVERSITY-RELATED EMPLOYMENT  
IN SOUTH AFRICA

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## Abstract

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In the context of high and persistent unemployment in South Africa, this paper explores the extent to which the country's biodiversity assets, which are exceptional in global terms, contribute to providing jobs. A conceptual framework for defining biodiversity-related employment is presented. Using a methodology that draws on a combination of three different data sources (administrative data, national survey data, and existing estimates for particular biodiversity-related sectors or sub-sectors), an initial estimate was developed of 388 000 direct jobs related to biodiversity in 2014, representing 2.5% of national employment. The estimate was subsequently updated to 418 000 biodiversity-related jobs in 2017, representing 2.6% of national employment. Of these 418 000 jobs, 17% (72 000) were jobs involved in conserving biodiversity, and 83% (346 000) were jobs that depend on using biodiversity, including both non-consumptive and extractive use. The number of jobs that depend on using biodiversity is likely to be an underestimate, as data was available only for some biodiversity-related sectors or sub-sectors. An important finding is that for every job dedicated to conserving or managing South Africa's biodiversity assets and ecological infrastructure, approximately five jobs depend on utilising biodiversity. The implication is that current efforts to conserve and manage biodiversity should be seen not simply as an end in themselves or a cost to the economy but as an investment in a resource that supports wider economic activity and employment. The results suggest strong potential for biodiversity assets to support long-term inclusive growth and employment outside major urban centres, with further work needed to quantify this potential and to determine how best it can be enabled.

## Preface

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This paper was developed as part of the REDI 3x3 Research Project on Employment, Income Distribution and Inclusive Growth, within Focus Area 3 on Inclusive Growth. The research was undertaken by the South African National Biodiversity Institute (SANBI) with guidance from the Development Policy Research Unit (DPRU).

The initial work for the paper was done between 2014 and 2016, with a subsequent update of some data sources and estimates in 2019. The main body of the paper reports on the original set of results, while the updated results are reported in the Annexure.

This paper is accompanied by a [factsheet](#) for policymakers. The results have been incorporated in the [National Biodiversity Assessment \(NBA\) 2018](#) as one of the key messages in the NBA 2018 Synthesis Report (Skowno et al., 2019), and a summary of the paper is available in the Compendium of Benefits of Biodiversity (SANBI, 2019) that forms part of the supplementary material for the NBA 2018.

## Acknowledgements

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- Kensani Mangena and Dineo Makama (SANBI) for assisting with sourcing of administrative data;
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- Participants in two workshop sessions held in SANBI to discuss the conceptual framework for biodiversity-related employment, in August 2014 and December 2015.

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## Contents

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Abstract.....	i
Preface .....	ii
Acknowledgements.....	iii
List of tables .....	v
List of figures.....	vi
Acronyms .....	vii
1 Introduction .....	1
2 Conceptual framework for biodiversity-related employment.....	4
3 Methodology.....	8
3.1 Administrative data.....	8
3.2 Existing sector estimates .....	13
3.3 Survey data from the National Statistical System.....	14
4 Results.....	20
4.1 Results based on administrative data.....	20
4.2 Results from existing sector estimates .....	22
4.3 Results based on the Quarterly Labour Force Survey.....	25
4.4 Comparison of results across different data sources, and initial total estimate.....	31
5 Discussion.....	34
5.1 Key findings and policy implications .....	34
5.2 Methodological recommendations for a national indicator on biodiversity-related employment.....	38
5.3 Priorities for further work.....	39
6 Conclusion.....	42
References .....	44
Appendix 1: Biodiversity-related organisations for which administrative data was collected .....	47
Annexure: Update to the initial assessment of biodiversity-related employment in South Africa.....	52

## List of tables

---

Table 1: Biodiversity-related employers included in the administrative data gathering process, showing whether the organisation’s core mandate or function is biodiversity-related .....	9
Table 2: Industry codes selected as biodiversity-related from the full set of 3-digit level codes in the Standard Industrial Classification.....	16
Table 3: Occupation codes selected as biodiversity-related from the full set of 4-digit level codes in the South African Standard Classification of Occupations .....	16
Table 4: Number and percentage of industry and occupation codes for which all or most / some / few / no jobs are estimated to be biodiversity-related .....	19
Table 5: Proportions used to calculate number of biodiversity-related jobs from QLFS estimates.....	19
Table 6: Number of biodiversity-related jobs based on administrative data, for BDE Category A (2014)* .....	21
Table 7: Summary of existing sector estimates and job numbers, for BDE Sub-category B5 .....	22
Table 8: Overview of QLFS results, including range, mean and sensitivity testing of the mean .....	25
Table 9: Summary and comparison of QLFS 2014 results per BDE sub-category, by industry and occupation .....	27
Table 10: Detailed estimates of biodiversity-related employment from QLFS 2014, by industry .....	28
Table 11: Detailed estimates of biodiversity-related employment from QLFS 2014, by occupation... ..	29
Table 12: Comparison of results from administrative data, existing sector estimates and QLFS 2014, showing the preferred estimate for each BDE sub-category .....	32
Table 13: Initial estimate of biodiversity-related employment for 2014, by BDE sub-category .....	32
Table 14: Notes on spatial distribution, skills profile and growth potential per BDE sub-category.....	35
Table 15: Full list of biodiversity-related employers included in the administrative data gathering process, showing whether the organisation’s core mandate or function is biodiversity-related.....	47

## Additional tables in Annexure

Table A 1: Update for Sub-category A1 Protecting and managing biodiversity assets .....	53
Table A 2: Update for Sub-category A2 Restoring and maintaining ecological infrastructure.....	54
Table A 3: Detailed estimates of biodiversity-related employment for Sub-category A3, from QLFS by occupation, comparing results for 2014 and 2017 .....	55
Table A 4: Update for Sub-category A3 Research and professional services related to biodiversity... ..	55
Table A 5: Update for Sub-category B4 Non-consumptive use of biodiversity .....	56
Table A 6: Update for Sub-category B5 Consumptive use of biodiversity .....	59
Table A 7: Updated biodiversity-related employment estimates across all sub-categories .....	59
Table A 8: Comparison of biodiversity-related employment with employment in other sectors.....	60

## List of figures

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Figure 1: Conceptual framework for biodiversity-related employment, showing two broad categories and five sub-categories.....	7
Figure 2: Trends in biodiversity-related employment based on results from the QLFS 2008 – 2014, by industry and occupation .....	26
Figure 3: Initial estimate of biodiversity-related employment in 2014, by BDE sub-category.....	33
Figure 4: Employment trends by sector in South Africa, 2008 – 2014 .....	35

## Additional figure in Annexure

Figure A 1: Percentage biodiversity-related employment by sub-category, based on updated estimates.....	60
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## Acronyms

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BDE	Biodiversity-related employment
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DPRU	Development Policy Research Unit
EPWP	Expanded Public Works Programme
FTE	Full-time equivalent
NBA	National Biodiversity Assessment
NGO	Non-government organisation
PHASA	Professional Hunting Association of South Africa
QES	Quarterly Employment Survey
QLFS	Quarterly Labour Force Survey
REDI3x3	Research Project on Employment, Income Distribution & Inclusive Growth
SAHGCA	South African Hunters and Game Conservation Association
SAMWA	South African Wildlife Management Association
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SASCO	South African Standard Classification of Occupations
SIC	Standard Industrial Classification
Stats SA	Statistics South Africa
TEEB	The Economics of Ecosystems and Biodiversity
UN Environment	United Nations Environment Programme
WWF	World Wide Fund for Nature

# 1 Introduction

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As one of the most biologically diverse countries in the world, South Africa has an extraordinary wealth of biodiversity assets and ecological infrastructure (see box). Much of these are still relatively intact, as assessed in the National Biodiversity Assessment (Driver et al., 2012; Skowno et al., 2019).

South Africa also has an employment crisis. The unemployment rate (29.0% in quarter 2 of 2019; Stats SA, 2019) and poverty headcount (55.5% in 2015; Stats SA, 2017) remain critically high. South Africa's unemployment rate is one of the highest in the world (OECD, 2019). Unemployment was already high in the 1990s (Stats SA, 1998), and has persisted since then (Stats SA, 2015a). Joblessness has increased over the last decade, from an unemployment rate of 21.9% in 2008 (Stats SA, 2009), including as a result of ongoing significant job losses within the primary and labour-intensive sectors such as manufacturing and agriculture (DMR, 2012; Gwatidzo & Benhura, 2013).

The extent to which South Africa's biodiversity assets and ecological infrastructure contribute to the economy in general, and to employment in particular, is currently not well quantified. The few studies that have attempted to improve understanding of the contribution of biodiversity to employment have either focused on a single economic sector (e.g. hunting (Van der Merwe et al., 2014), traditional medicine (Mander, 2007)), or on selected professions within the biodiversity sector (e.g. SANBI & the Lewis Foundation, 2010). Moreover, attempts to date have adopted different definitions and estimation methodologies, complicating comparisons between these studies. Nevertheless, there is some evidence that jobs related to biodiversity may be substantial (Peter et al., 2010; Blignaut, et al., 2008; Vass, et al., 2009), and that the potential for biodiversity assets and ecological infrastructure to generate future employment and contribute to inclusive growth in South Africa may be significant (Maia et al., 2011).

## Defining biodiversity assets and ecological infrastructure

**Biodiversity assets** are ecosystems, species and other biodiversity-related resources (such as genetic material) that generate social, cultural or economic benefits, including supporting livelihoods, providing the basis for economic activity, and contributing to human wellbeing.

**Ecological infrastructure** refers to naturally functioning ecosystems that generate and deliver valuable services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and is just as important for providing services and underpinning socio-economic development.

(SANBI, 2015)

The widely cited "Green Jobs report" for South Africa (Maia et al., 2011) assessed how many additional jobs may be created in the medium and long-term by promoting the green economy. The report focused largely on energy generation, resource efficiency and pollution control, but also investigated potential employment in a fourth category – those jobs related to natural resource management. This included "the sustainable management and restoration of natural resources, specifically water, soil and land, as well as the conservation and restoration of ecosystems" (Maia et al., 2011: 3). The report found that the number of potential jobs in this last category outweighed all

the other three categories of green jobs (energy generation, resource efficiency and pollution control), providing the potential creation of over 230 000 jobs over the long term.

A European Union report (Jurado et al., 2012) on biodiversity and the labour market showed that as many as 14.6 million jobs in the European Union, or 7%, are highly dependent on biodiversity. This proportion would likely be substantially higher in developing countries where rural populations are more closely dependent on biodiversity. It has been estimated that 927 million jobs, or 35% of the workforce, in developing countries are dependent on biodiversity (Nunes et al., 2010).

The National Biodiversity Economy Strategy (DEA, 2017) includes ambitious targets for employment related to biodiversity, including 100 000 new jobs in the wildlife sector and 10 000 new jobs in the bioprospecting sector, but with no clear baseline. The finalisation and implementation of the National Biodiversity Economy Strategy is likely to highlight the need for good information on biodiversity-related employment, so this work is timely from that point of view. In addition, SANBI has identified the number of biodiversity-related jobs in the country as a potential headline indicator of the socio-economic benefits of biodiversity, to be monitored over time and reported on in the National Biodiversity Assessment.<sup>1</sup> DEA has proposed the development of a Green Jobs Index, into which such an indicator of biodiversity-related employment could feed.

In this context, this working paper aims to:

- Establish guiding principles for understanding employment in the biodiversity sector through the development of a framework for defining biodiversity-related employment,
- Establish a systematic, repeatable method for measuring biodiversity-related employment in South Africa,
- Quantify current biodiversity-related employment, to establish a baseline for future work.

As a broader goal, we hope to offer an employment perspective on the potential contribution that South Africa's wealth of biodiversity assets can make towards national development objectives including inclusive growth and sustainable development.

The following specific research questions were identified:

1. What constitutes biodiversity-related employment, and can we develop a coherent framework for defining and measuring it?
2. What data is available for measuring biodiversity-related employment, and what are the key data gaps?
3. How many jobs are currently related to biodiversity assets and ecological infrastructure in South Africa?
4. Where are these biodiversity-related jobs located (e.g. by province, municipality, urban/rural)?
5. What types of jobs are related to biodiversity (e.g. temporary/seasonal/permanent, skilled/semi-skilled/unskilled)? Are there skills barriers or other barriers to entering employment in this sector?

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<sup>1</sup> The National Biodiversity Assessment is led by SANBI as part of its mandate to monitor and report on the state of South Africa's biodiversity. The NBA is undertaken approximately every seven years, with the NBA 2018 recently completed. Biodiversity-related employment was not included in the previous two NBAs (2004 and 2011), but has been highlighted as a key message in the NBA 2018 (Skowno et al., 2019) based on the work reported in this paper.

6. What proportion of biodiversity-related jobs are held by women, youth and people with disabilities?
7. What are the priorities for addressing data gaps, with a view to laying the foundation for further research in this area?

We recognised from the outset that questions 4, 5 and 6 were probably over-ambitious for this initial assessment, given data limitations. As discussed later in the paper, this indeed proved to be the case, so this paper focuses on questions 1, 2 and 3.

Possible longer term research questions that were identified at the outset were:

8. What is the potential for growth in biodiversity-related employment in South Africa, and how could such growth be facilitated and supported?
9. Are there significant policies, institutional, educational, financial or other blockages to growing employment in this sector, and if so how might they be addressed?

The paper is structured as follows:

- Section 2 introduces the **conceptual framework** for defining biodiversity-related employment.
- Section 3 on **methodology** presents and explains the three approaches we adopted in measuring biodiversity-related employment.
- Section 4 presents and compares the **results** from each of the three approaches, and uses them to develop an estimate of total biodiversity-related employment in South Africa.
- Section 5 **discusses** the results and examines the implications and opportunities presented by the findings, as well as priorities for future work.
- Section 6 summarises the **conclusions** of the study.
- The Annexure provides an **update** of the original results presented in Section 4.

## 2 Conceptual framework for biodiversity-related employment

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The starting point for measuring biodiversity-related employment was to conceptualise clearly what we mean by biodiversity-related employment, in order to guide the scope of the measurement effort. The intention was to limit the scope to employment in activities directly linked to biodiversity, and not to include indirect employment effects in the wider economy via multipliers. This section sets out the logic and rationale for a conceptual framework that was developed and refined iteratively, including through two workshop sessions held within SANBI, one in August 2014 and the second in December 2015.

The first step in developing the framework was deciding what constitutes biodiversity-related economic activity or the biodiversity economy. Jobs linked to biodiversity-related economic activity would then be considered biodiversity-related employment. However, defining the biodiversity economy is not straightforward, and there is no international consensus on a definition.

One challenge is to distinguish between the “green economy” and the biodiversity economy. The United Nations Environment Programme (UN Environment) defines the green economy as “an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP, 2013). This is a broad concept, often related to renewable energy, reduced waste and more sustainable business choices. There is not necessarily a direct link to biodiversity.

The Economics of Ecosystems and Biodiversity (TEEB), a global project led by UN Environment, recognises that there are two ways that business can be linked with biodiversity, firstly through business impacts on biodiversity and secondly through business dependence on biodiversity (TEEB, 2012). Most business activities have both impacts and dependencies on biodiversity, but some economic sectors are more likely to have stronger links through either their impacts or dependence on biodiversity. In practice, business activities that depend on biodiversity are less well described and have received less attention in discussions about business and biodiversity than those that impact (often negatively) on biodiversity.<sup>2</sup>

South Africa’s National Biodiversity Economy Strategy adapted a definition for the biodiversity economy proposed by the World Wide Fund for Nature (WWF) (Van Paddenburg et al., 2012). This definition encompasses “businesses and other economic activities that either directly depend on biodiversity for their core business or that contribute to conservation of biodiversity through their activities” (DEA, 2017). An important subset of the biodiversity economy is the wildlife economy or wildlife sector, which in South Africa is usually taken to mean game ranching and hunting conducted by the private sector for profit. Another subset of the biodiversity economy is the public sector whose primary objective is the conservation of biodiversity or the management of natural resources.

We have used the WWF/DEA definition of the biodiversity economy as the basis for the conceptual framework for biodiversity-related employment. Fundamental to this definition is that it sets out

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<sup>2</sup> Examples of business activities that impact negatively on biodiversity include mining, intensive agriculture and plantation forestry, which usually result in irreversible loss of natural vegetation as well as degradation of freshwater ecosystems such as rivers and wetlands.

two broad categories of biodiversity-related economic activities: those that contribute directly to conservation, and those that depend directly on biodiversity. It does not include activities simply because they attempt to reduce impacts on biodiversity or the natural environment, even though such activities might be considered part of the “green economy”.

Given this definition, biodiversity-related jobs can be separated into two broad categories: those that contribute to conserving biodiversity and those that utilise biodiversity. Generally speaking, conserving biodiversity is the role of government agencies and NGOs, while use of biodiversity often occurs within the private sector or on a subsistence basis. Within these two categories of biodiversity-related employment (BDE) we identified further sub-categories as follows:

- **BDE Category A: Conserving Biodiversity**, including employment in:
  - A1. Protecting and managing biodiversity assets
  - A2. Restoring and maintaining ecological infrastructure
  - A3. Research and professional services related to biodiversity
  
- **BDE Category B: Using Biodiversity**, including employment that depends on:
  - B4. Non-consumptive use of biodiversity
  - B5. Extractive use of biodiversity

It was important to consider the boundaries of the sub-categories carefully, and to clarify the logic for both inclusion and exclusion of economic activities from each. A brief description of the sub-categories is provided below.

#### **A1. Protecting and managing biodiversity assets**

*Jobs directly involved in conservation of the country's biodiversity assets, both ecosystems and species.* This includes management of protected areas and conservation areas,<sup>3</sup> and efforts to conserve particular species. It also includes efforts to mainstream biodiversity in planning and decision-making in biodiversity priority areas<sup>4</sup> outside of the protected area network.

#### **A2. Restoring and maintaining ecological infrastructure**

*Jobs aimed at restoring the functioning of ecosystems to improve their ability to generate and deliver valuable services to people.* This includes, for example, removing invasive alien plants to improve water supply and agricultural productivity, and restoring wetlands to improve water quality and prevent flooding. It also includes a range of natural resource management and catchment management activities that contribute to maintaining healthy ecosystems.

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<sup>3</sup> Protected areas are areas that are formally protected in terms of the National Environmental Management: Protected Areas Act (Act 57 of 2003). Conservation areas are not formally protected but are managed for conservation goals.

