Recontextualisation of Biodiversity Knowledge in the Senior Phase Natural Sciences Curriculum

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by

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ABSTRACT

This study explored the nature of biodiversity knowledge in the Senior Phase Natural Sciences curriculum in relation to international and national scientific documents. Significant biodiversity key features were identified from a review of these documents. These concepts were then explored in terms of how they had been presented and recontextualised in the Senior Phase Natural Sciences CAPS policy document and a selection of three commonly used textbooks for this subject in South Africa. Using Bernstein's (1990) framework of the Pedagogic Device, the study traces how biodiversity knowledge was de-located from the scientific Field of Production (FOP) and relocated into the Official Recontextualisation Field (ORF) and Pedagogical Recontextualisation Field (PRF). In exploring the continuity, changes and discontinuities in the biodiversity content, as it has been recontextualised, the study utilised Bernstein's concepts of selective appropriation and ideological transformation.

The study is a qualitative case study that drew on document analysis and structured interviews to generate data. Data analysis for this study consisted of two phases. Phase One involved an analysis of biodiversity knowledge in the *Millennium Ecosystem Assessment* (MEA, 2005) and *Life: The State of South Africa's Biodiversity* (SANBI, 2013) which represented the FOP. This was in order to explore the nature of biodiversity knowledge in those documents. This knowledge was then compared to the Senior Phase Natural Sciences curriculum which represented the ORF and selection of textbooks representing the PRF. Phase Two sought to investigate the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge. This phase entailed an analysis of interviews.

The findings showed that both the international document and the national document presented biodiversity knowledge in terms of their fundamental value to humans. In addition, these documents illustrated human-environmental interactions. They presented procedural knowledge that allow us to understand ecosystems and their services to human well-being. The documents also described how ecosystem services are in decline in many places around the world. The documents presented knowledge of threats to biodiversity such as habitat loss, invasive species, pollution, and overharvesting. They also included knowledge of

conservation and sustainability which focused on preventing ongoing degradation and restoration and reversal of degradation of ecosystems.

In comparing the ORF and the PRF this study showed that the CAPS policy document appears to present concepts foundational to understanding biodiversity rather than discussing biodiversity itself. The textbooks contextualise these foundational concepts and broaden them mostly through pictorial illustrations, as case studies and contextual examples.

A recommendation from the research is that the official recontextualisation process should review opportunities to draw on international and national documents that present concepts and contemporary cases of biodiversity content knowledge to ensure that the complexities around biodiversity are presented in the curriculum. This study may contribute to the development and review of the Natural Sciences curriculum and environmental education in South Africa. The study also suggests areas of biodiversity knowledge that might be included as curriculum content in the future. It further suggests that curriculum developers consider including new environmental knowledge which deals with local, national and global needs and expectations.

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ACRONYMS

CAPS	Curriculum and Assessment Policy Statements
C2005	Curriculum 2005
CBD	Convention Biological Diversity
DBE	Department of Basic Education
DoE	Department of Education
DEA	Department of Environmental Affairs
ESD	Education for Sustainable Development
FET	Further Education and Training
FOP	Field of Production
IUCN	International Union for the Conservation of Nature
MEA	Millennium Ecosystem Assessment
NBSAP	National Biodiversity Strategy Action Plan
NCS	National Curriculum Statement
NEEP-GET	National Environmental Education Project General Education and Training
NGO	Non-Governmental Organisation
ORF	Official Recontextualisation Field
PRF	Pedagogic Recontextualisation Field
RNCS	Revised National Curriculum Statements
RSA	Republic of South Africa
SANBI	South African National Biodiversity Institute
SCBD	Secretariat of the Convention on Biological Diversity
SES	Senior Education Specialist
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WWF	World Wide Fund for Nature

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction

This chapter introduces the study and the thesis. It starts with a discussion of the context of the study. This is followed by a discussion of the rationale behind the study, and a brief introduction to the theoretical framework of the study. The chapter also introduces the research questions which guided the study and ends with an outline of the thesis structure.

1.2 Context of the Study

Since South Africa's first national democratic elections in 1994, the government issued several curriculum-related reforms, intended to democratise education and eliminate inequalities created by apartheid (Jansen, 1999). It was only after 1994, that the national curriculum set standards and expectations for the mainstreaming of environmental learning. In 1997, Curriculum 2005 (C2005) was implemented (ibid.). Later, environmental learning was promoted through guiding principles highlighting the relationship between human rights, social justice, a healthy environment and inclusivity (Schudel, 2014). Additionally, environmental learning gained prominence in C2005 when 'environment' was established as one of the five 'phase organisers' for Senior Phase around which all learning was expected to be designed (ibid.). The 'phase organisers' for Senior Phase were Personal development and empowerment, Environment, Culture and society (including citizenship), Economy and development, and Communication (Department of Education, 1997).

Later in 2002, the Revised National Curriculum Statement (RNCS) for General Education and Training, together with the National Curriculum Statement (NCS) for Further Education and Training emerged, and environmental learning was integrated explicitly in critical outcomes and specific learning outcomes defined by the curriculum (Schudel, 2014). In addition to the latter, environmental learning was also highlighted in the role and features of the RNCS/NCS learning areas, and in core knowledge foci of the Social Sciences, Natural Sciences and Economic and Management Sciences (Lotz-Sisitka, 2002). Section 2.5.1 elaborates on the emergence of environmental learning in the South African curriculum.

These historical initiatives of introducing an explicit environmental concern in the South African curriculum, have ensured that in the 2012 Curriculum and Assessment Policy

Statements (CAPS), environment is fundamental to the curriculum. This is evident in subjects such as:

> Natural Sciences, Life Orientation and Economic and Management Sciences which prescribe specific environmental concepts such as sustainability, environmental issues such as pollution and climate change, and concepts such as ecology and biodiversity, which are foundational to understanding the biophysical dimensions of environmental issues and risks. (Schudel, 2014, p. 100)

1.2.1 My role as an Eco-School coordinator

This research is influenced by my personal experiences with Grade 7 learners from the two schools where I was an Eco-School coordinator. These learners struggled to engage with the Eco-School theme of biodiversity actively and with the necessary and expected confidence. The Eco-Schools programme is an international programme of the Foundation for Environmental Education (FEE) that was developed to support environmental learning in the classroom.

I also became aware of the fact that teachers focus mainly on recalling definitions of biodiversity and related concepts. This was evident in the learners' work, and from observations of teaching and learning which I conducted as part of my role as an Eco-School coordinator. Teachers tended to avoid teaching the complexities of the topic, for example, how preserving our biodiversity secures our future, or how biodiversity contributes to our economy, and how biodiversity is affected by our agricultural, business and industrial sectors. This failure to deal with vital biodiversity intricacies and complexity became questionable educational practice, a question of educational quality for me that influenced my interest in this research.

1.3 Rationale for the Study

The research interest in biodiversity is influenced by the fact that South Africa has an incredibly rich biodiversity, third only after Brazil and Indonesia (South Africa. Department of Environmental Affairs [DEA], 2009). Most importantly the *Life: The State of South Africa's Biodiversity 2012* report noted that South Africa still needs many more scientists who are trained in different disciplines in the Natural Sciences, so that the country can

continue to produce world-class biodiversity science to inform the wise management and sustained use of our natural world (South African National Biodiversity Institute [SANBI], 2013). Lastly, the research is influenced by a warning in the above report which noted that some parts of the country have lost much more natural habitat than others. It also indicated that if Gauteng, KwaZulu-Natal and North West Province keep losing natural landscapes at the current rate (for example, to cultivation, mining and urban expansion), by 2050 these provinces will have almost no natural habitat left outside protected areas (ibid.). Thus it is important to know how the schooling system is informing and preparing learners in the sustainable use of biodiversity.

1.4 Educational Problem

In addition to my expressed personal concerns about the quality of biodiversity education, this study has also been informed by the 2009 NCS Review Report. This report criticised the NCS curriculum for knowledge gaps, especially in terms of the specification of content to be taught. The current curriculum (CAPS) has been designed to address these gaps (Dada et al., 2009). Section 1.2 described how environmental concerns have become integral to the post-apartheid curriculum, and how environmental topics are now specified in the CAPS curriculum. This study intended to explore how one of these topics, biodiversity, is recontextualised in the FOP, ORF and PRF of the Pedagogic Device (Bernstein, 2000).

This is an interest of the Fundisa for Change national teacher education programme, which has a research branch funded by the National Research Foundation. Fundisa for Change seeks to understand how new environmental knowledge, such as biodiversity, is produced and how it is also recontextualised (Fundisa for Change, 2014). My study focused on the latter that is recontextualisation of biodiversity knowledge between scientific research documents, the school curriculum and textbooks.

This study sought insight into the detail of the environmental content that schools are working with specifically concerning biodiversity. The study drew on the work of Bernstein to understand how biodiversity discourse moves within the Pedagogic Device.

1.5 Theoretical Framework of the Study

This study drew on Basil Bernstein's (2000) theory of the Pedagogic Device, in particular the recontextualisation of knowledge. The focus of the study is exploring the nature of biodiversity knowledge for schooling in curriculum policy and textbooks in relation to biodiversity knowledge produced by scientists in the Field of Production (FOP). The CAPS document, in Bernsteinian terms, represents the Official Recontextualising Field (ORF). The study also has an interest in the Pedagogic Recontextualising Field (PRF) which is represented in this study by Natural Sciences Provincial coordinator, subject advisors / Senior Education Specialists (SESs), and textbooks. The Pedagogic Device, and processes within it, are elaborated in Section 2.6.

1.6 The Research Questions

This research investigated biodiversity content presentation and recontextualisation by means of the following research questions:

MAIN QUESTION: How is biodiversity content presented in scientific documents and recontextualised in the Senior Phase Natural Sciences curriculum and supporting textbooks?

SUB QUESTIONS:

1. What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the Field of Production?

The representation of this discourse was then reviewed in an international and national scientific document (FOP), the CAPS Senior Phase Natural Science Curriculum (ORF) and three commonly used textbooks for this subject (one per grade across Grades 7, 8 and 9). These textbooks represented the PRF. This sub question required two analytic phases. The first was a review of the national and international scientific documents (FOP). The second phase reviewed progression of these knowledge in the CAPS and the textbooks.

2. What is the nature of biodiversity knowledge in the Natural Sciences curriculum and in the commonly used Grade 7-9 Natural Sciences textbooks?

3. Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge?