<sup>4</sup> Biodiversity priority areas are geographic areas that have been identified based on best available science as the areas that should remain in natural or at least semi-natural condition in order to secure a viable representative sample of ecosystems and species as well as the long-term ecological functioning of the landscape and seascape as a whole. These areas have been comprehensively identified and mapped across the country. Most of them fall outside major urban centres.

### **A3. Research and professional services related to biodiversity**

*Jobs that contribute to knowledge of biodiversity, forming the foundation for effective management of biodiversity as well as innovation in the management and sustainable use of biodiversity.* This includes the work of universities, other research institutions, biodiversity consulting services and biodiversity information management.

### **B4. Non-consumptive use of biodiversity**

*Jobs that depend on the enjoyment of biodiversity but do not involve extraction or consumption of the underlying biodiversity asset and can thus be sustained on a long-term basis.* This includes nature-based tourism (e.g. bird watching, whale watching, diving, hiking), some adventure sports, and production of media and art related to biodiversity (e.g. through nature journalism, photography, and film making). These activities can take place inside or outside of protected areas.

### **B5. Extractive use of biodiversity**

*Jobs that depend on the direct extraction or consumption of biodiversity in the form of indigenous species or ecosystems, either for profit or subsistence.* This includes:<sup>5</sup>

- game ranching and hunting,<sup>6</sup>
- rangeland agriculture (which depends on natural ecosystems such as Grassland and Karoo),
- harvesting of wild indigenous resources (e.g. fisheries, medicinal plants, wildflowers such as Proteas),
- biotrade (trade in harvested indigenous resources),
- cultivation of indigenous species (e.g. rooibos tea),
- horticulture and floriculture based on indigenous species,
- processing or manufacturing of products based on indigenous resources (e.g. fibres and building materials),
- bioprospecting (e.g. to develop pharmaceuticals, nutraceuticals, cosmetics based on indigenous species and genetic resources).

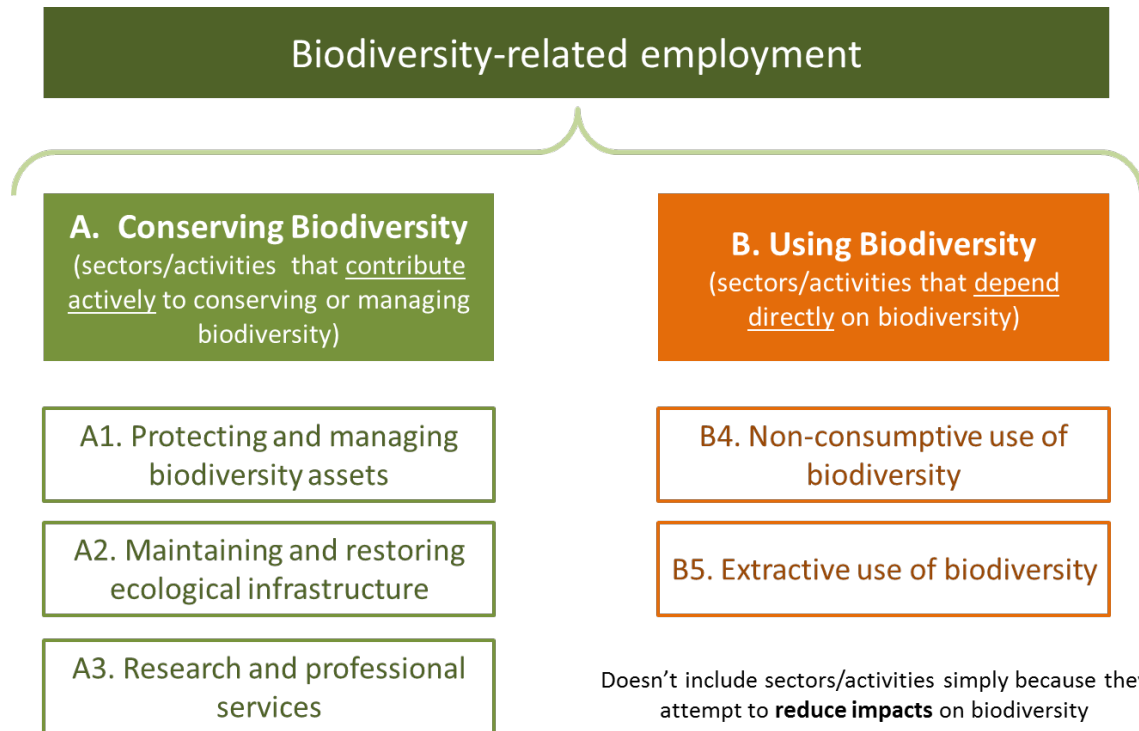
Some of these activities, such as game ranching, rangeland agriculture and harvesting of wild resources, can, at least in principle, be compatible with the long-term persistence of biodiversity if they are appropriately managed. Others, such as intensive cultivation or farming of indigenous species, such as rooibos tea, ostriches or game, almost always have substantial negative impacts on biodiversity as they result in outright and usually irreversible loss of natural ecosystems. All of these activities are included, partly because in practice it is often difficult to distinguish between products produced from wild-harvested indigenous resources and those from cultivated indigenous resources, and partly because cultivated or intensively farmed indigenous resources depend on indigenous genetic resources even if they are produced outside of their natural ecosystem context. *Not* included in this sub-category is intensive farming of non-indigenous species (i.e. conventional intensive agriculture or aquaculture).

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<sup>5</sup> This is not necessarily a comprehensive list, and some of these items might overlap depending on the definitions used (e.g. biotrade and bioprospecting, processing/manufacturing and bioprospecting). Nevertheless this can be considered a reasonable and adequate starting point for this research.

<sup>6</sup> Also referred to as wildlife ranching.

These two broad categories and five sub-categories of biodiversity-related economic activity, summarised in Figure 1, form a coherent conceptual framework for defining and classifying biodiversity-related employment, and provided the framework upon which our measurement of biodiversity-related employment was based.



**Figure 1: Conceptual framework for biodiversity-related employment, showing two broad categories and five sub-categories**



## 3 Methodology

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The methods developed here represent the first effort towards developing a standardised national methodology for measuring biodiversity-related employment. As discussed in Section 1, our aim is not simply to quantify biodiversity-related employment once-off, but also to establish methods that can be repeated at regular intervals to measure trends in biodiversity-related employment as a national indicator of the socio-economic benefits of biodiversity.

A key challenge for measuring biodiversity-related employment is that the jobs involved are scattered across the industry and occupational classifications that are conventionally used in the National Statistical System, which makes it difficult to extract data on biodiversity-related employment directly from national survey data. A similar challenge exists for using national survey data to quantify employment related to the tourism economy or “green jobs” related to the green economy. It arises because biodiversity-related economic activity, as with tourism-related economic activity, is not characterised by the primary activity of the firm. Firms are classified in terms of their primary activity or core activity, whereas the biodiversity economy or the tourism economy is a characteristic or objective that cuts across a range of primary activities. The same applies for occupations, although as discussed in Section 3.3 there is slightly more correspondence for occupation than for industry between biodiversity-related activities and the primary focus of some classes.

This challenge notwithstanding, we felt it was important to test whether it may in some cases be possible to link industry and occupation sub-classes either fully or partially to biodiversity-related economic activity, given that national survey data is readily available at regular intervals and presents a potentially convenient and cost-effective data source for measuring trends.

Recognising that data from the National Statistical System would probably provide only a partial picture, we also pursued two other approaches to gathering data on biodiversity-related employment:

- Administrative data, which we hoped would be relatively readily available for at least some biodiversity-related employers, especially public sector organisations,
- Existing estimates of employment arrived at through studies of particular biodiversity-related sectors or sub-sectors, which we knew to exist in some instances.

Since a wide range of differing data sources was used, broad levels of confidence were attached to the estimates derived from each data source based on its perceived strengths and weaknesses for the purpose of this research.

### 3.1 Administrative data

Using the conceptual framework for biodiversity-related employment as a starting point, we developed lists of organisations involved in biodiversity-related activities in different categories, based on our extensive working knowledge of the sector. The focus was mainly on BDE Category A: Conserving Biodiversity, which is made up predominantly of public sector organisations and NGOs. In

BDE Category B: Using Biodiversity, a very wide range of firms, households and communities are involved, so it was not possible to develop a comprehensive list, but we did list organisations such as industry associations where possible.<sup>7</sup>

In BDE Category A, 146 organisations were identified and grouped as shown in Table 1. The full list of organisations is provided in an expanded version of this table in Appendix 1. We attempted to be as comprehensive as possible, but may have missed some organisations. Feedback on these initial results will help to identify gaps that can be addressed in future work.

Within BDE Category A, it was important to distinguish between three different types of organisations:

- Organisations whose central mandate / core function is related to conserving and/or managing biodiversity,
- Organisations for which conserving and/or managing biodiversity forms an explicit part of a broader environmental mandate or function,
- Organisations which play a substantial role in relation to managing biodiversity, but for which this is secondary to their central mandate (which might be, for instance, water resource management or agriculture).

This distinction is reflected in Table 1, and its implications for the methodology are discussed below.

**Table 1: Biodiversity-related employers included in the administrative data gathering process, showing whether the organisation’s core mandate or function is biodiversity-related**

Organisations included	Biodiversity = all or part of core mandate /function	Biodiversity = secondary mandate/function
<b>BDE Sub-category A1: Protecting and managing biodiversity assets</b>		
Department of Environmental Affairs (relevant sections)	✓	
Other national departments (relevant sections) <ul style="list-style-type: none"> <li>• Department of Water &amp; Sanitation</li> <li>• Department of Agriculture, Forestry &amp; Fisheries</li> <li>• Department of Mineral Resources</li> <li>• South African Police Services</li> <li>• South African Revenue Services</li> </ul>		✓
Public entities related to biodiversity <ul style="list-style-type: none"> <li>• South African National Biodiversity Institute (including National Botanical Gardens)</li> <li>• South African National Parks</li> <li>• iSimangaliso Wetland Park Authority</li> <li>• National Zoological Gardens</li> </ul>	✓	

<sup>7</sup> In future, it may be possible to source bioprospecting permits from DEA, for which applicants are required to disclose employment figures. This could contribute towards estimates for Sub-category B5.

<b>Organisations included</b>	<b>Biodiversity = all or part of core mandate /function</b>	<b>Biodiversity = secondary mandate/function</b>
Provincial departments of environmental affairs (relevant sections/ programmes) (In some provinces, the environmental affairs department incorporates the provincial conservation authority; other provinces have a stand-alone conservation agency)	✓	
Provincial conservation agencies <ul style="list-style-type: none"> <li>• CapeNature (Western Cape)</li> <li>• Eastern Cape Parks and Tourism Agency</li> <li>• Ezemvelo KwaZulu-Natal Wildlife</li> <li>• Mpumalanga Tourism and Parks Agency</li> <li>• North West Parks &amp; Tourism Board</li> </ul>	✓	
Provincial departments of agriculture (relevant programmes/sections)		✓
Metropolitan municipalities (relevant sections) <sup>8</sup> <ul style="list-style-type: none"> <li>• Buffalo City Metropolitan Municipality</li> <li>• City of Cape Town</li> <li>• City of Johannesburg (including Johannesburg City Parks and Zoo)</li> <li>• City of Polokwane</li> <li>• City of Tshwane</li> <li>• eThekweni Municipality</li> <li>• Mangaung Metropolitan Municipality</li> <li>• Nelson Mandela Bay Metropolitan Municipality</li> </ul>		✓
Conservation NGOs (32 of these)	✓	
Other conservation-related organisations and projects	✓	
<i>Total number of organisations in Sub-category A1</i>		<b>83</b>
<b>BDE Sub-category A2: Restoring and maintaining ecological infrastructure</b>		
Expanded Public Works Programme – DEA Environmental Programmes <ul style="list-style-type: none"> <li>• Staff of Environmental Programmes branch</li> <li>• Work opportunities created in Working for Water, Working for Wetlands, Working on Fire, Working for Land, Working for Coasts</li> </ul>	✓	
Expanded Public Works Programme – other relevant elements <ul style="list-style-type: none"> <li>• Department of Public Works: EPWP Programme</li> <li>• Department of Agriculture, Forestry &amp; Fisheries: LandCare Programme, Working for Fisheries</li> <li>• Department of Water and Sanitation: Adopt-a-River Project</li> </ul>		✓
Catchment Management Agencies (relevant staff) <ul style="list-style-type: none"> <li>• Inkomati Catchment Management Agency</li> <li>• Breede Overberg Catchment Management Agency</li> </ul> (These are the two Catchment Management Agencies that have been established, out of a potential nine)		✓
NGOs involved in restoration and maintenance (5 of these)	✓	
<i>Total number of organisations in Sub-category A2</i>		<b>12</b>

<sup>8</sup> Most metropolitan municipalities have a unit or section that deals with biodiversity-related issues, with at least some staff (in some cases quite large numbers) dedicated to biodiversity-related work. The same may be true for some district and local municipalities, but it was not feasible to include district and local municipalities at this stage – it may be worth exploring this in future work.

Organisations included	Biodiversity = all or part of core mandate /function	Biodiversity = secondary mandate/ function
<b>BDE Sub-category A3: Research and professional services related to biodiversity</b>		
Government research institutions and agencies <ul style="list-style-type: none"> <li>• Department of Science &amp; Technology (relevant sections)</li> <li>• Agricultural Research Council (ARC)</li> <li>• Council for Scientific and Industrial Research (CSIR)</li> <li>• South African Environmental Observations Network (SAEON)</li> <li>• South African Institute of Aquatic Biodiversity (SAIAB)</li> <li>• Water Research Council (WRC)</li> <li>• Museums (natural history components)</li> </ul>		✓
Education and training related to biodiversity <ul style="list-style-type: none"> <li>• Universities (staff of relevant departments, such as Botany, Zoology, Life Sciences, Ecology)</li> <li>• Colleges specialising in wildlife</li> <li>• Relevant education NGOs</li> </ul>		✓
Human capital development programmes related to biodiversity <ul style="list-style-type: none"> <li>• Groen Sebenza Programme</li> <li>• DEA's Environmental Monitors</li> </ul>	✓	
Media organisations (relevant staff)		✓
Membership organisations and associations (staff of the organisation) <ul style="list-style-type: none"> <li>• South African Association of Botanists</li> <li>• South African Council for Natural Scientific Professions (SACNASP)</li> <li>• Southern African Institute of Ecologists and Environmental Scientists (SAIEES)</li> </ul>		✓
Biodiversity specialists registered with SACNASP and SAIEES <sup>9</sup>	✓	
<i>Total number of organisations in Sub-category A3</i>		<b>51</b>
<b>Total number of organisations in BDE Category A</b>		<b>146</b>
<b>BDE Sub-category B4: Non-consumptive use of biodiversity</b>		
No administrative data found for this category.		
<i>Total number of organisations in Sub-category B4</i>		<b>0</b>
<b>BDE Sub-category B5: Consumptive or extractive use of biodiversity</b>		
Membership organisations and associations for biodiversity-related industries (staff of the organisation) <ul style="list-style-type: none"> <li>• Professional Hunting Association of South Africa (PHASA)</li> <li>• National Confederation of Hunters Associations of South Africa</li> <li>• Protea Producers of South Africa</li> <li>• Southern African Wildlife Management Association (SAWMA)</li> <li>• South African Flower Export Council</li> <li>• South African Hunters and Game Conservation Association (SAHGCA)</li> <li>• Cape Flora South Africa</li> <li>• Wildlife Ranching South Africa</li> </ul>		✓

<sup>9</sup> We recognise that this may result in some double-counting, as some of these specialists may work for an organisation already included in the list. Others may be independent consultants who would otherwise not be counted. However, the numbers are relatively small and we included only 50% of the registered consultants in the final results.

<b>Organisations included</b>	<b>Biodiversity = all or part of core mandate /function</b>	<b>Biodiversity = secondary mandate/function</b>
Bioprospecting and natural products – specific projects/initiatives <ul style="list-style-type: none"> <li>• Council for Scientific and Industrial Research: Bioprospecting section</li> <li>• Individual bioprospecting projects granted permits by DEA (includes harvesting, processing and distribution of the biodiversity resources concerned)</li> </ul>		✓
Game ranching and hunting <ul style="list-style-type: none"> <li>• Certain private game reserves and game farms for which studies are available</li> </ul>		✓
Indigenous flower harvesting and floriculture – specific projects/initiatives <ul style="list-style-type: none"> <li>• Flower Valley Conservation Trust</li> </ul>	✓	
<i>Total number of organisations in Sub-category B5</i>		<b>12</b>
<b>Total number of organisations in BDE Category B</b>		<b>12</b>
<b>Total number of organisations across all categories</b>		<b>158</b>

For the organisations in BDE Category A, relevant external data sources on employment were identified and accessed. Data sources included:

- Annual reports, usually downloaded from the organisation’s website,
- Websites of the organisations concerned, which were consulted for information about numbers of employees and the organisation’s mandate and programmes.

This was supplemented in some cases by primary data collected through email and telephone correspondence with key informants, usually one or more staff members in the organisation, who provided further information on request.

Administrative data were collected preferably for 2014, but in some cases for 2013 or 2012.<sup>10</sup> This was not considered a major limitation, as job numbers in the organisations concerned do not usually fluctuate greatly from year to year.

For those organisations whose core mandate focuses on biodiversity, we counted all employees as contributing to biodiversity-related employment, including jobs in supporting functions such as administration, finance and marketing. All employment within the organisation was regarded as biodiversity-related since if it was not for biodiversity functions the other jobs would become obsolete. We did not include board members and/or trustees of these organisations as they are not considered to be employees. Examples of organisations for which this applied are SANBI, South African National Parks (SANParks), provincial conservation agencies and conservation NGOs.