This sub-question was aimed at understanding who the role players are during the recontextualisation of biodiversity knowledge. It also aims at understanding their roles during this process.

1.7 Overview of the Study

Chapter 1 introduces the study and the thesis. It provides the context and a rationale for conducting the study, and briefly introduced the conceptual and theoretical frameworks of the study. The chapter also introduces the research questions of the study. The chapter ends with an overview of the thesis structure.

Chapter 2 firstly reviews literature relevant to this study's focus, giving an overview of biodiversity and how it has been evolving in the school curriculum, nationally and internationally. It also focuses on what is taught in the curriculum. Secondly, the chapter explores key features of biodiversity discourse, which are used in Chapter 4 to describe how biodiversity content is represented in documents. The chapter also discusses conceptual and theoretical tools that guide the study.

Chapter 3 describes the research methodology that guides this study. It outlines the research orientation and the case study method used in the study. It also explains how the data was generated and analysed. The chapter describes the steps taken to ensure validity and trustworthiness throughout the study, as well as the efforts to ensure that the study was conducted in an ethical manner.

Chapter 4 presents the data generated from document analyses and interviews. It provides insight into biodiversity content in one international and one national document, the Senior Phase Natural Science curriculum policy document, and textbooks. Chapter 4 highlights evidence of selective appropriation and ideological transformation. Insights on biodiversity content are discussed using the themes: ecosystems services, threats to biodiversity, and conservation and sustainability of biodiversity. The chapter also highlights and provides a description of the recontextualising process across the Pedagogic Device.

Chapter 5 discusses the findings which are presented in Chapter 4. The findings highlight the biodiversity knowledge and how it is presented in the FOP, ORF and PRF. The findings discuss the selective appropriations and ideological transformations identified in the study, and recontextualisation processes. The chapter also discusses the overall findings of the study and makes recommendations from the study to inform biodiversity education in the Grade 7-9 Natural Sciences Curriculum.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter commences with a broad overview of biodiversity in the global and national context. It then discusses the integration of environmental education, in relation to biodiversity in the South African national curriculum. Furthermore, it details the theoretical and conceptual framework of the study with recontextualisation as a specific interest. It also discusses the biodiversity content knowledge explored in the study.

2.2 Biodiversity and Biodiversity in South Africa

According to Guthrie (2007), the biodiversity of a system simply includes biotic and abiotic elements of that system. 'Biotic elements' refer to species, populations and communities while 'abiotic elements' refer to non-living elements such as water, soil and climate. Biodiversity includes three main types: diversity within species- genetic diversity, between species - species diversity and between ecosystems - diversity (Convention on Biological Diversity (CBD, 2010). Furthermore, according to Guthrie (2007), biodiversity mainly consists of the interactions of species and populations, and the services and functions that they bring about within ecosystems.

Rouwenhorst (2007) described biodiversity in terms of animals, plants, fungi, ciliates and flagellates (microscopic organisms), amoeboids, archaea bacteria (a type of prokaryote, a unicellular organism without a cell nucleus) and bacteria. Biodiversity also includes all aspects of biological diversity, species richness, ecosystem complexity and genetic variation, and involves all the evolutionary and ecological aspects, and includes the intraspecific and interspecific patterns in the ecosystem. Biological diversity includes the entire range of species that can be found on earth (ibid.).

Researchers have developed other complex explanations of biodiversity. Blanchard (2014) includes components such as genetics, species richness and abundance. Snyder and Read (2012) described biodiversity as "the complex web of life", which embraces the diversity of life on Earth at every level, including genes, species and ecosystems. Reflections on biodiversity loss as part of the Earth's socio-ecological crisis need to take these broad definitions of biodiversity into account.

South Africa has the third highest variety of flora and fauna in the world (South Africa. DEA, 2009). Although it only covers 2% of the land surface of the world, it is home to nearly 10% of the planet's plants, 5.8% of its mammals, 8% of its bird species, 4.6% of its reptiles, 5.5% of its insects and almost 15% of all known coastal marine species (South Africa. DEA, 2009). South Africa's economic growth depends greatly on its rich biodiversity (Algotsson, 2009) and Turpie (2009) emphasised that economic growth can be achieved through local agriculture, tourism and recreational well-being. Part of the analytic work of the thesis is to gain insight into biodiversity and biodiversity knowledge in South Africa. Therefore in Section (4.2.2) this will be elaborated. The following section will expand on biodiversity loss, as well as global and national educational responses.

2.3 Global and South African Biodiversity Loss

Human beings are part of the planet's ecosystems and thus the present biodiversity crisis poses a risk to human health, environment and economies. According to the WWF (2014), population growth and human consumption are the main causes of biodiversity loss. Humans are using one quarter more natural resources than the Earth regenerates, and this, together with large amounts of waste that humans produce, causes biodiversity loss.

The 2014 International Union for the Conservation of Nature (IUCN) presented the case that the Earth's biodiversity is unable to bear the demands of present trends of human production and consumption. The document also reported that 26 million hectares of primary forest have been lost annually and 70% of coral reefs are destroyed or threatened, yet they are important sources of food and provide storm protection. Biodiversity loss affects the income of 50 million people worldwide. Furthermore, the report noted that of the world's 5 494 mammal species, 78 are extinct, 191 are critically endangered, 447 are endangered and 496 are vulnerable. Of the Earth's 6 312 amphibians, 1 910 are in danger of extinction. The report stated that the main threats to biodiversity are habitat loss and degradation, which affects 86% of all threatened birds, 86% of threatened mammals and 88% of all threatened amphibians (IUCN, 2014).

A Technical Report for the Global Biodiversity Outlook 3 shows that the targets for reducing biodiversity loss have not been met in any part of the world, while the drivers of biodiversity loss, namely the destruction and conversion of natural habitats, are intensifying (Leadley et

al., 2010). The report also shows that biodiversity loss is increasing in all three spheres of biodiversity that is with respect to species, genetics and ecosystems (ibid.).

In response to requirements of the Convention on Biological Diversity (CBD), as well as national needs, South Africa developed a National Biodiversity Strategy and Action Plan (NBSAP) that was published in 2005 (Cadman et al., 2010). NBSAP assessed the threat status and protection levels of South Africa's ecosystems, and identified national areas of biodiversity importance that should be prioritised for conservation action. The single biggest cause of biodiversity loss in South Africa is the outright loss of natural habitats and ecosystems (Cadman et al., 2010). In addition, the report emphasised that the greater the extent of loss, the more ecosystem functioning is affected, leading eventually to the collapse of the system and the loss of services it provides (ibid.).

In addition to NBSAP, the South African National Biodiversity Institute (SANBI) was created in 2004 as a direct requirement of the Biodiversity Act. Its purpose is to "champion the exploration, conservation, sustainable use, appreciation and enjoyment of South Africa's exceptionally rich biodiversity, for all people". SANBI assesses biodiversity in South Africa every five to seven years.[1] In its 2011 National Biodiversity Assessment, it reported that 48% of the country's wetland ecosystems were endangered and that only 18% of high water yield areas have some form of formal protection (SANBI, 2011). It also reported that 24% of coastal and in-shore ecosystems and 12% of off-shore were critically endangered, only 4% of off-shore ecosystems were well protected (ibid.).

St Lucia, South Africa's flagship estuary and part of a World Heritage Site, is in a poor state and consequently unable to fulfil its role as the most important nursery for marine fish on the south-east African coast (SANBI, 2011). In addition, the report stated that terrestrial ecosystems are threatened by the loss of natural habitat (ibid.). The report warned that in KwaZulu-Natal, North-West Province and Gauteng, conversion of natural vegetation to other land uses will result in no natural habitat being left outside of protected areas (ibid.). Of

[1] The National Biodiversity Assessment is due to be released in 2019.

South Africa's over 2 000 medicinal plant species, 656 are traded. Of those, 56 are threatened, of which seven are critically endangered. Between 1990 and 2007, invasive alien plants doubled from 10 to 20 million hectares (ibid.). Invasive species can cause great damage to native species by competing with them for food, eating them, spreading diseases, causing genetic changes through inter-breeding with them and disrupting various aspects of the food web and the physical environment.

This loss of biodiversity resources (the loss of natural capital) occurring across South Africa, decreases society's ability to adapt and respond to the challenges of increasing poverty, climate change and other environmental risks and vulnerabilities(SANBI, 2011). The following section will discuss biodiversity education at international and national levels. As mentioned in Section 2.2 the analytic work of this thesis will be to look at biodiversity loss in South Africa in more detail (see Section 4.2.2).

2.4 International Actions towards Biodiversity Loss

Countries have responded to recommendations and commitments to work towards promoting a sustainable environment through international initiatives such as the *Belgrade Charter* (UNESCO-UNEP, 1975), the *Brundtland Report of the World Commission on Environment and Development in* 1987, the 1992 *Earth Summit* that was held in Rio de Janeiro and the *World Summit* in 2002. Agenda 21, signed in 1992 at the Earth Summit, committed countries to education as one way of dealing with environmental problems. Most developing countries depend on natural resources to fight poverty. Consequently, the term 'sustainability' evolved to include social, political and economic causes of the environmental crisis. In 1991, some of the world's strongest environmental organisations, in particular the International Union for the Conservation of Nature (IUCN), the United Nations Environmental Programme (UNEP) and the World Wildlife Fund (WWF) drew up a strategic plan called *Caring for the Earth* which projected a systemic, process directed view of sustainability. It is based on two interdependent principles: people's responsibility to care for nature (ecological responsibility) and people's responsibility to care for each other (social justice).

As briefly indicated earlier in this section, one way in which the international agreements committed to addressing biodiversity loss was through education. Education has been acknowledged as an important tool to achieve sustainability as well as biodiversity protection

through the transformation of human attitudes towards nature (Ehrlich & Pringle, 2008). In addition Lindemann-Matthies (2009), suggests a biodiversity education that enables people to understand the different meanings, interpretations and uses of biodiversity as well as their cultural, spiritual and economic heritage. The following section discusses national actions towards biodiversity education in South Africa.

2.5 National Actions towards Biodiversity Education

2.5.1 History and background of environmental education

Post-apartheid educational transformations were influenced by a fragmented and unequal education system. The need to establish a national curriculum for all South Africans led to the introduction of Outcome Based Education and a National Qualifications Framework (Republic of South Africa [RSA], 1995) as indicated in Chapter 1. Some immediate responses were put in place to reduce the racial stereotyping in the curricula and materials, while other progressive policies such as continuous assessment were introduced, and a more comprehensive curriculum development process was introduced in 1997 *Curriculum 2005* (C2005).