For organisations that have part of their mandate related to biodiversity as part of a broader environmental mandate, we included those programmes or sections directly focused on biodiversity,

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<sup>10</sup> For example, in a few cases provincial agencies did not have annual reports for 2014 on their websites at the time the administrative data collection was undertaken, and in another few cases the information needed to extract the biodiversity-related employment figures was much more straightforwardly presented in the 2012 or 2013 report.

as well as a portion of the jobs in other programmes likely to include biodiversity elements. In most cases it was possible to identify these from annual reports, which usually categorise employment per programme of work or function. Jobs in support functions or corporate services were excluded. Examples of organisation for which this applied are DEA and provincial environmental affairs departments and metropolitan municipalities. Notes on decisions about what portion of jobs to include are detailed in a spread sheet available on request.<sup>11</sup>

Organisations for which biodiversity is a secondary part of their function or mandate generally do not have specific programmes or sections dedicated to biodiversity-related work, but include biodiversity related aspects in some of their programmes. For example, provincial departments of agriculture usually have sustainable resource management programmes which are likely to deal with some biodiversity issues, especially related to ecological infrastructure. For these organisations we included a proportion of the jobs in relevant programmes. Again, notes on decisions made are detailed in a spread sheet available on request.<sup>12</sup>

For biodiversity-related work opportunities created through the Expanded Public Works Programme (EPWP), we decided to present the number of jobs based on full-time-equivalents (FTEs) rather than the total number of short-term work opportunities created. The reasons for this are discussed in Section 4.1.

Levels of certainty or confidence are relatively high for administrative data for organisations whose core mandate is biodiversity-related, as it is a relatively straightforward matter to acquire total employment numbers for these organisations, and in most cases these numbers are likely to be relatively stable.

For organisations with only part of their mandate related to biodiversity, or with biodiversity as a secondary mandate, confidence levels for administrative data are medium. Uncertainty is introduced because in some cases assumptions have to be made about which programmes or sections of these organisations should be counted as biodiversity-related. For future work, it may be worth spending time interviewing key informants in these organisations to verify which programmes or positions should be considered biodiversity-related.

A further source of uncertainty is whether we have included all relevant organisations – we welcome suggestions for additions.

### 3.2 Existing sector estimates

As discussed in Section 2, the biodiversity economy includes several identifiable commercial or subsistence sectors or sub-sectors that depend on biodiversity (such as nature-based tourism, game

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<sup>11</sup> For example, in provincial environmental affairs departments we counted a portion of the jobs in programmes that are likely to have a biodiversity-related element, such as compliance monitoring and enforcement and environmental authorisations. We used the following rule to estimate the proportion: if there was a standalone provincial conservation agency (i.e. a public entity or board separate from the environmental affairs department), we counted 20% of staff in relevant environment programmes, based on the assumption that the biodiversity-related aspects would be carried out mainly by the conservation agency; if the provincial conservation authority was part of the department we counted 40% of staff in relevant environment programmes.

<sup>12</sup> For example, in provincial departments of agriculture we counted 40% of staff in programmes dealing with sustainable resource management, including LandCare programmes.

ranching and hunting, fisheries and traditional medicine). For some of these sectors, studies have been done estimating their size, for example their contribution to the economy and to employment. We decided to source relevant reports and papers to glean information about biodiversity-related employment where possible.

Our preference was that estimates should:

- Include jobs throughout the industry value-chain (for example, in the game ranching industry this would include ranch management, accommodation on ranches, hunting activities, and taxidermy; in the rooibos tea industry this would include cultivation or harvesting, processing, packaging, and production of rooibos-based products such as cosmetics and nutraceuticals),
- Include only employment in activities directly linked to the industry or sub-sector, not indirect employment effects in the wider economy via multipliers,
- Be based on primary research, such as sample surveys or gathering first-hand information from key industry stakeholders.

A challenge with existing sector estimates is that they come predominantly from grey literature, with varying degrees of reliability, and are frequently not up-to-date. In some sectors, a particular figure for the number of jobs is repeatedly cited and becomes accepted wisdom, with no source provided and no description of what the figure encompasses. It took some detective work in these cases to track down the original source of the figure. This is discussed further in Section 4.2.

The studies found for the larger sectors that make up the bulk of the employment numbers from this data source (traditional medicine, game ranching and fisheries) seem to be credible and well considered – see Section 4.2 for further discussion of these studies. Nevertheless, overall levels of confidence in the sub-sector estimates are lower than levels of confidence in the administrative data. It may be worthwhile to explore whether data from the Quarterly Employment Survey (see Section 3.3) could be used to cross-check some of the existing estimates in BDE Category B.

A further key weakness for this data source is that we have estimates for only a subset of biodiversity-related sectors, with many gaps. This means that adding up the various employment figures from these sector estimates does not yield a comprehensive total. This is discussed further in Section 4.2. Future work should include more comprehensive secondary research to identify existing estimates for further biodiversity-related sub-sectors, and primary research to develop estimates for sectors that are likely to be significant contributors to employment.

### **3.3 Survey data from the National Statistical System**

In South Africa, labour market surveys are undertaken by Statistics South Africa. Two types of surveys are used, the Quarterly Labour Force Surveys (QLFS) and Quarterly Employment Survey (QES). The QES is a quarterly survey of approximately 20 000 VAT-registered businesses, and it provides detailed information regarding the number of persons employed in South Africa's non-agricultural formal sector, as well as their gross and average monthly earnings for the reference quarter. The QLFS, on the other hand, is a household-based sample survey which collates data on the number of people who are employed (across formal and informal sectors), unemployed or not economically active. The QLFS is conducted in 30 000 private households and worker hostels across South Africa, after which the data is weighted to provide estimates that are representative of the

South African population as a whole. QLFS data are compiled annually into the Labour Market Dynamics Survey (LMDS) data, which is made up of data from the four QLFS surveys.

Although the two surveys are complementary, the QLFS was preferred as a source of data in this research since the QES is limited to formal, VAT-registered and non-agricultural businesses while the QLFS takes into account both the formal and informal sectors of the economy. Furthermore, Statistics South Africa does not publish detail below the one-digit level of industry for the QES data, so any use of these data would require extensive engagement to access information that is not in the public domain. As noted in Section 3.2, the QES may be useful for further work in cross-checking existing sector estimates for BDE Category B.

Those QLFS respondents who are employed are required to give a brief description of the type of work they do, which is used to assign each respondent to an industry and an occupation, based on the Standard Industrial Classification (SIC) and the South African Standard Classification of Occupations (SASCO). These are hierarchical classification systems that use a set of nested codes to classify industries and occupations from broad through to detailed levels. As discussed earlier, biodiversity-related industries and occupations cut across the codes used in SIC and SASCO in most cases, making it challenging to identify biodiversity-related industries and occupations. Nevertheless, some of the codes at the more detailed levels can be linked to biodiversity.

Using the Standard Industrial Classification 5<sup>th</sup> edition and SASCO 2003,<sup>13</sup> we worked through the industry codes and descriptions at the 3-digit level, and the occupation codes and descriptions at the 4-digit level, and assigned each of them to one of four groups:

- **All or most** jobs related to biodiversity (> 80%)
- **Some** jobs related to biodiversity (between 20% and 80%)
- **Few** jobs related to biodiversity (< 20%)
- **No** jobs related to biodiversity (0%)

In many cases it was clear which group a particular code should fall into; in others a judgement call was required. Decisions were made based on the description for each code, combined with our knowledge of industries and occupations that contribute directly to conserving biodiversity or depend directly on biodiversity. The groups were kept broad, reflecting the fact that in most cases there was insufficient basis for finer divisions. Notes on the decisions about allocation of codes to groups have been documented in a spread sheet which is available on request, and in further work it may be worth revisiting these decisions and testing them with a wider group of expert informants.

Table 2 and Table 3 list the industry and occupation codes that were identified as being biodiversity-related in all or most / some / few cases. In each case, the number of codes for which all or most jobs are considered biodiversity-related is notably small, as summarised in Table 4 – just two industry codes (1% of the total number of 3-digit codes) and six occupation codes (1.4% of the total number of 4-digit codes).

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<sup>13</sup> These are the versions used in the QLFS.



**Table 2: Industry codes selected as biodiversity-related from the full set of 3-digit level codes in the Standard Industrial Classification**

Industry code (3-digit level)	Industry description	Group based on estimated proportion related to biodiversity			BDE category
		All or most (estimate >80% BDE)	Some (estimate 20-80% BDE)	Few (estimate <20% BDE)	
115	Game hunting, trapping and game propagation, including related services	✓			B5
131	Ocean and coastal fishing	✓			B5
641	Hotels, camping sites and other provision of short stay accommodation		✓		B4
964	Sporting and other recreational activities		✓		B4
112	Farming of animals			✓	B5
121	Forestry and related services			✓	A2
315	Dressing and dyeing of fur; manufacture of articles of fur			✓	B5
871	Research and experimental development on natural sciences and engineering			✓	A3
911	Central government activities			✓	A1
914	Provincial administrations			✓	A1
920	Education			✓	A3
932	Veterinary activities			✓	A1
951	Activities of business, employers and professional organisations			✓	A3*
959	Activities of other membership organizations			✓	A3*
961	Motion picture, radio, television and other entertainment activities			✓	B4
963	Library, archives, museums and other cultural activities			✓	A3

Table note:

\* These two codes were difficult to allocate to a BDE category, as they could belong to any of the five categories. Our decision to allocate them to A3 is relatively arbitrary. The results for these codes from QLFS 2014 were 634 and 1988 respectively, which did not influence the overall results greatly. Another option would be to divide the number of jobs for these codes equally between all five sub-categories.

**Table 3: Occupation codes selected as biodiversity-related from the full set of 4-digit level codes in the South African Standard Classification of Occupations**

Occup code (4-digit level)	Occupation description	Group based on estimated proportion related to biodiversity			BDE category
		All or most (estimate >80% BDE)	Some (estimate 20-80% BDE)	Few (estimate <20% BDE)	
2211	Biologists, botanists, zoologists and related professionals	✓			A3
3241	Traditional medicine practitioners	✓			B5

Occup code (4-digit level)	Occupation description	Group based on estimated proportion related to biodiversity			BDE category
		All or most (estimate >80% BDE)	Some (estimate 20-80% BDE)	Few (estimate <20% BDE)	
6152	Inland and coastal waters fishery workers	✓			B5
6153	Deep-sea fishery workers	✓			B5
6154	Hunters and trappers	✓			B5
9213	Fishery, hunting and trapping labourers	✓			B5
1221	Production and operations managers/department managers in agriculture, hunting, forestry, fishing and mining		✓		B5
1225	Production and operations managers/department managers in hotels, restaurants and other catering and accommodation services		✓		B4
1311	General managers in agriculture, hunting, forestry and fishing		✓		B5
1315	General managers of hotels, restaurants and other catering or accommodation services		✓		B4
2212	Biological sciences, Chemical sciences, Medical sciences, Physical sciences and Veterinary sciences		✓		A3
3111	Natural science technicians		✓		A3
6210	Subsistence agricultural and fishery workers		✓		B5
7121	Builders, traditional materials		✓		B5
7424	Basketry weavers, brush makers and related workers (including apprentices/trainees)		✓		B5
1120	Senior government officers			✓	A1
1143	Senior officers of humanitarian and other special-interest organisations			✓	A1
1210	Directors and chief executives			✓	**
2210	Scientist			✓	A3
2213	Agronomists, food scientists and related professionals, Agriculture, forestry and food scientists, Natural sciences technologists			✓	A3
2223	Veterinarians			✓	A1
2290	Life science and health professionals not elsewhere classified			✓	A3
2310	Technikon, teacher training, technical and other colleges, university and other higher education institutions teaching professionals and Other post-secondary education teaching professionals			✓	A3
2431	Archivists and curators			✓	A3

Occup code (4-digit level)	Occupation description	Group based on estimated proportion related to biodiversity			BDE category
		All or most (estimate >80% BDE)	Some (estimate 20-80% BDE)	Few (estimate <20% BDE)	
2451	Authors, journalists and other writers, Editors, Reporters, journalists, Writers, poets, playwrights and Other writers, commentators, proof-readers			✓	B4
2452	Sculptors, painters and related artists			✓	B4
3131	Photographers and image recording equipment operators, Sound recording equipment operators			✓	B4
3211	Life science technicians, Biological science and Medical science			✓	A3
3213	Farming and forestry advisers/consultants			✓	A3
3227	Veterinary assistants			✓	A1
3242	Faith healers			✓	B4
3444	Government licensing officers			✓	A2
4211	Cashiers and ticket clerks			✓	B4
5113	Travel guides			✓	B4
5161	Fire-fighters			✓	A2
5169	Protective services workers not elsewhere classified, Rangers and game wardens			✓	A1
6113	Gardeners, horticultural and nursery growers (farm owners and skilled farm workers)			✓	B4
6121	Dairy and livestock producers (farm owners and skilled farm workers)			✓	B5
6123	Apiarists and sericulturists (farm owners and skilled farm workers)			✓	B4
6141	Forestry workers and loggers			✓	A2
6190	Market-oriented skilled agricultural and fishery workers not elsewhere classified			✓	B5
6211	Subsistence farmers			✓	B5
7331	Handicraft workers in wood and related materials (including apprentices/trainees)			✓	B5
7332	Handicraft workers in textile, leather and related materials (including apprentices/trainees)			✓	B5
9211	Farmhands and labourers			✓	B5
9212	Forestry labourers			✓	A2
9290	Agricultural, fishery and related labourers not elsewhere classified			✓	B5

Table note:

\*\* In this case it is not possible to say which of the five categories of BDE is most likely to apply. The result for this code for QLFS 2014 was 3 997, which we divided equally between all five sub-categories.

**Table 4: Number and percentage of industry and occupation codes for which all or most / some / few / no jobs are estimated to be biodiversity-related**

	All or most	Some	Few	None	Total number of codes
<b>Industry codes (3-digit)</b>	2 (1%)	2 (1%)	12 (5.9%)	186 (92.1%)	202
<b>Occupation codes (4-digit)</b>	6 (1.4%)	9 (2.1%)	32 (7.4%)	384 (89.1%)	431

The LMDS data (comprising QLFS data pooled annually) for the years 2008 to 2014 were sourced and estimates for the relevant industry codes and occupations codes were extracted with assistance from the DPRU.

For each group of codes (All or most, Some, Few), a decision was necessary about the proportion of QLFS estimate that should be used to calculate the number of biodiversity-related jobs. The proportions used are shown in Table 5, together with alternative proportions that we used for sensitivity testing. The choice of these proportions was ultimately arbitrary but erred on the side of being conservative, with the proportion used in each case falling closer to the bottom than the top of the range. In further work, a process of triangulating the results based on this approach with administrative data and sub-sector research may help to refine the proportions on the basis of evidence, and we may want to take a more nuanced approach of using different proportions for different codes within a group instead of a blanket proportion per group.

**Table 5: Proportions used to calculate number of biodiversity-related jobs from QLFS estimates**

Group to which industry/occupation code allocated	Proportion used to calculate number of biodiversity-related jobs	Alternative proportions for sensitivity testing	
		Conservative	Generous
<b>All or most</b> (estimate >80% BDE)	85%	80%	90%
<b>Some</b> (estimate 20-80% BDE)	40%	30%	50%
<b>Few</b> (estimate <20% BDE)	3.5%	1%	5%

## 4 Results

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This section sets out the results based on administrative data, existing sector estimates and survey data, compares and contrasts these, and presents an aggregate estimate of biodiversity-related employment based on the data source judged to be most reliable for each BDE sub-category.

The results presented here are those from the original work undertaken between 2014 and 2016. Some data sources and estimates were subsequently updated in 2019. The updated results are reported in the Annexure.

### 4.1 Results based on administrative data

Results from the administrative data are summarised in Table 6 for BDE Category A: Conserving Biodiversity. Administrative data for BDE Category B: Using Biodiversity were insufficient to provide a meaningful result, so we report administrative results only for Category A. The bulk of Category A is accounted for by the public sector and NGOs, for which administrative data is relatively reliable. We thus have good confidence in these estimates. Uncertainty is introduced in some cases through having to estimate what proportion of jobs within a particular organisation, or within a particular section/programme within an organisation, are related to biodiversity. As explained in Section 3, this was done mainly based on descriptions in annual reports or on our knowledge of the types of work likely to be undertaken by different organisations. Further work may be warranted to verify or refine these estimates by engaging with key informants in the organisations concerned.

*The total number of jobs in BDE Category A based on administrative data was just over 61 000 in 2014. A third of these, just more than 20 000, were in Sub-category A1: protecting and managing biodiversity assets, which includes the management of South Africa's more than 500 state-owned protected areas totalling over 80 000 km<sup>2</sup>,<sup>14</sup> as well as work beyond the boundaries of protected areas to ensure that priority biodiversity assets in a range of landscape and seascape settings are appropriately managed. Public entities (including SANParks and SANBI) and provincial conservation authorities accounted for the bulk of the jobs in Sub-category A1.*

A further 59% of the jobs in BDE Category A were in Sub-category A2: Restoring and maintaining ecological infrastructure, with jobs related to the Expanded Public Works Programme (EPWP) making up by far the bulk of these. Public employment schemes have featured in job creation and poverty alleviation efforts in South Africa post-1994, predominantly in the form of EPWP, which is co-ordinated by the Department of Public Works and implemented by various government departments. Maintaining and restoring ecological infrastructure has been a strong focus of EPWP from the outset, particularly in DEA's Environmental Programmes, which include Working for Wetlands, Working on Fire, Working for Land and Working for Coasts. The Department of Agriculture, Forestry and Fisheries (DAFF)'s Working for Fisheries and LandCare programmes are also part of EPWP but have not been implemented on nearly as large a scale.

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<sup>14</sup> Dr Stephen Holness (Nelson Mandela University), pers. comm. Feb 2016.

As mentioned in Section 3.1, we decided to present the number of jobs related to EPWP in terms of full-time-equivalents (FTEs) rather than the total number of short-term work opportunities created. FTEs are more compatible with the notion of employment or jobs than is the concept of work opportunities (e.g. 365 work opportunities could in fact be one job that is filled by a new person every day of the year). The results reported here show why this approach is necessary. The total of 35 575 jobs for DEA's Environmental Programmes in Table 6 consists of 252 staff within DEA's Environmental Programmes branch, and 35 323 FTEs which comprised more than 1 million work opportunities in 2014. Presenting the number of jobs in terms of work opportunities would unduly inflate the figures for Sub-category A2, and would explode the overall estimate of biodiversity-related employment, reducing its credibility. Further, our view is that the work involved in maintaining and restoring ecological infrastructure is ongoing and long-term, and should preferably be undertaken not primarily through short-term work opportunities. As such, FTEs provide a more meaningful estimate of the number of full-time jobs that might be involved in this work. We return to this issue in Section 5.