In C2005, 'environment' was a phase organiser in all the learning areas. Curriculum 2005 was an outcomes-based curriculum, and was introduced to South African schools in 1998. All subject teachers were to integrate environmental education into their teaching and learning. An environmental focus had to be considered in teaching (Irwin & Lotz-Sisitka, 2004). C2005 was revised to become the NCS, to promote a greater emphasis on subject-related content-based knowledge to balance out the over-emphasis on outcomes and integration, which characterised C2005 (Janse van Rensburg & Lotz-Sisitka, 2000). A national project for environmental education in the new NCS curriculum was established by the Education Minister (Irwin & Lotz-Sisitka, 2004). One of the principles underpinning the NCS curriculum was the recognition of the relationship between social justice, a healthy environment, human rights and inclusivity (National Environmental Education Programme for General Education and Training [NEEP-GET], 2004).

In 2009 the Minister of Basic Education called for a review of the national curriculum, to identify the challenges and pressure points that impacted negatively on the quality of teaching in schools, and to propose mechanisms that could address these. A single Curriculum and

Assessment Policy Statement (CAPS) for each subject was developed. CAPS included environmental knowledge content. Specific environmental content knowledge such as pollution, climate change, and biodiversity was included in various subjects including Natural Sciences.

2.5.2 Biodiversity curriculum

As indicated in the previous section, South Africa's first national curriculum under democracy was named *Curriculum 2005* (Jansen, 1999). Chisholm (2005) explained that C2005 was an outcomes-based curriculum, which was mainly characterised by specific outcomes, assessment criteria, phase and programme organisers, range statements, performance indicators and expected levels of performance. The curriculum included 'environment' as a phase organiser, with biodiversity appearing in two of the six phase organisers (Chisholm, 2005). Biodiversity content that was introduced in this curriculum, was inadequate to equip learners with a full understanding of biodiversity and its complexities (Isaacs, 2016).

The new RNCS set clearer knowledge and skills guidelines for teachers. The RNCS streamlined and simplified the curriculum to eight learning areas, with clearer content knowledge to be taught as well as clearer assessment guidelines provided by learning outcomes and assessment standards. Natural Science in the RNCS comprised four strands: Life and Living, Energy and Change, Planet Earth and Beyond and Matter and Materials (South Africa. Department of Education [DoE], 2002). The Senior Phase (Grades 7, 8 and 9) included the topic of biodiversity under the Life and Living strand, which stated that: "Life and Living focuses on life processes and healthy living, for understanding balance and change in environments, and on the importance of biodiversity" (South Africa. DoE, 2002).

The most important knowledge and concepts about biodiversity for the Senior Phase which learners needed to grasp were: biodiversity; change and continuity – variation in species; natural selection and extinction of species; human biological characteristics as a social construct; biodiversity in relation to ecosystems, and in sustaining life; classification of vertebrates and invertebrates; causes of biodiversity loss; mass extinctions of the past; cells and life processes (South Africa. DoE, 2002).

The Natural Sciences Senior Phase (Grade 7-9) CAPS has three Specific Aims. Specific Aim 1 relates to procedural knowledge. Learners complete investigations, analyse problems and use practical processes and skills in evaluating those solutions" (South Africa. Department of Basic Education [DBE], 2011, p.10). Specific Aim 2 foregrounds the importance of learners knowing their subject content and making connections between the ideas and concepts in their minds, and their real-life experiences. It specifies that the objective of Natural Science teaching is to: "build a framework of knowledge for learners and to help them make connections …this is different to learners just knowing facts…connections must be made" (South Africa. Department of Basic Education [DBE], 2011, p.10). Specific Aim 3 emphasises that "science learnt at school should produce learners who understand that school science can be relevant to everyday life, they must be able to apply it to engage with issues such as improving water quality, growing food without damaging the land and building energy-efficient houses, the latter are examples of applications" (South Africa. DBE, 2011). The CAPS curriculum is intended to prepare future world citizens to cope with issues such as biodiversity and other environmental issues, by infusing the specific aims appropriately throughout the content knowledge in the curriculum.

In Grade 7, CAPS Natural Sciences biodiversity is presented as a concept to be explored through topics presented in the first term. Biodiversity includes: "plants, animals and micro-organisms, and their habitats [that] make up the total biodiversity of the Earth" (South Africa. DBE, 2011). There is also a topic on the interdependent relationship between all plants, animals and micro-organisms in their biotic community and the interdependent relationship between the biotic and abiotic elements. Biodiversity is allocated 3½ weeks of teaching in the first term, covering the following: biodiversity (the classification of all living things), the diversity of animals and the diversity of plants (South Africa. DBE, 2011).

The Grade 8 Natural Sciences content, which is also covered in Term 1, has topics that address biodiversity. These are interactions and interdependence in an ecosystem and how these are driven by the need for energy, to sustain life and interactions and interdependence within the environment (South Africa. DBE, 2011). In addition, there is a topic on harmful and useful micro-organisms (ibid.).

Grade 9 outlines topics related to biodiversity in Term 4 in the 'Planet Earth and Beyond' knowledge strand. Here there are sub-topics such as the greenhouse effect. Learners are

expected to know that the greenhouse effect is a natural phenomenon – it warms the atmosphere sufficiently to sustain life and also that greenhouse gases trap the ultraviolet radiation, which then warms the air closest to the surface of the Earth (like inside a greenhouse). Further, the CAPS document outlines that learners need to know the common greenhouse gases of carbon dioxide, water vapour and methane and how an increase in greenhouse gases leads to global warming (South Africa. DBE, 2011). Though the greenhouse effect is not a biodiversity topic, it is fundamental to biodiversity education. According to the Millenium Ecosystem Assessment (MEA, 2005), changes in ecosystems that contribute to greenhouse gas emissions contribute to global climate changes that affect all countries. The next section discusses some of the aspects relating to teaching biodiversity and key features of biodiversity knowledge.

2.5.3 Teaching biodiversity

The goals that teachers are able to achieve in practice are influenced by the way in which they convey biodiversity knowledge, which is how they represent biodiversity as a concept, and how they get learners to engage with it (Isaacs, 2016). According to Gayford (2010), although UK teachers in a focus group understood the complexity of biodiversity concerns, they did not make essential links between core concepts due to time constraints of the science curriculum. The study recommended that 'good' biodiversity education should allow learners to explore the social, political, economic, spiritual and cultural aspects of biodiversity (Gayford, 2010).

Furthermore biodiversity education teaching methods should help stimulate learners to ask critical reflective questions and to make decisions in collaboration with others in order to be empowered to take action for biodiversity conservation (UNESCO, 1985). These methods should possibly help achieve individual learners' desired functionings and be aligned with specific subject methods (Fundisa for Change, 2013).

As indicated in Section 2.1, this study will consider specifically biodiversity knowledge that is presented by the South African school curriculum and taught in South African classrooms.

The Fundisa for Change Programme (2013) reported that a fragmented approach to teaching concepts such as biodiversity, ecosystems and climate change, prevents teachers and learners

from understanding the 'big picture' and prevents them from developing coherent, holistic understandings of socio-ecological challenges (Fundisa for Change, 2013). Part of the solution to these concerns might be to contextualise biodiversity for educational purposes and to use active learning teaching methods in biodiversity education. One of The National Curriculum Statement Grades R-12 principles is "encouraging an active and critical approach to learning, rather than rote and uncritical learning of given truths" (South Africa. DBE, 2011, p. 4).

Biodiversity knowledge ought to be well anchored and meaningful in the thoughts and actions of people in a specific context. I have discussed biodiversity in the curriculum and some challenges with teaching it. To understand how this knowledge came to be presented in the South African curriculum, I used the Pedagogic Device which is discussed in the following section.

2.6 The Pedagogic Device and Recontextualisation

This section begins by providing a background to Bernstein's theories as briefly introduced in Chapter 1. According to Bernstein (1996), the Pedagogic Device is an attempt to describe the general principles which are central to the transformation of knowledge (Bernstein, 1996). According to Bernstein, recontextualisation refers to the rules or procedures by which educational knowledge is moved and changed, from one educational field to another. Bernstein used the term to refer to systemic and institutionalised ways in which knowledge is recontextualised from the FOP into the school system, and its distribution and evaluation within the schooling system (Jacklin, 2004). The Pedagogic Device structures and organises the content and distribution of what is relayed. Singh (2002) described the Pedagogic Device as an ensemble of rules or procedures described by Bernstein, which provide a model for analysing the processes by which expert knowledge is converted into classroom talk and curricula. In the case of this study the focus was on how biodiversity scientific knowledge is recontextualised in the formal curriculum and textbooks.

2.6.1 The Pedagogic Device

The Pedagogic Device is made up of a number of fields. For the purposes of this study, 'field' can be defined as a systematic space, constituted by discourses, and structured by specialised social relationships and practices (Bernstein, 2000). The FOP is where new

knowledge discourses are generated. Furthermore, Bernstein distinguished between two fields within the recontextualising field: ORF and the PRF. The ORF includes specialised departments and sub-agencies of the state and local educational authorities, together with their research and system of inspectors (in short, the government). The PRF includes other educational professionals, teacher educators, NGOs and textbook authors (Bernstein, 1990). Then the FOP is where recontextualised discourses are transformed a second time for general consumption, where pedagogy and curriculum are actually enacted in schools (Apple, 2003). The process of recontextualisation, according to Bernstein, takes place in keeping with ideas developed through the direct and indirect influence of a range of agents (lecturers, curriculum developers, professional bodies and government).

2.6.2 Recontextualisation within the Pedagogic Device

In this study, Bernstein's (2000) notion of recontextualisation is used to explain the transformation of biodiversity knowledge within the national curriculum. Some of the concepts used in this study are clarified below.

Selective appropriation

Appropriation is the assimilation of concepts into a governing framework. It involves assimilating new ideas into schema. People use these schemas to organise their current knowledge and provide a framework for future understanding. Ramsarup (2005) showed how teachers and other educators selectively take essential aspects of the Official Pedagogic Discourse (OPD) which, in their view, are most relevant and desirable for learners to understand and internalise or selectively appropriate the discourse to align with their existing schema, or prior knowledge and experience (Bernstein, 2000). For Bernstein, the OPD is produced through three main fields, which are hierarchically related. This are the FOP, ORF and PRF as described in the previous section (2.6.1). It is seen as the work of recontextualisers, who draw on knowledge from a range of subject disciplines, in order to construct recommendations and prescriptions of different types, either universal, for all learners. Different forms of educational prescriptions work for different groups of learners (ibid.).