The remaining 8% of the jobs in BDE Category A were in Sub-category A3: Research and professional services related to biodiversity, and included jobs in government agencies and universities related to research and teaching, as well as specialist consultants.

**Table 6: Number of biodiversity-related jobs based on administrative data, for BDE Category A (2014)\***

Number of jobs	BDE Category		
	A. Conserving biodiversity		
	A1 Protecting & managing	A2 Restoring & maintaining	A3 Research & professional services
<b>Biodiversity-related employers**</b>			
Department of Environmental Affairs (relevant branches)	314		
Other national departments (relevant sections)	2 195		
Public entities related to biodiversity	5 700		
Provincial departments of environmental affairs	929		
Provincial conservation agencies	6 155		
Provincial departments of agriculture (relevant programmes/sections)	1 624		
Metropolitans municipalities (relevant sections)	1 206		
Conservation NGOs	1 770		
Other conservation-related organisations and projects	481		
EPWP: DEA Environmental Programmes		35 575***	
EPWP: Other relevant elements		711	
Catchment Management Agencies		48	
NGOs involved in restoration and maintenance		86	
Government research institutions and agencies			806

Education and training related to biodiversity (relevant staff)			1 270
Human capital development programmes related to biodiversity			2 241
Media organisations (relevant staff)			6
Membership organisations and associations (staff of the organisation)			17
Biodiversity specialists registered with SACNASP and SAIEES			310
<i>Total employment per sub-category</i>	<i>20 373 (33%)</i>	<i>36 420 (59%)</i>	<i>4 650 (8%)</i>
<b>Total employment for BDE Category A</b>	<b>61 443 (100%)</b>		

Table notes:

\* As explained in the text, in a few cases figures for 2013 or 2012 were used.

\*\* See Table 1 for a full list of the organisations included in each row.

\*\*\* This figure includes 35 323 full-time-equivalents which comprise more than 1 million short-term work opportunities – see further discussion in text.

## 4.2 Results from existing sector estimates

Results based on existing sector or sub-sector estimates are summarised in Table 7, with just over 230 000 jobs across four sectors, all within BDE Sub-category B5: Extractive use of biodiversity. Each estimate is discussed further below.

**Table 7: Summary of existing sector estimates and job numbers, for BDE Sub-category B5**

Industry sector or sub-sector	Description	Source	Number of jobs (rounded to '000s)
<b>BDE Category B5: Extractive use of biodiversity</b>			
Trade in traditional medicine	Estimate includes the whole traditional medicine industry value chain i.e. harvesters, healers, street traders, transportation, wholesale, processing and packaging of muti.	Mander et al. 2007	133 000
Game ranching and hunting	Estimate restricted to permanent employment directly on game ranches. Excludes temporary employment and employment in related industries such as wildlife translocators, fencing businesses, and taxidermists.	Taylor et al. 2015	65 000
Fisheries	Estimate for commercial fisheries only, not subsistence fisheries. Includes activities related to harvesting, processing and marketing of wild-caught fish.	Mather et al. 2003, Sauer et al. 2003	28 000
Indigenous tea production	Estimate includes: <ul style="list-style-type: none"> <li>Rooibos tea industry (whole value chain i.e. harvesting, production/cultivation, fermenting, drying, packaging)</li> <li>Honeybush tea industry (whole value chain i.e. harvesting, production/cultivation, retail packaging plants, distribution, marketing and export research and maintenance)</li> </ul>	DAFF 2012a, DAFF 2012b	6 000
<b>Total number of estimates</b>	<b>4</b>	<b>Total number of jobs</b>	<b>232 000</b>

The largest estimates are for trade in traditional medicine, and game ranching and hunting. The estimate of over 133 000 jobs related to trade in traditional medicine comes from a paper by Mander et al. (2007), which synthesises the research findings from four seminal studies. It deals with the full range of activities linked to the trade, including plant harvesters (63 000), street traders (3 000) and full-time traditional healers (68 000). Mander et al. stress that many of the people involved are rural women. This work is dated, but we decided to include it because of the major contribution of this sector, which is likely to have been a relatively stable sector not subject to major market fluctuations. As will be seen in Section 4.3, the QLFS 2014 estimate for traditional medicine practitioners was over 45 000 people, which is reasonably consistent with Mander et al.'s figure of 68 000 traditional healers.<sup>15</sup>

The estimate of 65 172 jobs (rounded to 65 000 here) in game ranching and hunting comes from a study led by the Endangered Wildlife Trust, funded through the Development Bank of Southern Africa's Green Fund (Taylor et al., 2015). Based on a detailed survey of 251 game ranches in 2014 (out of an estimated 9 000 game ranches nationally), the median number of permanent employees per hectare was extrapolated to the estimated area of 170 000km<sup>2</sup> over which game ranches occurs in South Africa. The estimate is for permanent employment directly on game ranches, and excludes temporary employment and employment in related industries such as wildlife translocators, fencing businesses, and taxidermists. The median salary per person per month was R3 441.

The estimate we found initially for fisheries was 27 000 jobs, which is cited in many DAFF documents (such as annual reports and the Integrated Growth and Development Plan for Agriculture Forestry and Fisheries produced in 2012) without an explicit source. This estimate appears to originate from a detailed study commissioned by the Department of Environmental Affairs and Tourism in 2000 and led by Rhodes University. The study included a survey of all commercial fisheries right holders and processing establishments, with a response rate of 87%. The total number of jobs was found to be 27 730, which we have rounded to 28 000, the bulk of which came from the line fish, squid, hake, rock lobster and tuna fisheries. A wealth of information is reported in two volumes (Mather et al., 2003; Sauer et al., 2003) including information about the demographic profile and incomes from the industry. This work is dated, but given the high quality of the information and the substantial contribution of the fisheries sector we decided to include it. In future it may be possible to update this figure based on knowledge of trends in the industry and complementary data from the QLFS and QES. The figure of 28 000 is for commercial fisheries only, and does not include livelihoods supported by subsistence fisheries.<sup>16</sup>

The estimate of 6 000 jobs in indigenous tea production is based on profiles produced by DAFF of the rooibos tea and honeybush tea industries (DAFF, 2012a; DAFF, 2012b). Although the methodology for arriving at job numbers is not explicit, it seems to be based on detailed information provided by key industry stakeholders. The estimate includes 5000 jobs in the rooibos industry (including jobs on

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<sup>15</sup> Of these 45 000 people, we included 85% or 38 740 in the final results in reported in Table 10.

<sup>16</sup> Subsistence fisheries are reported in many DAFF documents to support 28 000 households, but it is not clear where this figure comes from.



350 – 500 farms and in eight large processors, both temporary and permanent), and 780 jobs in honeybush (including jobs in harvesting, processing, distribution, research). The honeybush tea profile notes that current supply is not able to keep up with demand.

A frequently cited estimate of 17 500 jobs in floriculture in South Africa seems to originate from a study by Kaiser Associates (2000). It deals with traditional greenhouse floriculture as well as indigenous floriculture, and points out that demand for South African indigenous products (especially Proteas and other Fynbos species) is strong world-wide. Although the study discusses the relative capital intensity and employment per hectare in traditional greenhouse vs indigenous floriculture it is not possible to determine what proportion of employment is from the indigenous sub-sector, and we were thus not able to use the estimate.<sup>17</sup>

We did not find any existing estimates for sectors or sub-sectors within BDE Sub-category B4: Non-consumptive use of biodiversity, which, as discussed in 2, we have defined to include nature-based tourism (e.g. bird watching, whale watching, diving, hiking), some adventure sports, and production of media and art related to biodiversity (e.g. through nature journalism, photography, and film making). Arguably the biggest gap in this regard is nature-based tourism, which is likely to be the largest contributor to Sub-Category B4. According to Statistics South Africa's Tourism Satellite Account (Stats SA, 2014), there were 617 287 people employed in tourism-related industries in 2012. Although the Tourism Satellite Account does not mention nature-based tourism or biodiversity, on the face of it there would seem to be an argument that much of South Africa's tourism potential is linked to the country's natural assets, and could thus be considered biodiversity-related. However, there are several challenges in quantifying numbers of jobs related to nature-based tourism. One is simply that estimating jobs related to any form of tourism is not easy, as they cut across conventionally recognised industry sectors. Another is that nature-based tourism can be defined either narrowly, as closely linked to protected areas and pristine or near-pristine areas, or more broadly as tourism related to range of natural and semi-natural features, sites or areas. Further research using the Tourism Satellite Account as a starting point and combining it with additional information, for example, on visitor numbers and bed nights in protected areas, may help to provide a firmer estimate. Care would need to be taken not to double-count jobs in nature-based tourism (Sub-category B4), game ranching and hunting (Sub-category B5), and management of the country's protected area network (Sub-category A1).<sup>18</sup>

As discussed in Section 3, the results reported here based on existing sector estimates do not represent the full set of biodiversity-related economic activities in Sub-categories B4 or B5, and can thus be considered an underestimate of the number of jobs in BDE Category B: Using Biodiversity. Further work to identify additional sectors or sub-sectors for which estimates are available, as well as priority sectors or sub-sectors for which estimates could be developed, would be worthwhile.

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<sup>17</sup> Kaiser Associates also make reference to a study conducted by the Agricultural Research Council, analysing the floriculture sector using a social accounting matrix, but we were not able to locate that study.

<sup>18</sup> Subsequent to the initial work for this paper in 2015, SANBI commissioned a study to quantify biodiversity-based tourism, including numbers of jobs. The results of this further work, which drew directly on the Tourism Satellite Account, are discussed in the Annexure.

### 4.3 Results based on the Quarterly Labour Force Survey

As described in Section 3, data was extracted from the LMDS (comprising QLFS data pooled annually) for the years 2008 to 2014, using industry and occupation codes identified as being biodiversity-related. For each the identified codes, all or most / some / few jobs were considered to be biodiversity-related, and a proportion of the QLFS estimate for that code (85% / 40% / 3.5% respectively) was included in the total number of biodiversity-related jobs. The results across the seven years are summarised in Table 8 and Figure 2, and the results for 2014 are set out in detail by industry and occupation code in Table 10 and Table 11.

All QLFS results throughout the paper have been rounded to the nearest thousand to reflect the uncertainty associated with QLFS estimates, which, as discussed in Section 3.3, are extrapolated from a sample survey.

**Table 8: Overview of QLFS results, including range, mean and sensitivity testing of the mean**

	Range 2008 – 2014		Mean 2008 – 2014	Sensitivity testing of the mean	
	Lowest	Highest		Conservative proportions*	Generous proportions*
<b>Industry</b>	139 000 (2010)	150 000 (2008)	145 000	86 000	189 000
<b>Occupation</b>	152 000 (2010)	167 000 (2013)	159 000	97 000	203 000

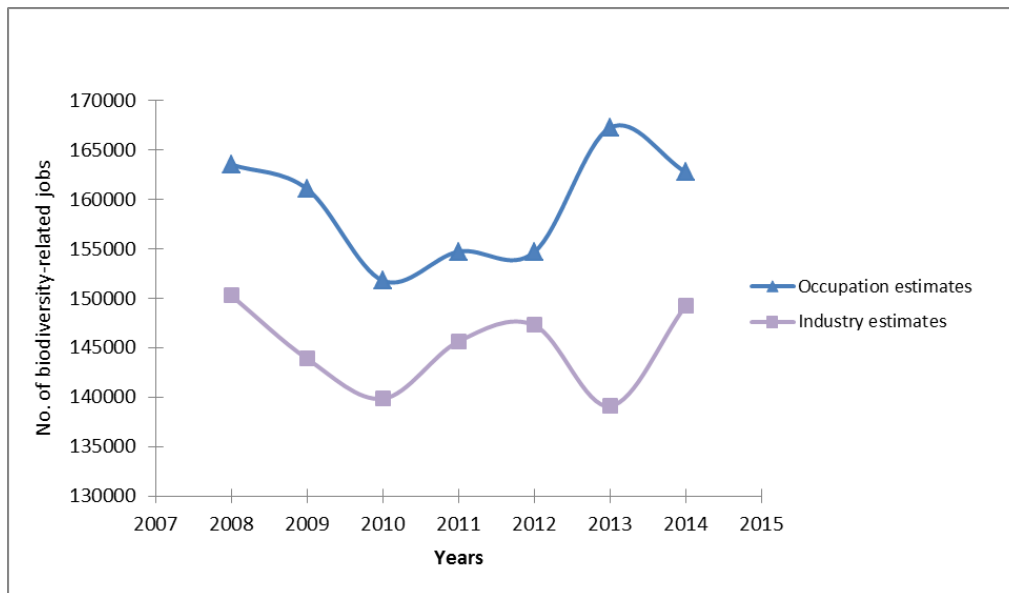
Table note:

\* See Table 5 in Section 3.3 for proportions used.

The total number of biodiversity-related jobs based on QLFS results by industry averaged 145 000 across the seven years, while the total based on QLFS by occupation was consistently higher than that based on industry, averaging 159 000 (Table 8). This is approximately 1% of total employment in South Africa, which averaged 14.6 million over this period.<sup>19</sup> For both industry and occupation, the results across the seven years were reasonably consistent, and there was no clear overall trend over the period. In 2013 the results by industry and occupation diverged most substantially, by just over 28 000 jobs, with a temporary trend in opposite directions. Aside from that year, they moved more or less together (Figure 2). More detailed analysis of the individual codes would be needed to determine the source of the divergence in 2013.

Sensitivity testing of the overall results shows the importance of the proportions used to calculate the number of biodiversity-related jobs, depending on whether all or most, some, or few jobs for a particular industry or occupation code are thought to be biodiversity-related, with differences of over 40 000 jobs in both directions. Further work is needed to settle on the most appropriate proportions, and there may well be an argument for a more nuanced approach in which the proportions are customised for different codes rather than applied uniformly within each group of codes.

<sup>19</sup> Based on QLFS figures for total employment, provided by the DPRU.



**Figure 2: Trends in biodiversity-related employment based on results from the QLFS 2008 – 2014, by industry and occupation**

Disaggregated analyses of the results for QLFS 2014, by industry and occupation and by biodiversity-related employment sub-category, are shown in the tables below. Table 9 gives an overview, and Table 10 and Table 11 show detailed results per industry and occupation code respectively.

**For BDE Category A: Conserving Biodiversity,** the analysis shows that:

- The industry codes do not seem to be reliable for picking up employment in the public sector, with 9 000 biodiversity-related jobs identified in Sub-Category A1 (including 8 000 in central government activities and provincial administrations) compared with the relatively certain estimate of approximately 20 000 based on administrative data.
- For Sub-category A2, the approximately 36 000 EPWP full-time-equivalents related to biodiversity (representing more than 1 million work opportunities) do not seem to be picked up at all in the result of 1 000 based on industry codes.
- The results for occupation codes look initially better for BDE Category A. However, the largest contributor, in Sub-category A1, is approximately 19 000 jobs in the occupation “Protective service workers not elsewhere classified, Rangers and game wardens”, which probably includes large numbers of security guards who should not be included as biodiversity-related employees. This substantially reduces the usefulness of QLFS occupational estimates for Sub-Category A1.
- As with QLFS results by industry, the result by occupation for Sub-category A2 of 3 000 jobs does not seem to pick up the 36 000 EPWP full-time-equivalents related to biodiversity.
- For Sub-category A3 (research and professional services), occupation codes provide a much more nuanced set of results than industry codes, because they are able to distinguish people working in specific disciplines. The result for occupation codes is 14 000 jobs, mostly natural science or biological science-related. Industry codes are un-usefully blunt for Sub-category A3, picking up 38 000 jobs, mainly from the code “Education”.
- For BDE Category A it thus seems that QLFS results by industry are not meaningful, but that QLFS results by occupation may be a useful estimate for Sub-category A3.

For **BDE Category B: Using Biodiversity**, the analysis shows that:

- For BDE Sub-category B4, results by industry give a total of 86 000 jobs, with the bulk coming from two codes: Hotels, camping sites and other provision of short stay accommodation (59 000); and Sporting and other recreational activities (25 000). Both of these codes fell into the group “Some jobs related to biodiversity”, so 40% of the total number of jobs in these codes are reflected in this result. These results may be useful as a starting point for estimating jobs related to nature-based tourism. Occupation codes seem blunter for BDE Sub-category B4, partly because they combine catering and accommodation, and most catering jobs are unlikely to be related in any firm way to biodiversity.
- For BDE Sub-category B5, results by industry give a total of 15 000 jobs, of which 7 000 are in ocean and coastal fishing. Existing sector estimates for Sub-category B5 give an estimate of 230 000 jobs, more than 15 times greater, suggesting that industry codes are not suitable for this sub-category. Results by occupation give a total of 88 000, the bulk of which come from two codes: traditional medicine practitioners (39 000, or 85% of 45 000), and farmhands and labourers (31 000). As with industry codes, occupation codes seem not to pick up most sub-sectors in Sub-category B5. Notwithstanding these limitations, the results for some industry and occupation codes in Sub-category B5 (such as those related to hunting, fishing and traditional medicine) may be useful for cross-checking some of the existing sector estimates and additional sector estimates that may be developed in future.

In summary, it seems that QLFS data may provide useful estimates for BDE Sub-categories A3 (using occupation codes) and B4 (using industry codes). Given that we expected substantial challenges in relating QLFS industry and occupation codes to biodiversity-related employment, this can be considered an encouraging result.

**Table 9: Summary and comparison of QLFS 2014 results per BDE sub-category, by industry and occupation**

BDE Category	Results by industry		Results by occupation	
	# jobs	Notes	# jobs	Notes
A1	9 000	Almost all from central and provincial government activities. Low compared with result of 20 000 from admin data. <i>Not useful.</i>	21 000	19 000 from “5169 Protective services workers not elsewhere classified, Rangers and game wardens”, likely to include large numbers of security guards. <i>Not useful.</i>
A2	1 000	Does not appear to pick up EPWP jobs. <i>Not useful.</i>	3 000	Does not appear to pick up EPWP jobs. <i>Not useful.</i>
A3	38 000	Almost 34 000 from “920 Education” – seems too high. <i>Not useful.</i>	<b>14 000</b>	Mostly natural science/biological science-related, including 9 000 natural science technicians. <b><i>May be useful.</i></b>

BDE Category	Results by industry		Results by occupation	
	# jobs	Notes	# jobs	Notes
B4	86 000	Almost all from “641 Hotels, camping sites and short stay accommodation”, and “964 Sporting and recreational activities”. <b>May be useful.</b>	36 000	Over 23 000 from hotels, restaurants and other catering and accommodation related codes; 10 000 from cashiers and ticket clerks. <i>Less useful</i> than results by industry for this sub-category, partly because the occupation codes mix catering and accommodation, and there are unlikely to be many catering jobs that are biodiversity-related.
B5	15 000	9 000 from “115 Game hunting etc” and “131 Ocean and coastal fishing” combined – certainty relatively high for these figures. 6 000 from “112 Farming of animals”. Less comprehensive than existing sector estimates, but <i>may be useful for cross-checking</i> some sector estimates.	88 000	Nearly 39 000 from “3241 Traditional medicine practitioners” – not picked up in industry codes. Over 30 000 from “9211 Farmhands and labourers”. Other large contributions from agriculture, hunting, forestry and fishing related codes. Doesn’t pick up all biodiversity-related sectors/sub-sectors but <i>may be useful for cross-checking</i> some sector estimates.

Table 10: Detailed estimates of biodiversity-related employment from QLFS 2014, by industry

Number of jobs		BDE Category				
		A. Conserving Biodiversity			B. Using Biodiversity	
Industry code and description		A1	A2	A3	B4	B5
<i>All or most related to biodiversity</i>						
115	Game hunting, trapping and game propagation, including related services					1 000
131	Ocean and coastal fishing					7 000
<i>Most related to biodiversity</i>						
641	Hotels, camping sites and other provision of short stay accommodation				59 000	
964	Sporting and other recreational activities				25 000	
<i>Few related to biodiversity</i>						
112	Farming of animals					6 000
121	Forestry and related services		1 000			
871	Research and experimental development on natural sciences and engineering			< 1 000		
911	Central government activities	8 000				
914	Provincial administrations	< 1 000				
920	Education			34 000		
932	Veterinary activities	< 1 000				

951	Activities of business, employers and professional organisations			1 000		
959	Activities of other membership organizations			1 988		
961	Motion picture, radio, television and other entertainment activities				1 000	
963	Library, archives, museums and other cultural activities			1 000		
<i>Total employment per sub-category</i>		9 000	1 000	38 000	86 000	15 000
<i>Total employment per broad category</i>		48 000			101 000	
<b>Total biodiversity-related employment</b>		<b>149 000</b>				

**Table 11: Detailed estimates of biodiversity-related employment from QLFS 2014, by occupation**

Number of jobs  Occupation code and description		BDE Category				
		A. Conserving Biodiversity			B. Using Biodiversity	
		A1	A2	A3	B4	B5
<i>All or most related to biodiversity</i>						
2211	Biologists, botanists, zoologists and related professionals			1 000		
3241	Traditional medicine practitioners					39 000
6152	Inland and coastal waters fishery workers					3 000
6153	Deep-sea fishery workers					1 000
6154	Hunters and trappers					< 1 000
9213	Fishery, hunting and trapping labourers					2 000
<i>Some related to biodiversity</i>						
1221	Production and operations managers/department managers in agriculture, hunting, forestry, fishing and mining					2 000
1225	Production and operations managers/department managers in hotels, restaurants and other catering and accommodation services				11 000	
1311	General managers in agriculture, hunting, forestry and fishing					8 000
1315	General managers of hotels, restaurants and other catering or accommodation services				12 000	
2212	Biological sciences, Chemical sciences, Medical sciences, Physical sciences and Veterinary sciences			< 1 000		
3111	Natural science technicians			9 000		
7121	Builders, traditional materials					< 1 000
7424	Basketry weavers, brush makers and related workers (including apprentices/trainees)					1 000
<i>Few related to biodiversity</i>						
1120	Senior government officers	1 000				
1210	Directors and chief executives	1 000	1 000	1 000	1 000	1 000
2210	Scientist			< 1 000		

Number of jobs  Occupation code and description		BDE Category				
		A. Conserving Biodiversity			B. Using Biodiversity	
		A1	A2	A3	B4	B5
2213	Agronomists, food scientists and related professionals, Agriculture, forestry and food scientists, Natural sciences technologists			< 1 000		
2223	Veterinarians	< 1 000				
2310	Technikon, teacher training, technical and other colleges, university and other higher education institutions teaching professionals and Other post-secondary education teaching professionals			2 000		
2431	Archivists and curators			< 1 000		
2451	Authors, journalists and other writers, Editors, Reporters, journalists, Writers, poets, playwrights and Other writers, commentators, proof-readers				1 000	
2452	Sculptors, painters and related artists				< 1 000	
3131	Photographers and image recording equipment operators, Sound recording equipment operators				< 1 000	
3211	Life science technicians, Biological science and Medical science			< 1 000		
3213	Farming and forestry advisers/consultants			< 1 000		
3227	Veterinary assistants	< 1 000				
3242	Faith healers				< 1 000	
3444	Government licensing officers		< 1 000			
4211	Cashiers and ticket clerks				10 000	
5113	Travel guides				< 1 000	
5161	Fire-fighters		1 000			
5169	Protective services workers not elsewhere classified, Rangers and game wardens	19 000				
6113	Gardeners, horticultural and nursery growers (farm owners and skilled farm workers)				< 1 000	
6121	Dairy and livestock producers (farm owners and skilled farm workers)					< 1 000
6123	Apiarists and sericulturists (farm owners and skilled farm workers)					< 1 000
6141	Forestry workers and loggers		1 000			
6211	Subsistence farmers					< 1 000
7331	Handicraft workers in wood and related materials (including apprentices/trainees)					< 1 000
7332	Handicraft workers in textile, leather and related materials (including apprentices/trainees)					< 1 000
9211	Farmhands and labourers					31 000
9212	Forestry labourers		1 000			
<b>Total employment per sub-category</b>		<b>21 000</b>	<b>3 000</b>	<b>14 000</b>	<b>36 000</b>	<b>88 000</b>
<b>Total employment per broad category</b>		<b>38 000</b>			<b>125 000</b>	
<b>Total biodiversity-related employment</b>		<b>163 000</b>				

#### 4.4 Comparison of results across different data sources, and initial total estimate

From the discussion above, it is clear that some data sources are better at picking up jobs in some BDE sub-categories than others. The approach we have taken in developing an estimate of total biodiversity-related employment is thus to see *the different data sources as complementary rather than as mutually exclusive alternatives*. The results from all three different sources of data are summarised for comparison in Table 12, together with an assessment of which we consider to be the best available data source for each BDE sub-category. Table 13 combines the best result for each sub-category to provide a total estimate of biodiversity-related employment, presented graphically in Figure 3.

The total estimate is 388 000 jobs in 2014 (subsequently updated to 418 000 in 2017, as reported in the Annexure). This total draws on a combination of administrative data for Sub-categories A1 and A2, QLFS data by occupation for Sub-category A3, QLFS data by industry for Sub-category B4, and existing sector estimates for Sub-category B5. The rationale for the choice of data source for each sub-category is discussed below.

In general, administrative data is considered more reliable than survey data, provided that it can be comprehensively gathered. Administrative data is especially suitable for Sub-Categories A1 and A2, which consist mainly of public sector and NGO jobs. It is less suited to Sub-category A3, which has a private sector component in the form of, for example, independent consultants and experts employed by consulting firms, for which administrative data sources are scanty. Because QLFS data by occupation is good at picking up jobs in particular professions, some of which are clearly related to biodiversity, we decided to use the QLFS result by occupation as the preferred data source for Sub-category A3. There is potentially some double-counting between administrative data for Sub-category A1 and QLFS data for Sub-category A3, as some biologists, botanists, zoologists and related professionals may work in government or NGOs; however, on balance we felt that the proportion of these specialist occupations in the public service is likely to be small. Although biodiversity-related public sector organisations may employ people with tertiary qualifications in biological and natural science, many of these people occupy non-scientific positions.<sup>20</sup>

For Sub-category B4, QLFS results by industry provide the best available estimate, as these results can be seen as a starting point for estimating jobs related to nature-based tourism, for which no other estimate is available. Further work is required for this sub-category, including exploring potential links with Stats SA's tourism satellite account.<sup>21</sup>

For Sub-category B5, the existing sector estimates that we have chosen to use are those that are based on surveys and/or first-hand information from industry stakeholders. We are confident that they are reliable, even though some of them are out of date. We are also confident that collectively they represent an underestimate of employment in Sub-category B5, as there are many sectors within this sub-category for which no estimates were available. There is unlikely to be significant

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<sup>20</sup> In fact, a concern in biodiversity-related public sector organisations is the small and declining number of scientific positions, such as ecologists in provincial conservation authorities.

<sup>21</sup> This was done in a study on biodiversity-based tourism that SANBI commissioned subsequent to the development of this paper, discussed in the Annexure.



double-counting across the existing sector estimates we have used (trade in traditional medicine, game ranching and hunting, fisheries, and indigenous tea production) as these sectors are by and large unrelated to each other. There may be some double-counting between jobs in game ranching and hunting in Sub-category B5 and those in accommodation, sporting and recreation activities in Sub-category B4; however, the employment estimate for game ranching and hunting is for on-ranch jobs only, and to the extent that this includes some jobs in, for example, hotel or short-stay accommodation, these jobs are likely to be a tiny proportion of such jobs nationally.

As noted, the estimate for Sub-category B5 is based on sources that are out of date in some cases (and 2015 rather than 2014 in the case of game ranching). Nevertheless, we have chosen to give the date of the initial overall estimate as 2014. This is partly to meet the objective of creating an indicator that can be tracked over time, with this research providing the baseline. It is thus necessary to provide a year, and 2014 seems to be the best option, as it is a largely accurate reflection of the dates for Sub-categories A1, A2, A3 and B4.

Table 13 shows that of the total of 388 000 jobs, 18% or 70 000 come from BDE Category A and 82% of 318 000 come from BDE Category B, giving a ratio of 1:4.5. This suggests that for every job dedicated to conserving biodiversity, there are more than four jobs that depend directly on using biodiversity. (This ratio was subsequently updated to 1:5, as discussed in the Annexure.) In fact, this is likely to be an underestimate of the ratio given that the Category B figure is not comprehensive. We return to this issue of the ratio between jobs in BDE Categories A and B in Section 5.

**Table 12: Comparison of results from administrative data, existing sector estimates and QLFS 2014, showing the preferred estimate for each BDE sub-category**

BDE sub-category	Admin data	Existing sector estimates	QLFS by industry	QLFS by occupation	Preferred estimate
A1 Protecting & managing biodiversity assets	20 373		9 000	21 000	Administrative data
A2 Restoring & maintaining ecol. infrastructure	36 420		1 000	3 000	Administrative data
A3 Research & professional services	4 650		38 000	14 000	QLFS by occupation
B4 Non-consumptive use of biodiversity			86 000	36 000	QLFS by industry
B5 Extractive use of biodiversity		232 000	15 000	88 000	Existing sector estimates

**Table 13: Initial estimate of biodiversity-related employment for 2014, by BDE sub-category**

BDE category	Best estimate	% of total	Source
A1 Protecting & managing biodiversity assets	20 000	5%	Administrative data
A2 Restoring & maintaining ecol. infrastructure	36 000	9%	Administrative data
A3 Research & professional services	14 000	4%	QLFS by occupation
<b>A: Conserving biodiversity</b>	<b>70 000</b>	<b>18%</b>	
B4 Non-consumptive use of biodiversity	86 000	22%	QLFS by industry

B5 Extractive use of biodiversity	232 000	60%	Existing sector estimates
<i>B: Using biodiversity</i>	<i>318 000</i>	<i>82%</i>	
<b>Total biodiversity-related employment</b>	<b>388 000</b>	<b>100%</b>	

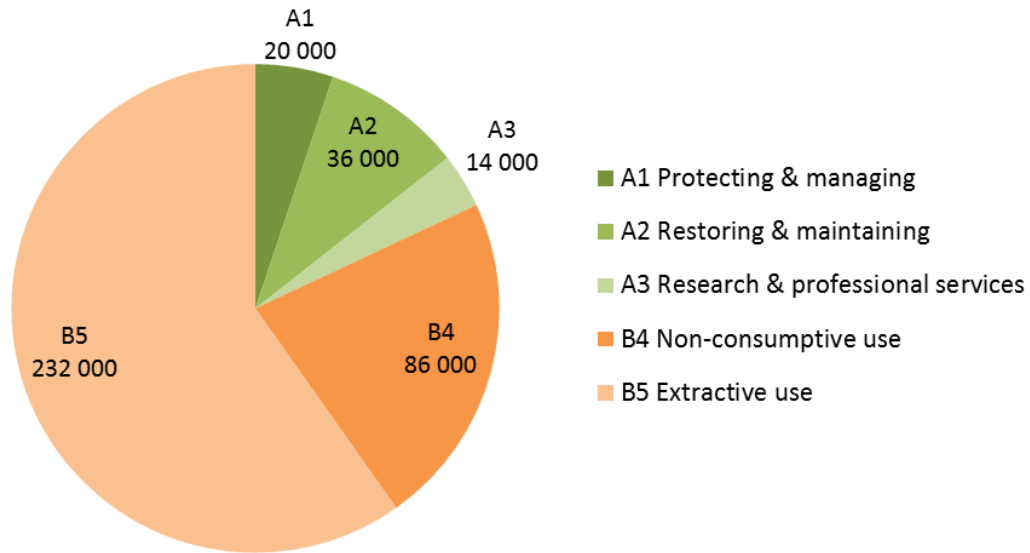


Figure 3: Initial estimate of biodiversity-related employment in 2014, by BDE sub-category

## 5 Discussion

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This section discusses biodiversity-related employment in the context of other sectors in the economy, provides initial thoughts on the spatial distribution and skills profile of biodiversity-related jobs, suggests some policy implications of the work presented in this paper, reflects on the extent to which the objective of establishing a repeatable methodology for a national indicator on biodiversity-related employment has been achieved, and sets out priorities for further work.

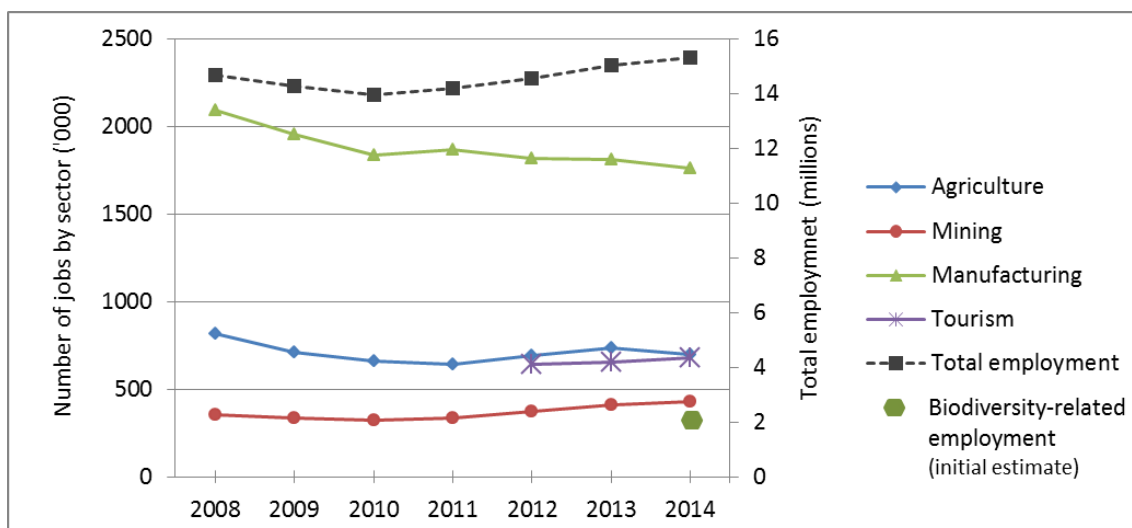
### 5.1 Key findings and policy implications

It is important to put the results presented in Section 4 in the context of employment in other sectors and the country as a whole, as shown in Figure 4. The initial estimate of approximately 388 000 biodiversity-related jobs in 2014 represented 2.5% of national employment, and compared with approximately 430 000 jobs in the mining sector, 700 000 jobs in the agricultural sector, and 1.8 million jobs in manufacturing.

An advantage of biodiversity-related employment is that it is based on a renewable resource that, if appropriately managed, can provide the basis for ongoing economic activity in the very long term. We suggest that in a context where employment in traditional sectors such as manufacturing and agriculture is declining, biodiversity-related sectors could provide a source of sustainable long-term growth. This may not apply across every biodiversity-related sector or sub-sector (for example, growth in wild-caught fisheries is firmly constrained by the ecological limits of the underlying resource base), but it may apply to large well-established biodiversity-related sectors such as nature-based tourism and game ranching, and also to smaller emerging sectors such as indigenous tea production, indigenous floriculture and bioprospecting. Tourism in particular is regarded as a rapidly growing sector globally and in South Africa, and is estimated to provide an increasing number of jobs nationally based on Stats SA's Tourism Satellite Account. Game ranching has grown rapidly in the last 25 years, from a very small number of commercial game ranches in the 1980s to an estimated 9 000 in 2014 (Taylor et al., 2015).<sup>22</sup>

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<sup>22</sup> This growth was enabled by the Game Theft Act (Act 105 of 1991), which allowed for legal ownership of wildlife by landowners for the first time in South Africa. Previous to that a range of government policies and practices had actively discouraged game farming in favour of livestock farming (Taylor et al., 2015).



**Figure 4: Employment trends by sector in South Africa, 2008 – 2014**

(Source: Stats SA, 2014; Stats SA, 2015b)

This research did not extend to analysis of the spatial distribution and skills profile of biodiversity-related employment. However, on the face of it there is a case to be made that many biodiversity-related jobs are located outside major urban centres, and that they are likely to include a substantial proportion of low-skilled jobs. Initial reflections on how this might apply to the different BDE sub-categories are given in Table 14, and this is an area that warrants further work. Our hypothesis is that growth in biodiversity-related sectors could support rural development and inclusive growth, and that a biodiversity lens could be useful in national and sub-national discussions and efforts towards employment creation and poverty alleviation.