Ramsarup's (2005) study showed how teachers and other educators selectively take essential aspects of the Official Pedagogic Discourse which, in their view, are most relevant and

desirable for learners to understand and internalise or selectively appropriate the discourse to align with their existing schema, or prior knowledge and experience. For example, Ramsarup (ibid.) stated that in selectively appropriating the environmental discourse as 'problems in the community', the teacher steered the discourse into focusing on problems learners raised, such as issues of 'lack of transport; lack of houses; lack of roads; lack of nutrition'.

Ideological transformation

Ideology can be described as a linked set of ideas and beliefs that we use to guide or frame our discursive practice, which often manifests as organising structures (Bernstein, 1990). This study used the notion of ideological transformations, as described by Bernstein, to mean transformation of the OPD based on ideas and beliefs that are strongly held, or unconsciously held by curriculum developers. For example, Ramsarup (2005) showed that teachers ideologically transformed the NCS (R-9) environmental discourse into a problem discourse, focusing learners on the problems in their school. One of the teachers in Ramsarup's study highlighted that the work "they are doing is important in identifying issues in the school and by getting teachers to identify the priorities in the school, they will be able to bring out the issues of context to a greater extent" (Ramsarup, 2005 p.70).

According to Bernstein (1996), this process of movement of curricular knowledge opens a space for changes in power and control relations and thereby a change in ideological meaning. Ideologies are not merely carried as surface features of the knowledge, but are structured into the selection, organisation, transmission and acquisition of curricula (ibid.). For example, MEA (2005) described land use in terms of its economic value to countries and SANBI (2013) highlighted the importance of ownership of the land by certain tribes.

In the case of this study, during recontextualisation the curriculum developers and the textbook writers hold a significant and powerful role. The OPD can be influenced by conceptions acquired by these individuals during their own time of studying the discipline and their experience within the discipline.

Delocation

The process of recontextualising entails a principle of delocation which involves selective appropriation and ideological transformation of a discourse or content from the field of production (Bernstein, 2000).

Relocation

As the knowledge is recontextualised, a principle of relocation is used to explain how knowledge is transformed to legitimate content within the recontextualising field. According to Bernstein (2000), in the processes of delocation and relocation, the original knowledge undergoes ideological transformation as it is influenced by history, experience, prior knowledge and beliefs and the values of the practitioner.

2.6.3 Recontextualisation in the context of this study

This study focused on the recontextualisation of biodiversity knowledge in the Senior Phase Natural Sciences Curriculum (see section 1.5). Although I am aware of the Field of Reproduction (FOR) in Bernstein's framework (see Section 2.6.1) the scope of this half thesis only enabled research in the FOP, ORF and PRF. The study investigated biodiversity knowledge in international and national scientific documents (MEA, 2005 and SANBI, 2013) in the FOP. It then investigated further how scientific biodiversity discourse is recontextualised into the ORF (CAPS Grade 7-9) and the PRF (Grade 7-9 supportive textbooks). Selective appropriation in this case involves delocation of a discourse from the FOP, and relocation of the discourse recontextualising fields (the OFR and the PRF). Figure 2.1 below illustrates recontextualisation in this study. In the processes of delocation and relocation the original discourse can undergo ideological transformation according to the ideas and beliefs of curriculum developers in the recontextualising field (ibid.).

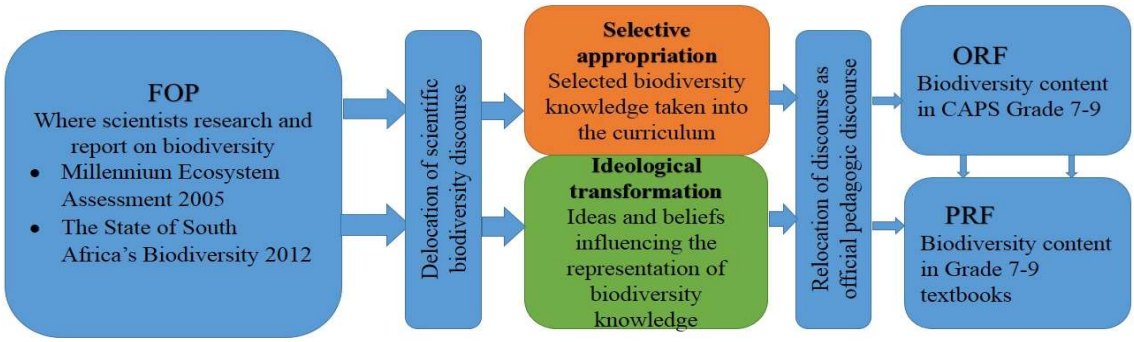

Figure 2.1: Illustration of recontextualisation process in the context of this study

2.6.4 Knowledge dimensions and Foundational Knowledge

To deepen the review of the recontextualisation of biodiversity knowledge, this study will also describe the 'nature' of knowledge presented in the FOP and the PRF.

Knowledge dimensions adapted from Anderson and Krathwohl in their revision of Bloom's Taxonomy were used to describe the type of knowledge. This section describes the following knowledge dimensions used in this study: factual knowledge (facts), conceptual knowledge (concepts), and procedural knowledge (processes) (Anderson & Krathwohl, 2001). According to Anderson and Krathwohl (2001), factual knowledge refers to knowledge of terminology and knowledge of specific details and elements while conceptual knowledge refers to knowledge of classifications and categories, knowledge of principles and generalisations and knowledge of theories, models, and structure. Procedural knowledge refers to how to do something, methods of inquiry, and criteria for using skills, techniques, and methods (Anderson & Krathwohl, 2001).

The notion of foundational knowledge was also explored by this study. Schudel (2014) states that in the CAPS, environment is integral to the curriculum in the form of specific content knowledge in environmental concepts such as the notion of sustainability, environmental issues such as pollution and climate change, and concepts such as ecology and biodiversity which are foundational to understanding the biophysical dimensions of environmental issues and risks. Kamhi (2007) also emphasises that limited attention to fostering children's foundational knowledge development in school settings may be a contributing factor to so-called knowledge deficits or gaps. Consequently it was essential for this study to identify and state what type of foundational biodiversity knowledge is presented by the scientific documents, curriculum and the textbooks.

2.7 Biodiversity Content Knowledge

This section discusses the biodiversity themes which emerged from inductive analysis of MEA and SANBI documents (see Section 3.5.1). These themes were later used to compare the nature of biodiversity knowledge as presented in the CAPS curriculum document and textbooks in relation to the scientific document. In the following sections, these key themes are elaborated below.

2.7.1 Ecosystem services

The concept of ecosystem services brings out different ways in which humans value their natural environment, and improves understanding of how biodiversity contributes to human well-being. It is now well-established that biodiversity supports critical ecosystem services for people, such as food and raw materials, that support lives and livelihoods (MEA, 2005).

Interest in ecosystem assessments also have been growing from both scientific and policy perspectives. During the past ten years, there has been increasing research regarding the investigation of ecosystem services (Fisher et al., 2008). The ability of ecosystems to provide sufficient ecosystem services to humans not only supports basic human needs, but also has an important protective function for human mental health (Dean et al., 2011).

The MEA clarified the many kinds of benefits that humans derive from ecosystems and used the term 'ecosystem services' to describe them. In the MEA, the services were classified into four categories: provisioning, regulating, cultural and supporting services (MEA, 2005). Ecosystem services are the goods and services that biodiversity provides. Provisioning services are the products obtained from ecosystems such as food, fresh water, wood, fibre, genetic resources and medicines. Regulating services are defined as the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination or pest control. Supporting services include services such as nutrient recycling, primary production, soil formation, habitat provision and pollination (ibid). These services make it possible for the ecosystems to continue providing services such as food supply, flood regulation, and water purification. Cultural services include non-material benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values (ibid).

Figure 2.2 below illustrates these four services. The MEA represents the services as flowing directly from the presence of life on earth. This is an important point because it suggests that ecosystem services depend fundamentally on the structures and processes generated by living organisms and their interactions with, and processing of, abiotic materials. Smith (2006), stated that it may be useful to distinguish between ecosystem services that are a consequence of biodiversity, and a more general class of 'environmental services', like wind, that have a more indirect connection. The supporting services have a different relationship to human

well-being compared to the other three types of service. They do not directly benefit people, but are part of the often complex mechanisms and processes that generate them.

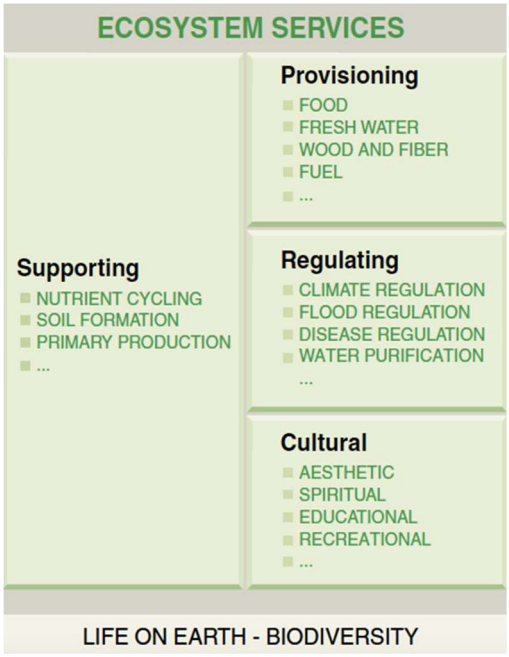

Figure 2.2: Four categories of ecosystem services and constituents of well-being (MEA, 2005)

Biodiversity plays an important role in the delivery of many of these ecosystem benefits. According to the UK's Department for Environment, Food and Rural Affairs (DEFRA, 2007), some of these ecosystem services are well-known including food, fibre and fuel provision and the cultural services that provide benefits to people through recreation and appreciation of nature. In addition, biodiversity and ecosystem functioning are influenced by interactions between individuals or species, which directly rely on habitat availability and stipulated habitat conditions (Gray, 2014). For instance, Harrison et al. (2010) stated that the ecosystem services that improve water quality (such as water purification) and flow regulation (such as flood protection) are enhanced by increases in community and habitat area (Harrison et al., 2010). Lastly, according to Tilman (1996) and Schindler et al. (2010), biodiversity is also reported to stabilise the delivery of ecosystem services over time.

Other services provided by ecosystems include the regulation of the climate, the purification of air and water, flood protection, soil formation and nutrients. Cultural ecosystem services are non-material and they are also benefits people obtain from ecosystems. Some cultural services include aesthetic values, which are expressed by humans seeking contact with nature, since natural and wild landscapes are aesthetically pleasing. They provide

opportunities to escape from large cities dominated by pollution and human-made landscapes (Alho, 2008).

Decades of research have shown that biodiversity plays a vital role in ecosystem functioning (Cardinale et al., 2012). Therefore, it is essential to identify and manage biodiversity threats to curb biodiversity loss.

2.7.2 Threats to biodiversity

For the purpose of this study, threats will be defined as any direct or indirect human activity which threatens the planet's biological diversity in the form of genes, populations, species, ecosystems, or other levels of biological organisation (Sechrest et al., 2002). MEA (2005) finding #1 emphasised that biodiversity is under serious threat as a result of human activities. The main dangers worldwide are population growth and resource consumption, climate change and global warming, habitat conversion and urbanisation, invasive alien species, over-exploitation of natural resources and environmental degradation (MEA, 2005). Understanding biodiversity threats might be a tool necessary to inform knowledgeable decisions concerning biodiversity loss, conservation and restoration.

2.7.3 Restorative actions

Restoration actions for the purpose of this study focused on practical strategies aiming at improving environmental quality. These actions are part of the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. Restoration projects differ in their objectives and their methods of achieving those goals (Young, Petersen and Clary, 2005). Many restoration projects aim to establish ecosystems composed of a native species. Other projects attempt to restore, improve, or create particular ecosystem functions, such as pollination or erosion control (ibid.). Some examples of restoration include vegetation, habitat enhancement, remediation and mitigation. According to Young et al. (2005), restoration activity would involve direct revegetation of sites. Habitat enhancement involves the process of increasing the suitability of a site as a habitat for some desired species. Remediation is the improving of an existing ecosystem or creating a new one with the aim of replacing another that has deteriorated or been destroyed. Lastly, mitigation is a legally mandated remediation for loss of protected species or ecosystems (ibid.).

2.7.4 Conservation and sustainability of biodiversity

In simple terms, conservation is the sustainable use and management of natural resources including wildlife, water, air, and earth deposits, both renewable and non-renewable. For the purpose of this study, conservation will include the formal control of rivers, forests and other natural resources in order to preserve and protect them under legalised management, for example National Parks. Sustainability has no universally agreed definition, but its meaning revolves around what it is and how it can be achieved. It also includes prevention of depletion of natural resources in order to maintain ecological balance.

This study partly drew from a Biodiversity Global Reporting Initiative Resource (GRI, 2007) to define sustainability as considering the interactions between the environment, economics, and society to ensure sustainability for ecosystems and people today and for future generations.

The realisation of biodiversity conservation as a global concern has resulted in various international conventions to conserve biodiversity. These include the Convention of Biological Diversity of 1992; Convention of International Trade in Endangered Species of 1973; and the United Nations Framework Convention on Climate Change of 1992 (Shava & Schudel, 2013). South Africa also has national policies aimed at conserving biodiversity. Those include the National Environmental Management Act 107 of 1998, and particularly the National Environmental Management Biodiversity Act 20 of 2004 (Shava & Schudel, 2013).

The aspects of biodiversity in this section formed the framework for analysing the biodiversity content in the FOP, ORF and PRF.

2.8 Conclusion

This chapter began with a discussion about biodiversity, defining it as all life on earth, including humans, and explaining that it is characterised by complex relationships and is under threat. Global and national responses to biodiversity loss, in particular policy frameworks and sustainable development agendas, were briefly discussed and followed by discussion on education as a response to biodiversity loss. In line with the focus of the study, biodiversity in the South African school curriculum was discussed.

The chapter outlined what is biodiversity and biodiversity loss. It also discussed international and national actions towards biodiversity education, as well as further biodiversity curriculum and teaching. It further discussed Bernstein's theory of the Pedagogic Device with a focus on recontextualisation across the fields of the device, as well as selective appropriation and ideological transformation that constitutes the recontextualisation process. The chapter also outlined the knowledge dimensions used in this study. Lastly, it outlined the biodiversity content knowledge in the study. The next chapter outlines the research processes and methodology used in the study.

CHAPTER 3: RESEARCH PROCESS AND METHODOLOGY

3.1 Introduction

This chapter sketches out the research design decisions that directed the study of biodiversity knowledge in the Senior Phase Natural Science CAPS curriculum. It includes an outline of the case study research orientation and methods used to generate data. The chapter then outlines the research analysis process and its two phases. The chapter ends with a discussion of ethics, validity and trustworthiness in the study.

3.2 Research Orientation

3.2.1 Social realism approach

This study was a social realist investigation into biodiversity knowledge recontextualisation. According to Lilliedahl (2015), social realism is about understanding the social conditions of knowledge production and exchange as well as its structuring in the curriculum. It enables knowledge to be recognised in itself, not merely as a reflection of some essential truth. That shifts the focus from 'whose' knowledge to emphasis on 'what' knowledge (ibid.). The study's interest was in what biodiversity knowledge has been taken up from the FOP into the school system through the ORF to the PRF.

According to Maton and Moore (2010), knowledge is the very basis of education as a social field of practice. It is the production, recontextualisation, teaching and learning of knowledge that makes education a distinct field (p. 2). This study also has this social realist interest in putting knowledge as an object at the centre in thinking about education.

Young (2008) also shifted from viewing knowledge in terms of construction to a focus on its production within relatively autonomous fields of practice according to socially developed and applied procedures that may have both arbitrary and non-arbitrary bases.

> Young advocates a knowledge-based approach to curriculum designed to enable all students, regardless of their socio-economic status, races, and genders, to gain access to disciplinary knowledge which he sees as the central purpose of schooling. (Deng, 2015, p. 725)

This study begins with a focus on knowledge production in the FOP which is part of the Pedagogic Device (see Section 2.6.1).

3.2.2 Case study approach

A case study is useful for developing a deeper understanding of a situation (Tellis, 1997). A case study method was used to investigate a case of biodiversity knowledge presentation, and to tell a story about processes of recontextualisation towards the construction of knowledge in the ORF and PRF.

A case study can be considered a methodology, strategy of inquiry, or research strategy. It involves the study of an issue through specific cases. Case studies answer 'how' and 'why' questions (Yin, 1998). Case studies can also be used to research questions about processes, because of the use of multiple data sources that support the retrospective investigation of events. This case study focused on the presentation of biodiversity knowledge in three fields of the Pedagogic Device, and explored how the processes of knowledge recontextualisation occurred. A case study is a particular way of observing any natural phenomenon which exists in a set of data (Yin, 1984). In particular, this means that only a very small geographical area or number of subjects of interest is examined in detail. Creswell (2007), described case study research as a qualitative approach in which the investigator explores a bounded system (case) or multiple bounded systems (cases) over time. In this case, the geographical boundaries of the subject were not so significant, but the case was bounded by a specific document – the Natural Science CAPS curriculum as well as two particular scientific documents representing biodiversity knowledge from the field of science and three textbooks representing the PRF.

According to Creswell (2007), case study research usually involves a number of different data sources and methods, for example, observations, interviews, audio-visual material, documents. This case study used document review and interviews (see section 3.3) as research methods. Case studies give rich descriptive information that can provide insight into a specific situation or context. This was important and appropriate for this study, because the intention was for the findings to be used by curriculum reviewers, curriculum developers and textbook developers to make the curriculum more responsive to the environmental crisis in the future.

An advantage of case studies is that the approach may make the research more accessible to diverse audiences, than some other designs. In the context of information systems research, Dubé and Paré (2003) argued that case studies can help academics and practitioners keep up

with a fast-changing field. In this case, the ‘fast-changing field’ is the South African curriculum introduction of ‘new’ environmental knowledge such as biodiversity.

Despite these advantages, case studies have received criticisms. Yin (1984) pointed out that case studies are often accused of lack of rigour. Yin (1984, p. 21) noted that “too many times, the case study investigator has been sloppy, and has allowed equivocal evidence or biased views to influence the direction of the findings and conclusions”. In this study, I prevented this by always being aware of my position. This helped me to be conscious of any particular biases that arose, which might have influenced the research. I have been rigorous by not only constantly reflecting on the process, data and findings, but by relating it back to the broader literature on the subject. During interviews, I used a tape recorder and after each interview specifically listened to reflect on my role during the interview. This method allowed me to be conscious of my communication during interviews and focus on the responses of participants.

The phenomenon that constituted the study, that is the biodiversity knowledge, was not a tangible product which existed ‘out there' for a researcher to apprehend and study. Instead, I had to regularly refer to the two scientific documents as a ‘benchmark’ against which to compare the knowledge as presented in the Grade 7-9 Natural Sciences curriculum policy and supporting textbooks.

In addition, Stenhouse (1985) also stated that findings from case study research can provide an understanding of the narratives and descriptive explanations of practices. He further elaborated that interpretive researchers should acknowledge that their constructs are based on evidence and data collected from people and events associated with the case under study within the research (Stenhouse, 1985). This is particularly relevant for the second analytic phase in this study which relies on interviews with role players that are part of the Pedagogic Device.

3.3 Data Generation Techniques

Two data generation techniques were used for this study, namely document review and semi-structured interviews. The *Millennium Ecosystem Assessment* (MEA, 2005) and the *Life: The State of South Africa’s Biodiversity 2012* (SANBI, 2013) were used to identify the nature of biodiversity knowledge in the FOP. The CAPS policy document and the Grade 7-9 textbooks

were also used to look at how the identified biodiversity knowledge had been recontextualised. The Natural Sciences Senior Education Specialists, Natural Sciences Provincial Coordinator and textbook publisher were interviewed. The aim of the interviews was to obtain a detailed account of what was happening in the recontextualisation process.

3.3.1 Document review: Field of Production

Two documents were selected to represent biodiversity knowledge in the FOP, that is an international scientific document the *Millennium Assessment Ecosystem* (MEA, 2005) and a national scientific document the *Life: The state of South Africa's biodiversity 2012* (SANBI, 2013). It is important to note that the purpose of the document analysis was not to do an extensive review of all biodiversity knowledge available. The purpose was to provide an illustration of the nature of available biodiversity knowledge from international and national perspectives.