**Table 14: Notes on spatial distribution, skills profile and growth potential per BDE sub-category**

BDE sub-category	Notes on spatial distribution	Notes on skills profile	Notes on growth potential
A1 Protecting & managing (70 000 jobs)	Many jobs involved in conserving biodiversity are located in protected areas. With a few exceptions (such as Table Mountain National Park in Cape Town) these are located outside major centres.	Likely to include labour-intensive activities with low formal skills requirements. Higher skill levels required for managerial and specialist positions.	Limited by resource constraints in the public sector and by the extent to which protecting and managing biodiversity assets is viewed as a priority amongst many other pressing priorities for government.
A2 Restoring & maintaining (36 000 jobs)	Many of these jobs are located in rural areas, where the bulk of priority areas for restoring ecological infrastructure are located. Distributed across the country.	Likely to include labour-intensive activities with low formal skills requirements. Higher skill levels required for managerial and specialist positions.	Limited by resource constraints in the public sector and by the extent to which restoring and maintaining ecological infrastructure is viewed as a priority amongst many other pressing priorities for government.

BDE sub-category	Notes on spatial distribution	Notes on skills profile	Notes on growth potential
A3 Research & professional services (14 000 jobs)	Likely to be based mainly in urban centres.	Likely to have require high levels of formal skills (most jobs would require a tertiary qualification).	Likely to be modest.
B4 Non-consumptive use (86 000 jobs)	Many of these jobs likely to be located in rural areas – where the nature-based assets occur.	May have a similar skills profile to the hospitality sector more generally.	May be substantial. Further work required to determine growth potential of nature-based tourism, a large contributor to this sub-category.
B5 Extractive use (232 000 jobs)	Likely to vary substantially across different sectors within this sub-category e.g. game ranching – mainly rural, bioprospecting more high-tech and based in major centres (although with backward linkages into rural areas to source raw materials).	Skills profile varied across sectors within the sub-category. Some sectors likely to include substantial numbers of jobs with low formal skills requirements (e.g. game ranching likely to have a similar skills profile to livestock farming).	May be substantial in some sectors within this sub-category. Further work needed to identify which are most promising from a growth perspective as well as barriers to growth (e.g. bioprospecting generally considered to have high growth potential that is currently constrained by a restrictive regulatory environment)

An important aspect of the results reported here is that for every job dedicated to conserving or managing South Africa’s biodiversity assets and ecological infrastructure, more than four jobs (subsequently updated to approximately five jobs – see Annexure) depend on utilising biodiversity (see Section 4.4). The implication is that current efforts to conserve and manage biodiversity should be seen not simply as an end in themselves or a cost to the economy but as an investment in a resource that supports wider economic activity and employment. A key challenge is to ensure that activities in BDE Category B: Using Biodiversity are sustainably managed and are not depleting the underlying biodiversity assets on which they depend. Many of the public sector and NGO jobs in BDE Category A make an essential contribution in this regard.

BDE Category A also includes large numbers of employment opportunities related to managing and conserving ecological infrastructure, which currently take the form mainly of short-term work opportunities through EPWP. As discussed briefly in Section 1, ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to people. Examples of ecological infrastructure include Strategic Water Source Areas that provide the bulk of the country’s water supply,<sup>23</sup> intact wetlands that prevent flooding by acting as sponges in the landscape and improve water quality by filtering toxins, coastal dunes that buffer human settlements from storm surges, riparian (river-bank) vegetation that filters nutrients and pesticides from irrigation return flows, estuaries (river mouths) that provide nurseries for commercially important fish species (without

<sup>23</sup> Ten percent of South Africa’s land area provides 50% of mean annual run-off, supporting approximately half of South Africa’s population and two-thirds of the economy, often in urban and industrial centres a long distance away (Nel et al., 2017).

which stocks cannot be replenished), and healthy natural rangelands that support agricultural productivity. In the face of climate change, ecological infrastructure will be increasingly important in buffering people from the impacts of extreme weather events and natural disasters.

In many cases ecological infrastructure is subject to a range of human-induced pressures and requires ongoing maintenance (for example, to prevent infestation or re-infestation by invasive alien plants), or in some cases active restoration to re-establish its functioning (for example, restoring wetlands). Restoring and maintaining ecological infrastructure is not a once-off activity but requires sustained effort, in the same way that transport infrastructure or other forms of built infrastructure must be regularly maintained if they are not to become dilapidated. (See SANBI (2014) for a framework and set of principles for investing in ecological infrastructure.)

Recognising that work related to maintaining and restoring ecological infrastructure is of a long-term nature and contributes to an important public asset, we suggest that it would be useful to consider alternative models for this type of employment, rather than restricting it mainly to short-term work opportunities. There may be the potential to embed some of this employment in the public sector organisations that have the mandate and responsibility for managing the country's natural assets, providing further long-term employment in BDE Category A with a direct public benefit. We recognise that there would be many complexities in restructuring or reconfiguring the current approach, and that a combination of approaches may be required.

In BDE Category B, further work is required to assess which sectors or sub-sectors have the greatest potential for inclusive growth that is labour-absorbing, and to understand how best to support these sectors through policy interventions, recognising that the barriers to growth may differ in different sub-sectors. Such support is likely to require close collaboration between the Department of Trade and Industry, DEA and the Department of Science and Technology, among others. Some of this work was initiated as part of the Biodiversity Economy Lab which was convened by the Presidency in May 2016 with a focus on unlocking the economic potential of the wildlife economy (game ranching and hunting), marine and coastal tourism, and bioprospecting.

In summary, key policy-relevant findings of the work presented here include the following:

- South Africa's biodiversity assets provide substantial employment in a range of sectors, and should be seen as a public good that contributes to the economy.
- For every job dedicated to conserving or managing South Africa's biodiversity assets and ecological infrastructure, more than four jobs (subsequently updated to approximately five jobs – see Annexure) depend on utilising biodiversity.
- Development based on biodiversity assets has the potential to support growth in non-traditional sectors and to provide employment outside major urban centres.

Policy implications that follow from these findings include the following:

- Public sector expenditure on managing and conserving biodiversity assets can be seen as an investment in a resource that supports employment rather than simply as a cost.
- Continued investment in managing and conserving biodiversity assets, led by the public sector, is essential in order to ensure that private sector economic activities that depend on biodiversity are sustainably managed and do not deplete the underlying resource base.

- Investment in restoring and maintaining ecological infrastructure should be approached as a long-term endeavour and should be seen as an opportunity to create long-term employment in labour-intensive activities, many of which would be located outside major urban centres.
- Biodiversity-related sub-sectors that are growing or have the potential to grow should be the focus of support through industrial policy and related interventions.

## 5.2 Methodological recommendations for a national indicator on biodiversity-related employment

In addition to determining how many jobs are currently related to biodiversity assets and ecological infrastructure in South Africa, a key objective of this research was to establish a systematic, repeatable method for measuring biodiversity-related employment, in order to develop a headline indicator of the socio-economic benefits of biodiversity that can be reported regularly in the National Biodiversity Assessment. Our recommendations in this regard include the following:

- A national indicator on biodiversity-related employment is feasible to develop and track over time, and provides a meaningful measure of the socio-economic contribution of South Africa's biodiversity assets.
- The indicator requires a methodology that draws on multiple data sources. For the foreseeable future these will include all three data sources used here: administrative data, sector or sub-sector estimates, and national survey data (in the form of the QLFS, possibly also drawing on the QES), notwithstanding limitations of each of them.
- Although administrative data is time-consuming to collect, it provides a reliable data source for biodiversity-related employment in the public and NGO sectors and should form a component of the methodology. The number of jobs in these sectors, which make up the bulk of BDE Sub-categories A1 and A2, are unlikely to change rapidly over time and it may be sufficient to re-assess them at intervals of, say, seven years. The time-intensive effort required to gather this data is thus not necessarily prohibitive. It may also be possible to set up arrangements with some of the larger biodiversity-related employers to collate the data themselves.
- Given the inherent limitations of using industry and occupation codes to identify biodiversity-related employment, sector estimates are likely to remain an essential component of the methodology if a meaningful total estimate is to be achieved. Two challenges in relation to sector estimates stand out:
  - There is no standard methodology for developing such estimates, and their quality and reliability is variable. As part of formalising this methodology, a set of criteria or requirements for sector estimates will need to be developed.
  - Sector estimates tend to be undertaken on a once-off basis and there is often no impetus to update them. Once estimates have been developed for a reasonably comprehensive range of biodiversity-related sectors, a set of priority sectors for regular updating will need to be identified, and arrangements for regular updates will need to be put in place. Again, because the timeframe for updates is five to seven years, this seems feasible. Research to develop and refine sector estimates may be able to be supported by research institutions, NGOs and industry associations.

- Because QLFS data is readily available and has proved useful for estimating employment in some BDE sub-categories, it should also remain a component of the methodology. Suggestions for further work to refine the use of QLFS data for this purpose are discussed below.
- SANBI is well-placed to lead the process of formalising the national indicator on biodiversity-related employment, and should develop a working document that sets out the methodology based on the research and recommendations presented here, including a set of guidelines for sector estimates. Regular updates of the indicator should be co-ordinated by SANBI in collaboration with a range of data providers and partners.

### 5.3 Priorities for further work

Several priorities for further work have been mentioned in the preceding sections, and are gathered together below. For **administrative data**, further work should include:

- Confirming that the 146 organisations identified for BDE Category A (Table 1 and Appendix 1) provide a comprehensive list. We welcome suggestions for additions.
- For organisations with only part of their mandate related to biodiversity, or with biodiversity as a secondary mandate, verifying or refining estimates of the proportion of jobs within these organisations that should be considered biodiversity-related, for example by engaging with key informants in the organisations concerned.
- Exploring options for gathering administrative data to support BDE Category B estimates, for example administrative data derived from permitting or authorisation requirements at provincial or national level.

For **sector estimates**, further work should include:

- More comprehensive secondary research to identify additional existing estimates that we may have missed, and to develop a list of additional sectors or sub-sectors for which estimates are could be developed.
- Prioritising sectors or sub-sectors for development of estimates, based on several criteria including whether they are likely to be significant contributors to employment and whether they have potential for growth. This could involve a combination of secondary research and consultation with sector experts or knowledge holders.
- Primary research to develop estimates for these priority sectors or sub-sectors.
- Research to develop an estimate for nature-based tourism, which in itself is likely to require drawing on several data sources. For example, it may be possible to use the Tourism Satellite Account as a starting point and combine it with additional information, such as visitor numbers and bed nights in protected areas.<sup>24</sup>
- Updating the existing estimates for the traditional medicine and fisheries sectors, both of which are known to be substantial contributors to employment.
- Exploring the use of QLFS or QES data to cross-check some sector estimates.

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<sup>24</sup> Acting on this recommendation, SANBI commissioned a study to quantify biodiversity-based tourism, including numbers of jobs. The results of this further work, which drew directly on the Tourism Satellite Account, are discussed in the Annexure.



- Developing a set of guidelines or minimum requirements for sector estimates that are to be used in the national indicator of biodiversity-related employment.

For **QLFS data**, further work should include:

- Engaging with Stats SA on the process of coding for occupation and industry in the QLFS. Respondents are asked to describe their occupation and industry in words, which is subsequently coded, and it would be useful to understand the decisions made during coding.
- Confirming the allocation of industry and occupation codes to BDE sub-categories and to groups (all or most, some, few, or no jobs likely to be related to biodiversity), through revisiting these with a wider group of expert informants.
- For the codes in the “all or most”, “some” and “few” groups, taking a more nuanced approach to the proportion of jobs counted as biodiversity-related, with a view to customising the proportions for different codes rather than applying them uniformly to all codes within a group. It would be worth doing this only for BDE sub-categories for which the QLFS data has proved useful (A3 and B5).
- Analysis of trends between 2008 and 2014 for QLFS data for BDE Sub-categories A3 and B5, and exploring whether cross-tabulations for the industry and occupation codes in these sub-categories provide any useful insights.

Areas of possible **collaboration with Stats SA** include:

- Exploring whether data from the QES could be used to cross-check any of the existing sector estimates or could feed into the development of new sector estimates.
- Exploring whether it would be possible to include a specific focus on nature-based tourism within the Tourism Satellite Account.

Lastly, we return to the original set of research questions posed in Section 1. The first three questions as well as question 7 have been reasonably comprehensively addressed in this paper:

1. What constitutes biodiversity-related employment, and can we develop a coherent framework for defining and measuring it?
2. What data is available for measuring biodiversity-related employment, and what are the key data gaps?
3. How many jobs are currently related to biodiversity assets and ecological infrastructure in South Africa?
7. What are the priorities for addressing data gaps, with a view to laying the foundation for further research in this area?

Questions 4 and 5 have been tentatively discussed, but require further research to develop a firm evidence base:

4. Where are biodiversity-related jobs located (e.g. by province, municipality, urban/rural)?
5. What types of jobs are related to biodiversity (e.g. temporary/seasonal/permanent, skilled/semi-skilled/unskilled)? Are there skills barriers or other barriers to entering employment in this sector?

Questions that remain to be addressed are:

6. What proportion of biodiversity-related jobs are held by women, youth and people with disabilities?
8. What is the potential for growth in biodiversity-related employment in South Africa, and how could such growth be facilitated and supported?
9. Are there significant policies, institutional, educational, financial or other blockages to growing employment in this sector, and if so how might they be addressed?

Answering questions 4, 5 and 6 would require further consideration. Acquiring detail on gender, age, disability status, location, income and skills of current workers will be challenging. Furthermore, the approaches used here have not necessarily been designed to cater for this level of demographic detail, and more advanced methods may be needed to analyse it. The various data sources may have further advantages or drawbacks if additional demographic information is required, including ease of access, effort required collate the data, and criteria for inclusion.

Questions 8 and 9 especially would need to be addressed in a way that focuses on particular biodiversity-related sectors or sub-sectors, rather than for biodiversity-related economic activities as a whole, given the varied nature of these activities and sectors. Further work on questions 4, 5, 6, 8 and 9 could be incorporated into the development and revision of sector estimates, and would help both to identify those biodiversity-related sectors that have the greatest potential to contribute to inclusive growth, to understand barriers to growth specific to those sectors, and to provide the basis for designing policy interventions that could enable growth in those sectors and the employment they provide.

## 6 Conclusion

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This paper set out to develop a conceptual framework for defining and measuring biodiversity-related employment; to establish a systematic, repeatable method for measuring biodiversity-related employment in South Africa; and to estimate the number of jobs currently related to biodiversity assets and ecological infrastructure in order to establish a baseline for a national indicator of the socio-economic benefits of biodiversity. A broader goal was to highlight the potential for biodiversity-related economic activity to contribute to the country's national development priorities.

A conceptual framework for biodiversity-related employment was developed, with a key distinction made between jobs in sectors or activities that *contribute actively to conserving and managing biodiversity*, termed BDE Category A, and jobs in sectors or activities that *depend directly on using biodiversity*, termed BDE Category B. Generally speaking, conserving biodiversity is the role of government and NGOs, while use of biodiversity often occurs within the private sector or on a subsistence basis. Three sub-categories were identified within Category A, relating to protecting and managing biodiversity assets, restoring and maintaining ecological infrastructure and research and professional services related to biodiversity. Two sub-categories were identified within Category B, relating to non-consumptive use of biodiversity and extractive use of biodiversity.

An initial estimate of approximately 388 000 biodiversity-related jobs in 2014 was developed, based on multiple data sources (subsequently updated to approximately 418 000 jobs in 2017 – see Annexure). Administrative data proved the most reliable source for Sub-categories A1 and A2, QLFS data for Sub-categories A3 and B4, and existing sector estimates for Sub-category B5. The estimate of 388 000 jobs is an underestimate, as available data for BDE Category B5 is not comprehensive. It represents approximately 2.5% of employment nationally, and compares with 430 000 jobs in the mining sector and 700 000 in agriculture. (See the Annexure for subsequent updates of these figures.)

Of the 388 000 biodiversity-related jobs, 70 000 or 18% are in BDE Category A, and 318 000 or 82% are in BDE Category B. This means that for every job dedicated to conserving biodiversity, there are more than four jobs (subsequently updated to approximately five jobs – see Annexure) that depend directly on using biodiversity, highlighting the value of biodiversity to the economy and employment. Activities related to managing and conserving biodiversity should be recognised as an investment in an important socio-economic resource, not simply as an end in themselves or a cost to the economy.

Work related to restoring and maintaining ecological infrastructure (Sub-category A2) is currently undertaken mainly through short-term work opportunities in EPWP. Recognising that this work is of a long-term nature and contributes to an important public asset, it would be useful to consider alternative models, including embedding some of this employment in the public sector organisations that have the mandate and responsibility for managing the country's natural assets.

Biodiversity-related economic activity is based on a renewable resource that, if appropriately managed, can provide the basis for ongoing economic activity in the very long term. A key challenge is to ensure that the activities in BDE Category B are sustainably managed and do not erode the assets on which they depend.

Because biodiversity assets and ecological infrastructure are located largely outside major urban centres and because their management and use is often labour-intensive, biodiversity-related economic activity has the potential to provide labour-absorbing growth in rural areas. Further work is needed to map and quantify this potential in more detail.

Based on the methods explored in this research, a methodology for the proposed national indicator on biodiversity-related employment was recommended, with clear priorities for refining the use of administrative and QLFS data and for filling data gaps through further work on estimates for particular biodiversity-related sectors or sub-sectors.

Further work on sector estimates will help not only to increase confidence in the estimate of total biodiversity-related employment, but should also provide insight into which biodiversity-related sectors have the greatest potential to contribute to inclusive growth and how best those sectors might be supported through policy interventions.