As this study focused on knowledge, text documents were vital. All the documents in the study are primary sources. Irwin (2001) emphasised that it is important that a researcher verify that the documents are valid, trustworthy and accurate. Cohen and Manion (1994) defined documents as original objects that are related to the event that is being investigated. According to Seltiz, Wrightsman and Cook (1976), reliability is concerned with the consistency as well as accurately recorded information. Primary sources are documents that are original to the topic being researched or studied, and have a direct link with the phenomenon being studied (Cohen & Manion, 1994). Irwin (2001) stated that primary sources provide first-hand information. In this study the chosen documents were primary sources.

3.3.2 Document review: Curriculum document in the Official Recontextualising Field

The Senior Phase (Grades 7-9) Natural Sciences Curriculum and Assessment Policy Statement (CAPS) was the central focus in this study. This policy document is relevant to this study because it is the formal policy document which guides what biodiversity content is to be taught in this subject and phase. The content and concepts section for Grades 7, 8 and 9 were selected for analysis. The content and concepts for Grade 7 and 8 were from the Life and Living knowledge strand while the Grade 9 content and concepts were from the Planet, Earth and Beyond knowledge strand. These strands were chosen because they contain

biodiversity knowledge relevant to this study. An extract of the Grade 7 content and concepts section which was used for analytical purpose can be seen in Appendix A.

3.3.3 Document review: Textbooks in the Pedagogic Recontextualising Field

According to Taylor (2008, p.19), a good textbook "lays out the curriculum systematically providing expositions of the concepts, definitions of the terms and symbols of the subject in question". Richards (1998) stated that teachers may exercise control over which textbooks they use and how they use them. According to the Report of the Task Team for the Review of the Implementation of the National Curriculum Statement, teachers should be encouraged to use nationally approved textbooks, and schools will be allowed to choose their own textbooks (Dada et al., 2009). This was the strategy used for addressing Irwin's call for ensuring that quality documents are used. As a case within this study, the three textbooks chosen for analytical purposes were nationally approved and appear on the 'national LTSM catalogue' (Dada et al., 2009). The following textbooks were chosen: *Natural Sciences Grade 7 Learner Textbook, Natural Sciences Grade 8 Learner Textbook* and *Natural Sciences Grade 9 Learner Textbook*

3.3.4 Semi-structured interviews in the Pedagogic Recontextualising Field

Semi-structured interviews were chosen as they offer the potential to use open-ended questions and less formal questioning formats, thereby allowing the participants freedom to express their views in their own terms. This is also emphasised by Ezzy's (2002, p. 45) assertion that they enable one to "gain access to the people's ideas and thoughts, their perceptions of change and their fears and concerns in their own words rather than in the words of the researcher".

Semi-structured interviews provided insights into how the process of recontextualisation occurred, who is involved and what they do. In this study, the provincial coordinator (PC) for Natural Sciences gave insight into the ORF and PRF. His interview schedule set of questions (Appendix B) was the first and was used to guide the formulation of interview schedules for the following participants:

- two senior education specialists representing perspectives from the PRF, and
- one textbook publisher representing perspectives from the PRF.

The Provincial Coordinator (PC) who supervises all the Natural Sciences SESs in his province was amongst the stakeholders involved in the development of the CAPS Curriculum. Thus notes for the interview with him helped to guide the formulation of interview schedules for the other participants. The interview schedule was emailed to him prior to the face-to-face interview. Three telephonic interviews of 10-15 minutes each were also conducted to clarify points. Participants were interviewed individually using the same interview schedule (Appendix C). They were also emailed the interview questions prior to their interviews. These interviews were recorded and transcribed (Appendix D), coded and summarised. The two Natural Sciences Education Specialists (SES 1 and SES 2) are actively involved in environmental projects in the district, and hence were relevant participants for the study. SES 2 was interviewed telephonically due to time and distance constraints and SES 1 was interviewed face-to-face.

The Textbook Publisher (TP) was chosen because of her expertise in Natural Sciences in addition to her publishing experience. The publisher's interview was also held telephonically due to her tight schedule and lasted ten minutes. See interview schedule (Appendix E). This interview served to explore the textbook publishing field more systematically and comprehensively (Crabtree, 2006).

3.4 Data Management

Data was systematic and coherently organised to avoid the risk of it being 'miscoded and mislabelled' (Wolfe, 1992). A filing system was created to store all written responses. Separate files were used for each interview. Transcripts were stored in hard copies in a box, and digitally on my computer with a flash stick as back-up. Data was carefully labelled and an inventory created of each piece of data for reference purposes (see Table 3.1).

Table 3.1: Inventory of all the data sources used in this study, and how they were labelled for easy access and reference

INDEX LABEL	DOCUMENT	FIELD IN PEDAGOGIC DEVICE
DOC 1	Millennium Assessment Ecosystem	FOP
DOC 2	State of South Africa's Biodiversity	FOP
CAPS 7	Grade 7 content and concepts	ORF
CAPS 8	Grade 8 content and concepts	ORF
CAPS 9	Grade 9 content and concepts	ORF
TB 7	Grade 7 textbook	PRF
TB 8	Grade 8 textbook	PRF
TB 9	Grade 9 textbook	PRF
PCint1	Provincial coordinator interview 1	ORF and PRF
SES1int2	Senior Education Specialist 1 interview 2	PRF
SES2int3	Senior Education Specialist 2 interview 3	PRF
TBint4	Textbook publisher interview 4	PRF

3.5 Data Analysis

Freeman (1998, p. 90) described data analysis as "… the process of drawing responses out of the data, or finding them in the data". Altrichter, Posch and Somekh (1993, p. 122) emphasised that the purpose of data analysis is to "find explanations which fit our understanding and therefore seem emotionally plausible". According to Boyatzis, (1998) coding allows one to organise and group similarly coded data into categories or themes, because they share some characteristic. In addition, according to Halperin and Heath (2012), as one codes, one can make marginal notes, noting major key words and underlining or circling those items that appear important and meaningful.

Figure 3.1 below represents the summary of analytic process in the study. A description of Figure 3.1 and the phases is elaborated in the sub-sections that follow.

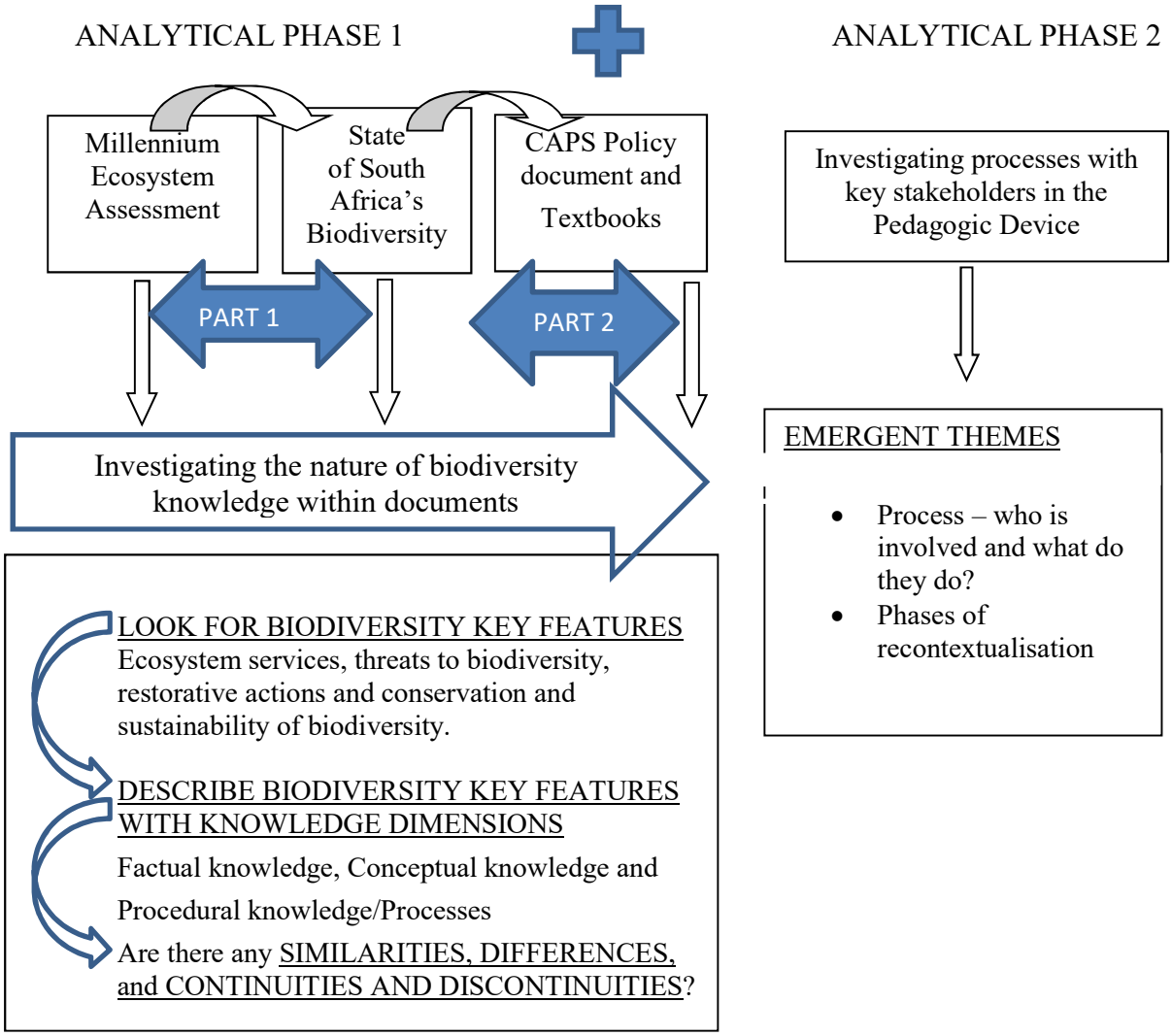

Figure 3.1: Summary of analytic process in the study

3.5.1 Analytic Phase One

Downe-Wambolt (1992) defined content analysis as a research method that provides a systematic and objective means to make valid inferences from verbal, visual, or written data in order to describe and quantify specific phenomena (p. 314). Content analysis can be used on all types of written texts no matter where the material comes from (Berg, 2001; Burnard, 1991; Catanzaro, 1988). According to Cohen, Manion and Morrison (2007), content analysis takes texts, reduces and interrogates it into categories and emergent themes in order to generate or test a theory. This study explored the biodiversity knowledge in the scientific documents to draw categories relating to biodiversity knowledge. Elo and Kyngäs (2007) stated that during content analysis, concepts are created. Qualitative content analysis can be used in an inductive way (ibid.). In this study, inductive content analysis was done using the MEA and the SANBI scientific documents. In the MEA the summary for decision makers

was used as the data source. This document elaborated on the four main findings of the working groups. In the case of SANBI, the whole document was used for data generation

Phase One entailed two parts. Part One involved an analysis of the biodiversity knowledge in the Millennium Ecosystem Assessment (MEA, 2005) and the State of South Africa's Biodiversity (SANBI, 2013) in order to identify biodiversity content knowledge. Phase One of the analysis focused on sub-question 1: What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the field of production?