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## Appendix 1: Biodiversity-related organisations for which administrative data was collected

Table 15: Full list of biodiversity-related employers included in the administrative data gathering process, showing whether the organisation's core mandate or function is biodiversity-related

Organisations included	Biodiversity = all or part of core mandate /function	Biodiversity = secondary mandate/function
<b>BDE Category A1: Protecting and managing biodiversity assets</b>		
Department of Environmental Affairs (relevant sections) <ul style="list-style-type: none"> <li>• Biodiversity &amp; Conservation Branch</li> <li>• Ocean and Coasts Branch</li> <li>• Legal, Authorisation, Compliance and Enforcement Branch</li> </ul>	✓	
Other national departments (relevant sections) <ul style="list-style-type: none"> <li>• Department of Water &amp; Sanitation</li> <li>• Department of Agriculture, Forestry &amp; Fisheries</li> <li>• Department of Mineral Resources</li> <li>• South African Police Services</li> <li>• South African Revenue Services</li> </ul>		✓
Public entities related to biodiversity <ul style="list-style-type: none"> <li>• South African National Biodiversity Institute (including National Botanical Gardens)</li> <li>• South African National Parks (SANParks)</li> <li>• iSimangaliso Wetland Park Authority</li> <li>• National Zoological Gardens</li> </ul>	✓	
Provincial departments of environmental affairs (relevant sections/programmes) <ul style="list-style-type: none"> <li>• Eastern Cape Department of Department of Economic Development, Environmental Affairs and Tourism</li> <li>• Free State Department of Department of Economic Development, Tourism and Environmental Affairs</li> <li>• Gauteng Department of Department of Agriculture &amp; Rural Development</li> <li>• KwaZulu-Natal Department of Department of Agriculture and Environmental Affairs</li> <li>• Limpopo Department of Economic Development, Environment &amp; Tourism</li> <li>• Mpumalanga Department of Agriculture, Rural Development and Land Administration</li> <li>• North West Department of Economic Development, Conservation &amp; Tourism</li> <li>• Northern Cape Department of Agriculture, Land Reform and Rural Development</li> <li>• Western Cape Department of Environmental Affairs &amp; Development Planning</li> </ul>	✓	
Provincial conservation agencies <ul style="list-style-type: none"> <li>• CapeNature (Western Cape)</li> <li>• Eastern Cape Parks and Tourism Agency</li> <li>• Ezemvelo KwaZulu-Natal Wildlife</li> <li>• Mpumalanga Tourism and Parks Agency</li> <li>• North West Parks &amp; Tourism Board</li> </ul>	✓	



Organisations included	Biodiversity = all or part of core mandate /function	Biodiversity = secondary mandate/ function
Provincial departments of agriculture (relevant programmes/sections) <ul style="list-style-type: none"> <li>• Eastern Cape Provincial Department of Rural Development and Agrarian Reform</li> <li>• Free State Provincial Department of Agriculture and Rural Development</li> <li>• Gauteng Provincial Department of Agriculture &amp; Rural Development</li> <li>• KwaZulu-Natal Provincial Department of Agriculture and Environmental Affairs</li> <li>• Limpopo Provincial Department of Agriculture</li> <li>• Mpumalanga Provincial Department of Agriculture, Rural Development and Land Administration</li> <li>• Northern Cape Provincial Department of Agriculture, Land Reform and Rural Development</li> <li>• Western Cape Department of Agriculture</li> <li>• [no data could be found for North West Province]</li> </ul>		✓
Metropolitan municipalities (relevant sections) <ul style="list-style-type: none"> <li>• Buffalo City Metropolitan Municipality</li> <li>• City of Cape Town</li> <li>• City of Johannesburg (including Johannesburg City Parks and Zoo)</li> <li>• City of Polokwane</li> <li>• City of Tshwane</li> <li>• Ethekewini Municipality</li> <li>• Manaung Metropolitan Municipality</li> <li>• Nelson Mandela Bay Metropolitan Municipality</li> </ul>		✓
Conservation NGOs <ul style="list-style-type: none"> <li>• Biowatch South Africa</li> <li>• BirdLife South Africa</li> <li>• Cape Leopard Conservation Trust</li> <li>• Conservation South Africa</li> <li>• Dyer Island Conservation Trust</li> <li>• Endangered Wildlife Trust</li> <li>• Fire Protection Association</li> <li>• FreeMe Wildlife Rehabilitation Centre</li> <li>• Human Wildlife Solutions</li> <li>• ICLEI-Local Governments for Sustainability</li> <li>• Indigo Development and Change</li> <li>• Natures Valley Trust</li> <li>• Ocean Research Conservation Africa - ORCA Foundation</li> <li>• Overberg Crane Group</li> <li>• Peace Parks Foundation</li> <li>• South African Shark Conservancy</li> <li>• Southern African Foundation for the Conservation of Coastal Birds (SANCCOB)</li> <li>• TRAFFIC</li> <li>• Vulture Programme for the Conservation of Vulture Species in Southern Africa</li> <li>• Wildlife and Environment Society of South Africa (WESSA)</li> <li>• Wilderness Foundation</li> <li>• Whale Coast Conservation</li> </ul>	✓	

Organisations included	Biodiversity = all or part of core mandate /function	Biodiversity = secondary mandate/function
<ul style="list-style-type: none"> <li>• Wildlife and Ecological Investment</li> <li>• WWF-South Africa</li> <li>• Cape West Coast Biosphere Reserve</li> <li>• Cape Winelands Biosphere Reserve</li> <li>• Kogelberg Biosphere Reserve</li> <li>• Kruger to Canyon Biosphere Reserve</li> <li>• Vhembe Biosphere Reserve</li> <li>• Waterberg Biosphere Reserve</li> </ul>		
<p>Other conservation-related organisations and projects</p> <ul style="list-style-type: none"> <li>• Drakensberg Botanical Garden</li> <li>• Durban Botanical Garden</li> <li>• Garden Route Botanical Garden</li> <li>• Manie van der Schifj Botanical Garden</li> <li>• North West University Botanical Garden</li> <li>• Stellenbosch University Botanical Garden</li> <li>• KwaZulu-Natal Sharks Board</li> <li>• Land Reform and Biodiversity Stewardship Initiative (22 projects)</li> </ul>	✓	
<i>Total number of organisations in Category A1</i>		<b>83</b>
<b>BDE Category A2: Restoring and maintaining ecological infrastructure</b>		
<p>Expanded Public Works Programme – DEA Environmental Programmes</p> <ul style="list-style-type: none"> <li>• Staff of Environmental Programmes branch</li> <li>• Work opportunities created</li> </ul>	✓	
<p>Expanded Public Works Programme – other relevant elements</p> <ul style="list-style-type: none"> <li>• Department of Public Works: EPWP Programme</li> <li>• Department of Agriculture, Forestry &amp; Fisheries: LandCare Programme, Working for Fisheries</li> <li>• Department of Water and Sanitation: Adopt-a-River Project</li> </ul>		✓
<p>Catchment Management Agencies (relevant staff)</p> <ul style="list-style-type: none"> <li>• Inkomati Catchment Management Agency</li> <li>• Breede Overberg Catchment Management Agency</li> </ul>		✓
<p>NGOs involved in restoration and maintenance</p> <ul style="list-style-type: none"> <li>• Association for Water and Rural Development (AWARD)</li> <li>• Institute of Natural Resources (INR)</li> <li>• South African Association for Marine Biological Research (SAMBR)</li> <li>• Oceanographic Research Institute (ORI)</li> <li>• National Association of Conservancies/Stewardship SA</li> </ul>	✓	
<i>Total number of organisations in Category A2</i>		<b>12</b>
<b>BDE Category A3: Research and professional services related to biodiversity</b>		
<p>Government research institutions and agencies</p> <ul style="list-style-type: none"> <li>• Department of Science &amp; Technology (relevant sections)</li> <li>• Agricultural Research Council (ARC)</li> <li>• Council for Scientific and Industrial Research (CSIR)</li> <li>• South African Environmental Observations Network (SAEON)</li> <li>• South African Institute of Aquatic Biodiversity (SAIAB)</li> <li>• Water Research Council (WRC)</li> <li>• East London Museum</li> </ul>		✓

<b>Organisations included</b>	<b>Biodiversity = all or part of core mandate /function</b>	<b>Biodiversity = secondary mandate/ function</b>
<ul style="list-style-type: none"> <li>• Iziko Museums of South Africa</li> <li>• KwaZulu-Natal Museum</li> <li>• Life Sciences Museum and Biodiversity Centre</li> <li>• National Museum Bloemfontein</li> <li>• Durban Natural Science Museum</li> </ul>		
<p>Education and training related to biodiversity</p> <ul style="list-style-type: none"> <li>• Universities (staff of relevant departments) <ul style="list-style-type: none"> <li>○ Cape Peninsula University of Technology</li> <li>○ Durban University of Technology</li> <li>○ Nelson Mandela Metropolitan University</li> <li>○ North West University</li> <li>○ Rhodes of University</li> <li>○ Tshwane University of Technology</li> <li>○ University of Cape Town</li> <li>○ University of Fort Hare</li> <li>○ University of Free State</li> <li>○ University of Johannesburg</li> <li>○ University of KwaZulu-Natal</li> <li>○ University of Limpopo</li> <li>○ University of Pretoria</li> <li>○ University of South Africa</li> <li>○ University of Stellenbosch</li> <li>○ University of Venda</li> <li>○ University of Western Cape</li> <li>○ University of Zululand</li> <li>○ Walter Sisulu University</li> <li>○ Wits University</li> </ul> </li> <li>• Colleges <ul style="list-style-type: none"> <li>○ Southern African Wildlife College (SAWC)</li> <li>○ Tracker Academy</li> </ul> </li> <li>• Relevant education NGOs <ul style="list-style-type: none"> <li>○ Cape Town Environmental Education Trust</li> <li>○ DELTA Environmental Education</li> </ul> </li> </ul>		✓
<p>Human capital development programmes related to biodiversity</p> <ul style="list-style-type: none"> <li>• Groen Sebenza Programme</li> <li>• DEA's Environmental Monitors</li> </ul>	✓	
<p>Media organisations (relevant staff)</p> <ul style="list-style-type: none"> <li>• Africa Media</li> </ul>		✓
<p>Membership organisations and associations (staff of the organisation)</p> <ul style="list-style-type: none"> <li>• South African Association of Botanists</li> <li>• South African Council for Natural Scientific Professions (SACNASP)</li> <li>• Southern African Institute of Ecologists and Environmental Scientists (SAIEES)</li> </ul>		✓

<b>Organisations included</b>	<b>Biodiversity = all or part of core mandate /function</b>	<b>Biodiversity = secondary mandate/function</b>
Biodiversity specialists registered with SACNASP and SAIEES <ul style="list-style-type: none"> <li>• Aquatic scientists</li> <li>• Biological scientists</li> <li>• Botanists</li> <li>• Ecologists</li> <li>• Marine scientists</li> <li>• Water care scientists</li> <li>• Water Resource Scientists</li> <li>• Zoologists</li> </ul>	✓	
<i>Total number of organisations in Category A3</i>	<b>51</b>	
<b>Total number of organisations in Category A</b>	<b>146</b>	
<b>BDE Category B4: Non-consumptive use of biodiversity</b>		
[No administrative data found for this category]		
<i>Total number of organisations in Category B4</i>	<b>0</b>	
<b>BDE Category B5: Consumptive or extractive use of biodiversity</b>		
Membership organisations and associations for biodiversity-related industries (staff of the organisation) <ul style="list-style-type: none"> <li>• Professional Hunting Association of South Africa (PHASA)</li> <li>• National Confederation of Hunters Associations of South Africa</li> <li>• Protea Producers of South Africa</li> <li>• Southern African Wildlife Management Association (SAWMA)</li> <li>• South African Flower Export Council</li> <li>• South African Hunters and Game Conservation Association (SAHGCA)</li> <li>• Cape Flora South Africa</li> <li>• Wildlife Ranching South Africa</li> </ul>		✓
Bioprospecting and natural products – specific projects/initiatives <ul style="list-style-type: none"> <li>• Council for Scientific and Industrial Research: Bioprospecting section</li> <li>• Individual bioprospecting projects granted permits by DEA (includes harvesting, processing and distribution of the biodiversity resources concerned)</li> </ul>		✓
Game ranching and hunting <ul style="list-style-type: none"> <li>• Certain private game reserves and game farms for which studies are available</li> </ul>		✓
Indigenous flower harvesting and floriculture – specific projects/initiatives <ul style="list-style-type: none"> <li>• Flower Valley Conservation Trust</li> </ul>	✓	
<i>Total number of organisations in Category B5</i>	<b>12</b>	
<b>Total number of organisations in Category B</b>	<b>12</b>	
<b>Total number of organisations across all categories</b>	<b>158</b>	

## Annexure: Update to the initial assessment of biodiversity-related employment in South Africa

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The original work for the assessment of biodiversity-related employment in South Africa reported in this paper was undertaken between 2014 and 2016. This Annexure reports on an update of some of the data sources undertaken in 2019. The definitions, conceptual framework and broad types of data sources used remain unchanged from the original work.

The original assessment made use of the best data sources and employment estimates available at the time, although some of these data sources were recognised as being outdated, incomplete or approximations. An estimate of 388 000 biodiversity-related jobs in 2014 was made, although this was acknowledged as likely to be an underestimate, and several recommendations were made to improve the estimate.

Since the original work was undertaken, additional information sources have become available with which to update the figures for some of the sub-categories of biodiversity-related employment. The updated estimate is 418 000 biodiversity-related jobs in 2017, 30 000 more than the original estimate. Nevertheless, even at this stage, it remains difficult to associate the total biodiversity-related employment estimates directly to a specific year, or to calculate trends over time. The reason for this is that the variety of data used originate from different sources with differing dates of collection. Notwithstanding the update, there remain gaps in the assessment due to limited information for a number of sub-sectors, poor understanding of how jobs extend across broader value chains and incomplete information in some sub-categories. This means that, as with the original estimate, the revised estimate is not comprehensive and is likely to be an underestimate of the total number of biodiversity-related jobs.

This Annexure explains where and how additional information was sourced, as well as providing explanations for certain decisions and a small number of methodological changes made during the update. The Annexure is structured according to the five sub-categories of biodiversity-related employment identified in the original assessment and focuses only on updating information based on the methods and data sources identified as the most reliable for each of those categories. It uses the same procedures and assumptions made in the original assessment, except for those changes described below. Therefore, this Annexure should be read in conjunction with the preceding paper to fully understand the terminology, methods and categories used.

### Sub-category A1: Protecting and managing biodiversity assets

*Jobs directly involved in conservation of the country's biodiversity assets, both ecosystems and species. This includes management of protected areas and conservation areas, and efforts to conserve particular species. It also includes efforts to mainstream biodiversity in planning and decision-making in biodiversity priority areas outside of the protected area network.*

The method identified as the best option for estimating jobs in this category was administrative data. A list of 83 organisations was drawn up, including both government and non-government organisations (NGOs) that are involved in protecting and managing biodiversity assets. Then, employment information was sourced from annual reports, organisational websites or direct

requests for information. This information can be considered relatively certain, since it is based on actual employment numbers gathered from the organisations themselves.

We are confident that the most significant government employers and largest NGO employers are included, and that the employment statistics for these are based on reliable sources such as audited annual reports. However, an acknowledged shortcoming of the administrative data is that smaller biodiversity organisations may have been missed and that the list may not be comprehensive. During this update, an attempt was made to identify a more systematic method of identifying all relevant biodiversity-related organisations, particularly those outside of government. The Department of Social Development’s register of all Non-Profit Organisations (NPOs) (DSD, 2018) was considered as a potentially systematic way of identifying such organisations, as it has an option to filter the database by those organisations registered under the theme “natural resources conservation and protection”. However, after investigation, it became clear that very many NPOs listed under this theme were community projects, clean-up campaigns, “friends” groups, conservancies and other volunteer-based organisations that were unlikely to employ permanent staff, and also may not meet our definitions for biodiversity-related employment.

Administrative data is time consuming to collect. When considering updating the employment numbers for the list of organisations from 2013/14 (the date of the administrative data collected for the original assessment) to 2017/18 values, it became clear that very little difference in employment numbers was likely, and that the time and effort required to both update and quality check the numbers was not justified. For this reason, the employment figures given in this category have not been updated, and the 2014 employment figures have been retained for the organisations identified in the original assessment. Only one minor edit was made, and that was to round numbers of jobs to zero decimal places for some organisations for which employment had been calculated based on proportions. This avoided counting of “fractional” jobs, and made minimal changes to the estimate.

**Table A 1: Update for Sub-category A1 Protecting and managing biodiversity assets**

	Data source	Update	Date	Estimate
<b>A1: Protecting and managing biodiversity assets</b>	Administrative data	Not updated	2014	20 376

### **Sub-category A2. Restoring and maintaining ecological infrastructure**

*Jobs aimed at restoring the functioning of ecosystems to improve their ability to generate and deliver valuable services to people.* This includes, for example, removing invasive alien plants to improve water supply and agricultural productivity, and restoring wetlands to improve water quality and prevent flooding. It also includes a range of natural resource management and catchment management activities that contribute to maintaining healthy ecosystems.

Administrative data was also considered the best source of information for employment in this sub-category. There are fewer organisations involved in this sub-category (13) and the list is dominated by public employment schemes in the form of the Expanded Public Works Programme (EPWP), which includes the Department of Environmental Affairs’ Environmental Programmes (“Working for Water, Working for Wetlands and several others). As discussed in the main paper, jobs numbers

related to EPWP are expressed in terms of full-time-equivalents (FTEs) rather than the total number of short-term work opportunities created. For the same reasons explained for Sub-category A1 above, these estimates have not been updated from those gathered in 2014.<sup>25</sup>

**Table A 2: Update for Sub-category A2 Restoring and maintaining ecological infrastructure**

	Data source	Update	Date	Estimate
<b>A2: Restoring and maintaining ecological infrastructure</b>	Administrative data	Not updated	2014	36 420

For both Sub-categories A1 and A2, further work is likely to be required to improve consistency and comprehensiveness of the administrative data. Further attempts could be made to identify additional biodiversity organisations that may have been missed, although it is unlikely that any large organisations that currently exist have been omitted. In addition, some additional consideration may need to be given to some of the judgement calls necessary when only a portion of an organisation is involved in biodiversity, or in assigning an organisation to a certain category. It would also be worthwhile to establish capacity and protocols to update administrative information more efficiently to enable the information to be assigned to specific years and to investigate trends over time.

### **Sub-category A3: Research and professional services related to biodiversity**

*Jobs that contribute to knowledge of biodiversity, forming the foundation for effective management of biodiversity as well as innovation in the management and sustainable use of biodiversity. This includes the work of universities, other research institutions, biodiversity consulting services and biodiversity information management.*

Data from Statistics South Africa’s Quarterly Labour Force Survey (QLFS) (annualised as the Labour Market Dynamics Survey (LMDS)) was considered the best data source for estimating employment in this category. This is because the occupation codes used to categorise the QLFS correspond fairly well with recognised biodiversity-related jobs in research and professional services. For example, there are occupation codes for biologists, botanists, zoologists, natural science technicians, life science professionals, post-secondary teachers in biological disciplines, museum archivists and curators, and other biodiversity-related research professions. Ten occupation codes were identified which were likely to have all, some or few jobs that relate to biodiversity. Jobs in these categories were counted based on the proportions of their totals that were expected to be directly related to biodiversity.