The MEA and SANBI documents were analysed separately by highlighting key biodiversity features in two analytic memos (Appendix F and G). The following features of biodiversity knowledge emerged from the analysis of these documents: ecosystem services (orange), biodiversity loss (including threats to and extent of biodiversity loss) (red), restorative actions (blue), conservation and sustainability (green). The aim of the coloured highlights was to distinguish each key feature clearly. These key features of biodiversity were analysed individually during the analysis process.

Part Two of the analysis focused on investigating how biodiversity knowledge identified in Part 1 in the FOP is recontextualised in the ORF and PRF. Analytical memos were constructed for CAPS Grade 7-9 (combined) and textbooks (per grade) (Appendices H-K). Thereafter the biodiversity key features in scientific and curriculum documents were consolidated in a table (see Appendix X). This part of the analysis is in response to sub-question 1 and 2:

Sub-question 1: What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the field of production?

Sub-Question 2: What is the nature of biodiversity knowledge in the Natural Sciences curriculum and in the commonly used Grade 7-9 Natural Sciences textbooks?

To analyse the biodiversity knowledge for Grades 7, 8, 9 in the CAPS document and in the Grade 7, 8 and 9 textbook, these key biodiversity features were highlighted with same colours as in Part One. Analytical memos H-K resulted from this analysis.

3.5.2 Analytic Phase Two

Analytic Phase Two entailed one part and a category sheet (see Appendix L) was then used to analyse the interviews. The categories used in Phase Two were phases of recontextualisation which included the development of CAPS, recontextualisation process which included the implementation phase and category and role players during recontextualisation and their responsibilities. This phase was in response to sub-question 3: Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge? According to Latif, Boardman and Pollock (2013), there are a number of ways in which researchers can synthesise and present their findings, but any conclusions drawn by the researchers must be supported by direct quotations from participants. In this way, it is made clear to the reader that the themes under discussion have emerged from the participants' interviews and not the mind of the researcher (ibid.). The provincial coordinator, SESs, and textbook publisher perspectives were used to understand who the role players are during the process of recontextualisation and their roles. Themes emerging from interviews were used to analyse the interviews in an analytic memo (Appendix M). Table 3.2 below gives a summary of the analytic phases in the study.

Table 3.2: Summary of the analytic phases

ANALYTICAL PHASE ONE (PART 1 and PART 2)

What is the main focus of the analysis and to which research question is it linked?	Main focus was to identify biodiversity knowledge in scientific documents (FOP) and CAPS document for Grade 7-9) (ORF) and Grade 7-9 textbooks(PRF) Focused on sub-question 1 Sub-question1: What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the field of production?
What data did I draw on?	PART 1: MEA and SANBI scientific documents (FOP). Main focus was to investigate the nature of biodiversity in these documents.
	PART 2: CAPS document (Content and concepts for Grade 7-9) (ORF), Grade 7-9 textbooks (PRF). Focused on Sub-question 2: What is the nature of biodiversity knowledge in the Natural Sciences curriculum and in the commonly used Grade 7-9 Natural Sciences textbooks? Main focus was to investigate nature of biodiversity in relation to the above scientific documents in the field of production.

What themes were used?	Ecosystem services, threats to biodiversity, restorative actions and conserving and sustaining biodiversity.
Which analytic memo/s were used for this phase?	Analytical memo F and G-PART 1 and Analytical memo H-K-PART 2

ANALYTICAL PHASE TWO

What is the main focus of the analysis and how it is linked to research question?	Main focus was to investigate sub-question 3:Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge?
What data did I draw on?	Semi-structured interviews.
• What themes were used? • How were these chosen? • Which category sheet was used?	The following themes emerged from the interviews (inductive analysis): Process: who is involved and what did they do? Phases of recontextualisation. Category sheet in Appendix L
Which analytic memo/s were used for this phase?	Analytical memo M

3.6 Ethical Considerations

According to Cohen, Manion and Morrison (2000, p. 51), "all participants in a research process need to be asked to sign consent forms so as to protect and respect the right of self-determination as well as to place some of the responsibility on the participants should anything go wrong with the study". Hence permission was asked from the provincial coordinator, subject advisors and publishers (Appendix N-Q).

Interviews were transcribed and shared with the participants who were encouraged to review, deduct or add to the interview before the analysis took place in order to address that respect for truth. According to Bassey (1999), respect for democracy, respect for truth, respect for people, knowledge and quality of educational research are five key aspects of research ethics. In terms of respect for persons and democracy (Bassey, 1999), I explained to the participants that they had the right not to take part in the study or to decide to no longer take part at any time, as well as the right to re-think their decision to participate in the study (Corti, 2000).

3.7 Validity

Maxwell (1992) described a number of levels of validity in qualitative research, one of which is interpretive validity which simply asks: How do you prove that your interpretation of an event or that what you say is right? The use of multiple sources of evidence allows triangulation of findings which, according to Yin (2009), is a major strength of the case study design. This study triangulated analysis of selective appropriation and ideology against the perspectives of the subject specialist and textbook publisher. This study also used member checking to strengthen internal validity (Merriam, 1988). Member checks involved taking data collected from the participants and tentative interpretations of these data back to them and asking if the interpretations ring true or sound credible (Patton, 2002). Data collected in this study was returned to each participants to check for accuracy and for obtaining participant approval for using quotations. In the case of this study, all interview transcripts were sent to the participants, however only the provincial coordinator and SES1 gave me feedback and confirmed that what was in the transcripts was true according to what they had said during their interviews.

3.8 Conclusion

This chapter has described the research design decisions made to identify and establish appropriate methods for generating data about biodiversity knowledge in the Senior Phase Natural Sciences curriculum. This chapter discussed social realism as the approach of the research project and its relation with knowledge production. The chapter further explained why the case study methodology was used. The chapter also described how data was generated and managed. It further explained the analytical phases. Lastly, there was a brief discussion on how issues of ethics and validity have been dealt with.

CHAPTER 4: PRESENTATION AND RECONTEXTUALISATION OF BIODIVERSITY KNOWLEDGE

4.1 Introduction

This chapter presents the data of the study. Section 4.2, describes the biodiversity content knowledge (see Section 2.7) as presented in the selected international and national documents chosen to represent the FOP for this study. It also presents role players in the ORF and PRF and their roles in recontextualisation process (see Section 4.4)

Section 4.3 describes the biodiversity content knowledge as represented in the ORF (Grade 7-9 CAPS Natural Sciences curriculum) and the PRF (three textbooks for Grade 7-9). The data in these two sections is aimed at answering sub-question 1, which is: What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the field of production?

4.2 FOP: Biodiversity Content in the MEA and SANBI

This section presents data on how biodiversity knowledge is presented in the MEA (2005) and SANBI (2013) – the documents chosen for this study to represent the FOP. For data analysis purposes, the MEA (2005) was named Doc 1 and the SANBI (2013) was named Doc 2 (see Section 3.4). This is in response to part of sub-question 1.

This section is organised according to the framework of biodiversity knowledge as outlined in Section 2.7 (ecosystem services, threats to biodiversity, restorative actions, and conservation and sustaining biodiversity. The following knowledge dimensions are used to help organise the biodiversity knowledge presented in this section: factual knowledge, conceptual knowledge and procedural knowledge (see Anderson & Krathwohl, 2001– Section 2.6.4). Facts mainly include information about the state of biodiversity, concepts include complex ideas such as climate change, provisioning, regulating services and other complex ideas. Procedural knowledge includes explanation and examples of how social ecological relations are structured and cause and effect relations between different parts of social ecological systems.

4.2.1 Ecosystem services

Chapter 2 discussed the benefits ecosystems provide to humans and also discussed diversity within and among living organisms and the ecological complexes of which they are a part. Biodiversity is the foundation of ecosystems functioning and services delivery. Biological diversity at species and population levels is closely linked to ecosystem functioning, and it positively influences the provision of particular ecosystem services across the system (see Section 2.7.1.1). The section below presents biodiversity from the perspective of ecosystem services.

Provisioning services

Doc 1 began by highlighting human-environmental relations, noting that "everyone in the world depends completely on Earth's ecosystems and the services they provide, such as food, water, disease management, climate regulation, spiritual fulfilment, and aesthetic enjoyment" (Doc 1:1). According to Doc 1, "between years 1960 and 2000, the demand for ecosystem services grew significantly as the world population doubled to 6 billion people and the global economy increased more than six fold" (Doc 1:5). According to Doc 1, to "meet this demand, food production increased by roughly two-and-a half times, water use doubled, wood harvests for pulp and paper production tripled, installed hydropower capacity doubled, and timber production increased by more than half " (Doc1:5). Doc 1 stated that timber, fuel wood and forests are of economic value in most countries (Doc 1:6).

Doc 2 acknowledged that agriculture and the entire global food production, is dependent on a healthy natural environment (Doc 2:9). Some of the South African wetland species are used for food, craft manufacture, medicines, grazing, building material and fuel, for both subsistence and commercial use (Doc 2:15). For example, Manalana wetland in Bushbuckridge Mpumalanga is the only source of food and income to a quarter of the surrounding community (Doc 2:17).