One minor modification of the methods was made for the occupation code “Directors and chief directors”. In the *original assessment*, the proportion of jobs in this category (only 3.5% were counted as biodiversity-related) was split amongst other the employment categories. Since we are

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<sup>25</sup> However, in practice the number of work opportunities, and hence FTEs, related to EPWP fluctuates more than other public sector employment in BDE Category A and may require a different approach to updating the figures. For example, one could take a rolling average of the past five years. This was not explored in the current work.

not using the QLFS data for any of the other categories in this update, we have downscaled this proportion to only 0.5%.

Summary information on labour statistics is freely available online from Statistics South Africa (Stats SA), where it is found within the quarterly QLFS and annual LMDS reports. However, more detailed statistics categorised by the 3- and 4-digit codes are only available on request. Updated occupation code statistics were requested, and the same methods as per the original assessment were used to update the estimate. The latest data that were available were for the year 2017. Hence, we have updated the estimate in this category with 2017 employment numbers, which gave a total of 15 193 jobs (rounded to 15 000) compared with the 2014 estimate of 14 000.

Table A 3 shows the detailed results per occupation code in 2014 and 2017, rounded to the nearest thousand to reflect the uncertainty associated with QLFS estimates. The largest change is for code 2211 Biologists, botanists, zoologists and related professionals, which increased fourfold.

**Table A 3: Detailed estimates of biodiversity-related employment for Sub-category A3, from QLFS by occupation, comparing results for 2014 and 2017**

Occupation code and description		2014	2017
<i>All or most related to biodiversity</i>			
2211	Biologists, botanists, zoologists and related professionals	1 000	4 000
<i>Some related to biodiversity</i>			
2212	Biological sciences, Chemical sciences, Medical sciences, Physical sciences and Veterinary sciences	< 1 000	1 000
3111	Natural science technicians	9 000	8 000
<i>Few related to biodiversity</i>			
2210	Scientist	< 1 000	< 1 000
2213	Agronomists, food scientists and related professionals, Agriculture, forestry and food scientists, Natural sciences technologists	< 1 000	< 1 000
2310	Technikon, teacher training, technical and other colleges, university and other higher education institutions teaching professionals and Other post-secondary education teaching professionals	2 000	2 000
2431	Archivists and curators	< 1 000	< 1 000
3211	Life science technicians, Biological science and Medical science	< 1 000	< 1 000
3213	Farming and forestry advisers/consultants	< 1 000	< 1 000
<b>Total for Sub-category A3</b>		<b>14 000</b>	<b>15 000</b>

**Table A 4: Update for Sub-category A3 Research and professional services related to biodiversity**

	Data source	Update	Date	Original estimate	New estimate
<b>A3: Research and professional services</b>	QLFS occupation codes	Updated	2017	14 000	15 000



## Sub-category B4: Non-consumptive use of biodiversity

*Jobs that depend on the enjoyment of biodiversity but do not involve extraction or consumption of the underlying biodiversity asset and can thus be sustained on a long-term basis. This includes nature-based tourism (e.g. bird watching, whale watching, diving, hiking), some adventure sports, and production of media and art related to biodiversity (e.g. through nature journalism, photography, and film making). These activities can take place inside or outside of protected areas.*

Biodiversity-related tourism is the primary focus of this category. In the original assessment, jobs in this category were estimated using the QLFS industry codes, particularly those relating to tourism accommodation, adventure sports and recreational activities. However, not all the jobs in these industries are directly related to biodiversity, so only a proportion of the total jobs within these industry codes were counted. A strong recommendation of the original assessment was that further research should be done to determine how many jobs in tourism were directly related to South Africa's natural attractions and biodiversity.

As a result, the South African National Biodiversity Institute (SANBI) commissioned a study, conducted by the consulting firm Grant Thornton, to undertake a quantification of tourism related to South Africa's biodiversity assets (Bac & Tlholoe, 2017). This study produced a model for biodiversity-related tourism based on the Tourism Satellite Account (Stats SA, 2018). The Tourism Satellite Account is a report published by Stats SA that "provides an overview of the role that tourism plays in South Africa and provides information on the contribution by tourism to the South African economy in terms of expenditure and employment". The model was developed in close consultation with Stats SA to determine the proportion of tourism revenue and jobs that could be directly attributed to South Africa's biodiversity. The resulting finding was that for the year 2015, 12.5% of all tourism jobs in the country could be attributed to biodiversity. In 2015, this amounted to 88 400 direct biodiversity-tourism related jobs. This figure corresponds very closely with the 2014 estimate in the original assessment, which was 86 000 based on the QLFS industry codes. The fact that these estimates agree so closely gives them further credibility.

For this update, we have therefore elected to change the preferred data source for this category from the QLFS industry codes, to the model based on the Tourism Satellite Account. The reasons for this change are twofold. Firstly, the model developed by Grant Thornton in association with Stats SA has a stronger methodical basis for the proportions used, in comparison to the somewhat arbitrarily estimated proportions of QLFS jobs used in the original assessment. Secondly, the QLFS data are available only on request, whereas the Tourism Satellite Account is regularly published online.<sup>26</sup>

The Tourism Satellite Account reports that, in 2017, 722 013 persons were directly employed in the tourism sector (Stats SA, 2018). Using the 12.5% proportion developed by the Grant Thornton model, this amounts to 90 252 biodiversity-related tourism jobs (rounded to 90 000) in 2017.

**Table A 5: Update for Sub-category B4 Non-consumptive use of biodiversity**

	Data source	Update	Date	Original estimate	New estimate
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<sup>26</sup> A subsequent development is that Stats SA plans to publish a regular report on experimental biodiversity tourism estimates, as a complement to the Tourism Satellite Account.

<b>B4. Non-consumptive use of biodiversity</b>	Tourism Satellite Account	Updated	2017	86 000 (based on QLFS)	90 000
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### Sub-category B5: Extractive use of biodiversity

*Jobs that depend on the direct extraction or consumption of biodiversity in the form of indigenous species or ecosystems, either for profit or subsistence. This includes may include sectors such as game ranching and hunting, rangeland agriculture (which depends on natural ecosystems such as Grassland and Karoo), harvesting of wild indigenous resources (e.g. fisheries, medicinal plants, wildflowers such as Proteas), biotrade (trade in harvested indigenous resources), cultivation of indigenous species (e.g. rooibos), horticulture and floriculture based on indigenous species, processing or manufacturing of products based on indigenous resources (e.g. fibres and building materials), bioprospecting (e.g. to develop pharmaceuticals, nutraceuticals or cosmetics based on indigenous species and genetic resources).*

In the original assessment, it was determined that employment estimates in this category would be most reliably based on existing estimates for particular sectors or sub-sectors rather than on QLFS or administrative data. These are estimates developed to determine the economic contribution of these sectors, usually in the form of studies undertaken by industry bodies or research institutions. The advantages and disadvantages of such data are discussed in further detail in the main paper, as well as factors to be considered in deciding whether to use such studies. As a result of both availability and reliability of such estimates, only four sub-sectors were included in the employment estimates of the original assessment: traditional medicine, wildlife ranching, fisheries and indigenous tea. For this update, we will address each of these estimates separately below:

**Traditional medicine:** The original assessment used an estimate of 133 000 jobs in traditional medicine that was sourced from a paper by Mander et al. (2007), which was based on four seminal studies about this sector. Additional research on the traditional medicine sector has been conducted since then, including a consultancy report for SANBI (Ground Level Landscapes and Zuplex Botanicals, 2017). This more recent report estimates that there are now between 200 000 and 300 000 Traditional Healing Practitioners that derive an income from traditional medicines. However, these figures are based on personal communications with experts rather than systematic methods. In addition, many of these are likely to be part-time jobs. Hence, the estimate of 133 000 jobs used in the original assessment has been retained and this sector estimate has not been updated.

**Wildlife ranching:** The *original assessment* used an estimate for employment in wildlife ranching that was sourced from a comprehensive assessment of the industry conducted by the Endangered Wildlife Trust (EWT) in 2015 (Taylor et al., 2015). Based on survey data, it determined that the median number of jobs per hectare within the industry was 0.0038. Given the area of the country under wildlife ranches at the time, an employment estimate of 65 172 was reported. Since the report provides a per hectare employment statistic, it is possible to update employment numbers as updated hectare estimates become available.

Estimates for the number of hectares under wildlife ranching vary and there is no reliable system to monitor this land-use. Estimates range from the 17 million ha in the EWT report (Taylor et al., 2015) to an earlier estimate of 20.5 million ha (NAMC, 2016). Wildlife ranching was a focus of the

Biodiversity Economy Lab led by DEA and the Department of Tourism, which reported a figure of 18.7 million ha in 2016. We have hence updated the estimate for employment in the wildlife ranching industry based on this most recent, and intermediate, area approximation: 18.7 million ha  $\times$  0.0038 = 71 060 (rounded to 71 000).

It should be noted that EWT is currently working on additional research that will further investigate the social, financial and economic impacts of the wildlife ranching industry. This will include more detailed information on employment numbers, including the fact that ranches with differing focus and in different provinces may have different employment estimates. For example, it will likely show that ecotourism-based ranches generally employ more workers than ranches focused on biltong hunting. However, this research has yet to be published as is therefore not used in this update.

**Fisheries:** The original assessment used a widely cited estimate of 27 000 jobs in commercial fisheries, which was traced to a Rhodes University study from 2002 (Mather et al., 2003; Sauer et al., 2003). This estimate is now over 17 years old. An updated source for employment in commercial fisheries was discovered in a detailed report by the consulting firm Feike (Feike, 2010) and reiterated in a WWF report on the South African fishing industry (WWF, 2011). The Feike report details fishing rights, economic impacts and jobs across 21 commercial fisheries. It estimates that in 2010 there were 43 458 direct jobs in commercial fisheries. The bulk of these (around 75%) came from five fisheries: small pelagic (pilchard, sardine, anchovy) (15 100 jobs), hake deep-sea trawl (9 000 jobs), West Coast rock lobster (4 300 jobs), squid (2 400 jobs) and hake longline (1 500 jobs) (figures rounded to nearest 100). Only direct jobs were counted, e.g. on vessels and in processing factories. This is a substantially more recent estimate than the older 2002 estimate. Personal communication with the consultants suggests that there have been job losses since 2010 due to closure of some fisheries. However, there is no more recent published report for this, so we have elected to use the 2010 estimate of 43 458 jobs (rounded to 43 000).

**Indigenous tea:** The *original assessment* used an estimate of 6 000 jobs in indigenous tea production based on industry profiles produced by the Department of Agriculture, Forestry and Fisheries of the rooibos tea and honeybush tea industries (DAFF, 2012a; DAFF, 2012b). Updates of these reports were produced in 2016, but contained similar employment estimates (DAFF, 2016a; DAFF, 2016b). A factsheet produced by the Rooibos Council in 2018, provided an updated estimate of 8 000 farm labourer jobs in the rooibos tea industry (Rooibos Council, 2018). This is acknowledged as an estimate, based on information from producers affiliated with the Rooibos Council. However, since this is an industry body representing a number of rooibos companies, we have used this updated figure for jobs in the rooibos industry. It is important to note that this estimate is only for farm workers and there are likely to be many more jobs in the broader value chain for rooibos tea and other rooibos-based products such as cosmetics. We have retained the DAFF estimate for jobs in the honeybush tea industry of 780 used in the original assessment, which includes jobs across the value chain for honeybush tea (DAFF, 2016b). Hence, this update uses 8 000 jobs in rooibos and 780 in the honeybush tea industry, to achieve a total of 8 780 jobs (rounded to 9 000) in indigenous tea industries.

**Other sector estimates:** The original assessment included a recommendation to investigate other potential sector estimates, such as those industries based on indigenous horticulture, indigenous fibres and building materials, or cosmetics and pharmaceuticals using indigenous species, amongst

other sectors. However, no reliable additional sector estimates could be found during this update. It is recommended that further communication and interaction with industry bodies in these sectors is necessary to discover whether any employment statistics are available or could be researched in the future.

**Table A 6: Update for Sub-category B5 Consumptive use of biodiversity**

	Data source	Update	Date	Original estimate	New estimate
Traditional medicine	Mander et al. (2007)	Not updated	2007	133 000	133 000
Wildlife ranching	Taylor et al. (2015)	Updated	2016	65 000	71 000
Fisheries	Feike (2010)	Updated	2010	28 000	43 000
Indigenous tea	Rooibos Council (2018), DAFF (2016b)	Updated	2016-2018	6 000	9 000
<b>B5. Consumptive use of biodiversity</b>	Existing sector estimates	Some updated	Various	232 000	256 000

### Final updated employment figures

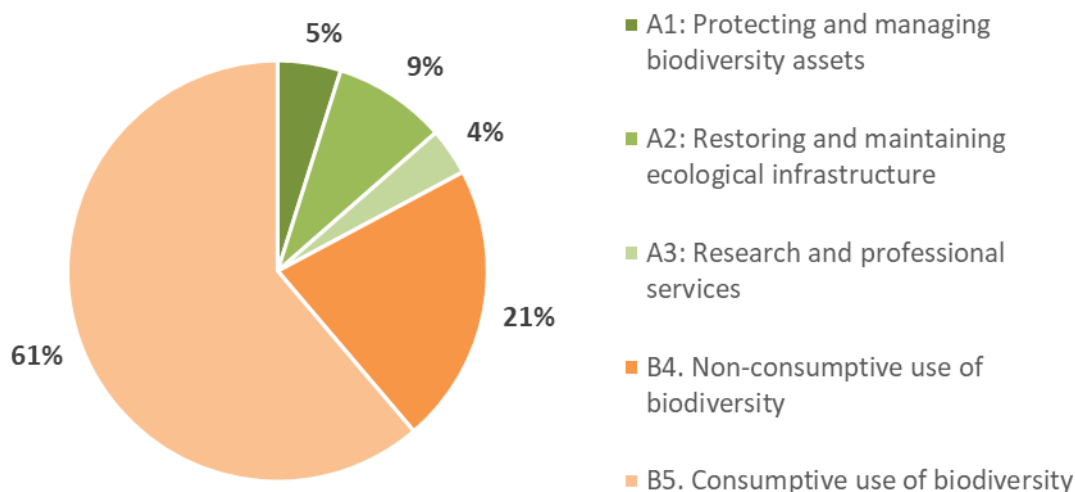
The original biodiversity-related employment estimates were 70 000 jobs related to conserving biodiversity and 318 000 jobs related to using biodiversity. The updated biodiversity-related employment estimates following this revision are 71 000 jobs related to conserving biodiversity and 346 000 related to using biodiversity, or 418 000 jobs in total (Table A 6; Figure A 1). This represented 2.6% of national employment of 16.2 million in 2017 (Stats SA, 2017).

The best estimates available at time of revision (March 2019) were used; nevertheless, the date range for these estimates is broad, between 2007 and 2018. As with the original estimate, we have elected to pin the updated estimate to a particular year, recognising that this is somewhat arbitrary. We have chosen 2017, which is the date for the Tourism Satellite Account figures used for Sub-category B4 and the QLFS data used for Sub-category A3.

**Table A 7: Updated biodiversity-related employment estimates across all sub-categories**

BDE category	Data source	Update	Date	Original estimate	New estimate
A1: Protecting and managing biodiversity assets	Administrative data	Not updated	2014	20 000	20 376
A2: Restoring and maintaining ecological infrastructure	Administrative data	Not updated	2014	36 000	36 420
A3: Research and professional services	QLFS occupation codes	Updated	2017	14 000	15 000
<b>A: Conserving Biodiversity</b>				<b>70 000</b>	<b>72 000</b>
B4. Non-consumptive use of biodiversity	Tourism Satellite Account	Updated	2017	86 000	90 000
B5. Consumptive use of biodiversity	Existing sector estimates	Some updated	Various	232 000	256 000

<i>B: Using Biodiversity</i>	318 000	346 000
<b>Total biodiversity-related employment</b>	<b>388 000</b>	<b>418 000</b>



**Figure A 1: Percentage biodiversity-related employment by sub-category, based on updated estimates**

The ratio of jobs involved in conserving biodiversity to those using biodiversity remains similar, increasing slightly from 1:4.5 based on the original estimate to 1:4.8 based on the updated estimate. Because the estimate for BDE Category B is likely to be an underestimate, we have rounded the ratio to approximately 1:5. As for the original estimate, this implies that the relatively small number of jobs involved in managing and conserving South Africa’s biodiversity supports a much larger number of jobs that depend on biodiversity.

### Comparison with other sectors

To make a comparison between biodiversity-related employment and employment in other conventionally defined employment sectors, employment statistics were sourced from Stats SA’s Labour Market Dynamics in South Africa report for 2017 (Stats SA, 2017) and the Tourism Satellite Account (Stats SA, 2018). Table A 6 shows how employment numbers compare across sectors. Biodiversity-related employment is most similar to employment in the mining sector, which employs almost the same number of people. Biodiversity-related employment is approximately half that in tourism, agriculture and transport.

**Table A 8: Comparison of biodiversity-related employment with employment in other sectors**

Employment sector	Number of jobs
<i>Biodiversity-related employment</i>	418 000
Utilities	118 000
Mining	434 000
Tourism	722 000

Agriculture	843 000
Transport	910 000
Private households	1 283 000
Construction	1 431 000
Manufacturing	1 692 000
Finance	2 275 000
Trade	3 178 000
Service	3 571 000

### Note on biodiversity expenditure

The Biodiversity Finance Initiative (BIOFIN)'s *Biodiversity Expenditure Review* was published in 2016 (DEA, 2016). It calculated that in 2014/15 expenditure by national government, government entities, provincial and local government on biodiversity was R10 198 million, which is less than 1% of all government expenditure. Biodiversity funding from the seven largest biodiversity NGOs amounted to R336 million and was largely sourced from donors. Operating expenditure in private protected areas was estimated at R668 million. Consolidated government expenditure directed towards biodiversity conservation-related activities was approximately 0.9% per year of total government expenditure between 2008/09 and 2014/15.

Taken together with the biodiversity-related employment figures presented in this paper, this suggests that a relatively modest investment by the public sector in managing and conserving biodiversity helps to secure the basis for around 350 000 jobs (or more) that make use of biodiversity.

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