Doc 2 elaborated procedural knowledge on interrelationships between people and their reliability on biodiversity and ecosystems services. It stated that "people use many different kinds of raw materials in estuaries: reeds and sedges for craft work; saltmarshes for grazing; firewood, timber and poles from mangrove forests" (Doc 2:28), thus enabling the rural poor to rely on this sort of 'free' service in order to make ends meet (Doc 2:28). This interrelationship is specifically contextualised to South Africa's rural communities that use

Forest, Albany Thicket and Savanna systems for fire wood, wild fruits, and to make wooden utensils and others gather traditional medicines from the natural environment" (Doc 2:9). Some benefits of biodiversity are represented in forms of goods that can be directly valued by the communities and the market. For example, Doc 2 reported that coastal resources in South Africa provided nearly 4% of the country's gross domestic product (GDP) in 2011, and that R85 billion was generated from fishing, coastal tourism, and ports and harbours (Doc 2:35). Another economic benefit of biodiversity in Doc 2 is that each year "South Africa hauls R6 billion worth of fish out of the water, a healthy source of wild food. The fishing industry provides 27 000 jobs to people in the commercial sector, and another 28 000 households are involved in subsistence fishing" (Doc 2: 155). "The natural veld gives us grazing for livestock, something which was valued at over R8 000 for every square kilometre annually in 2008" (Doc 2:9). Both documents displayed evidence of explicit benefits of ecosystem services and the value of biodiversity to humans. Doc 2 termed these benefits as a suite of services which include fresh water, firewood and fertile soils for agriculture (Doc 2: unpaged).

Regulatory services

Doc 1 explained that ecosystem services such as fresh water in aquifers and the use of the atmosphere as a sink for pollutants are available freely to those who use them (Doc 1:9). Doc 2 also acknowledged that South African wetlands support agriculture, filter pollution from water, and trickle-feed water into rivers even during the dry season (Doc 2:15). It further indicated that the value we get from wetlands include water purification and slowing down flood water (Doc 2:5). Doc 2 described areas with high natural runoff, such as the Drakensberg mountains, the Soutpansberg and the Wolkberg in Limpopo Province as water factories critical for gathering and channelling the water which this semi-arid country depends on (Doc 2:5).

Doc 1 stated that regulation of air quality, regulation of regional and local climate and in addition, regulation of erosion are also some of the ecosystem services (Doc 1:6). Doc 2 stated that some ecological infrastructure controls water flows and helps to protect and prevent extreme events associated with climate change, like floods, droughts and fires (Doc 2:5). Doc 2 emphasised the importance of regulatory services for understanding how the processes of healthy lands, healthy waters and healthy land-based environments, protect people from natural hazards, slow down floods and store water to help see us through times

of drought (Doc 2:9). Doc 2 explained how buffering effects of dunes in South Africa help us cope with the sometimes unpredictable storms which can damage coastal property (Doc 2:34). Doc 2 also mentioned that healthy rivers support a wide diversity of life, which helps to process pollutants and clean our water, and supports the people living in and around them (Doc 2:21). Healthy coastal systems in South Africa filter water and recycle nutrients (Doc 2: 35).

Doc 2 stated the value of pollinators by indicating that if it wasn't for pollination by certain insects, birds and rodents, many crops wouldn't grow (Doc 2:9). Doc 2 described the economic value of regulation services through an example that indicates that in 2008 in the Western Cape alone, wild pollinators gave a service to the deciduous fruit industry amounting to between US$49 million (R400 million) and US$311 million (R2 500 million) every year (Doc 2:9). The document further highlighted the importance of how creatures living in wild places also offer pest control for agriculture (Doc 2:9).

Cultural services

Humans experience both non-material and material benefits from ecosystems. Non-material benefits are included as cultural services such as which includes spiritual services, recreational and aesthetic services. Material benefits include food, water wood and other goods (see Section 2.7.1.1). Doc 1 stated that tourists are attracted to South Africa beaches, natural spaces and wild animals (Doc 1: 9).

Tourism is also one of the cultural services listed in the MEA. Even though both documents stated that tourism is a cultural (non-material) benefit, it does serve the purpose of material benefit for countries. For example, tourism brought an estimated R251 billion into South Africa's gross domestic product (GDP) in 2011 which is more or less equivalent to the mining sector (Doc 1: 9). Doc 2 provided examples about economic gains obtained from tourism and beaches. According to the document more and more tourists are flocking to our beaches every year. The money tourists spend drives local economic growth. Doc 2 showed benefits people obtain from ecosystems through recreation and tourism. According to Doc 2, the beaches around Cape Town have a recreational value of between R70 and R86 million per year, according to a 2009 report by the city. Meanwhile the beaches along the Garden Route attract some R950 million worth of tourist spend annually (Doc 2:10).

Doc 2 described aesthetic enjoyment brought by natural beauty, coastal settlements that are built on or near estuaries and extensively used for leisure (Doc 2:28). Another dimension of aesthetic appreciation in the document is how nature is used as playground and pleasure is derived from it. Doc 2 discussed interrelationships between nature and humans. It stated that "many of us feel a profound connection with the ocean's haunting beauty" (Doc 2:32).

According to Doc 2, in some cultures the "value of the land cannot be only reduced to mere rands and cents" (Doc 2:10). Doc 1 discussed the relationship between the land and the ancestors. According to the document, in some cultures when you walk on the land you respect ancestors or *abaphansi* (meaning 'those that are underground') (Doc1:10).

Supporting services

According to Doc 1 marine and freshwater ecosystems are key habitats for millions of aquatic species (Doc 1:17).

Although humans depend upon natural resources obtained from ecosystem services for their daily needs, we also indirectly depend on other essential services, such as the hydrological cycle, production of atmospheric oxygen, soil formation and retention and nutrient cycling. Doc 1 acknowledged that some soil nutrients, and fossil fuels are capital assets (Doc 1:9). It also indicated that good soil allows us to grow crops (Doc 2:9).
Doc 1 highlighted the fact that creation of a market in the form of a nutrient trading system may also be a low-cost way to reduce excessive nutrient loading in the United States (Doc 1:22).

Despite all the benefits of ecosystem services, according to Doc 1, ecosystems continue to be degraded and are severely under threat. The next section discusses threats to biodiversity presented in the content of the MEA and SANBI and brings in an understanding of how biodiversity loss comes about.

4.2.2 Threats to biodiversity

In this section, factual knowledge about the status of species and ecosystems, the extent of biodiversity loss and procedural knowledge on how to deal with potential threats and important concepts for understanding the complexity of biodiversity loss are discussed. Threats to biodiversity will be discussed under ecosystem degradation, habitat loss, species

loss introduction of exotic species, pollution and over exploitation of resources. These sections include considerations of cause and effect and gain and loss of biodiversity (see Section 2.7.1.2).

Ecosystem degradation

Doc 1 reported that humans have had a negative impact on ecosystems over the past 50 years due to rapidly growing demands for food, fresh water, timber, fibre, and fuel (Doc1:1). Doc 1 presented the degradation of ecosystem services as a barrier to achieving the Millennium Development Goals (Doc 1:1). Doc 2 stated that degradation of these ecosystem services is "difficult to measure, but the available evidence showed that they were fundamental and the degradation was increasing rather than slowing" (Doc 1:1).

Doc 1 quantitatively contextualised the severity of coral reef degradation by stating that 20% of the world's coral reefs have been lost and an additional 20% degraded in the last several decades of the twentieth century, and approximately 35% of mangrove area has also been lost. (Doc 1:11). Doc 1 presented knowledge of cause and effect by stating that the degradation of ecosystem services is harming many of the world's poorest people and is sometimes the principal factor causing poverty (Doc 1:12). The document also described how desertification affects the livelihoods of millions of people around the world, including a large portion of the poor in dry lands (Doc 1:13).

Doc 1 discussed how deforestation generally leads to decreased rainfall and this is because forest existence crucially depends on rainfall. According to Doc 2 climate change is already changing rainfall and evaporation patterns, putting further stress on these hard working ecosystems (Doc 2:21).

Doc 1 discussed gain-loss actions such as how one ecosystem service can cause the degradation of other services, for example an increase in food production usually involves increased use of water and fertilisers or expansion of the area of cultivated land. These same actions often degrade other ecosystem services, including reducing the availability of water for other uses, degrading water quality, reducing biodiversity, and decreasing forest cover which may lead to the loss of forest products and the release of greenhouse gases (Doc1:6).

Habitat loss

According to Doc 1, habitat transformation is a threat to biodiversity (Doc 1:14). Consequently globally habitat loss, and other ecosystem changes are projected to lead to a decline in local diversity of native species in all four MEA scenarios by 2050 (Doc 1:17). This is supported also by Doc 2 which states that in "South Africa if natural areas continue to be transformed into crops and forestry or turned over to mining or urban sprawl at the current rate, there will be little to no natural vegetation left in KwaZulu-Natal, Gauteng and the North West by 2050" (Doc 2:12). These negative impacts are contextualised in Doc 2 quantitatively, where it is reported that globally nearly a fifth of the land surface has been lost, mostly due to natural vegetation being ploughed up for crop farming of products such as maize, wheat and sugar cane (Doc 2:12).

According to Doc 2, loss of land cover is the greatest driver of habitat loss across South Africa. Nearly a fifth of the land surface has been lost, mostly due to natural vegetation being ploughed up for crop farming (like maize, wheat and sugar cane), and to a lesser extent, to mining, forestry and urban sprawl. The greatest losses are around hubs of economic activity (Doc 2:12). KwaZulu-Natal, Gauteng and the North West are amongst the provinces that have had the greatest loss of natural habitat (Doc 2:12). According to Doc 2, in South Africa the other most threatened coastal and inshore habitats tend to be rocky zones, like reefs and rocky shores and the Southern Benguela and Agulhas Eco regions (especially the shelf edge, which is highly productive for fishing (Doc 2:36).

The extent of biodiversity loss is described in both documents. Doc 1 stated that "more than two thirds of the area of two of the world's 14 major terrestrial biomes and more than half of the area of 4 other biomes had been converted by 1990, primarily to agriculture" (Doc 1:4). Doc 2 stated that the most threatened biomes in South Africa are Grasslands, Fynbos and Indian Ocean Coastal Belt (Doc 2:11).

Species loss

Doc 1 stated the statistics about the extent of loss of species. It reported that humans have increased the species extinction rate by as much as 1000 times over background rates typical over the planet's history (Doc 1: 6). The distribution of species on Earth is becoming more homogenous; in other words, the set of species in any one region of the world is becoming

more similar to the set in other regions primarily as a result of introductions of species, both intentionally and inadvertently in association with increased travel and shipping (Doc 1:4).

Doc 1 then listed threatened animal classes; for example, mammals, birds, and amphibians are currently threatened with extinction and also freshwater ecosystems tend to have the highest proportion of species threatened with extinction (Doc 1:4). Doc 2 mentioned that South Africa has over 2 000 plant species that are used for medicinal purposes, about a third of which are traded commercially. However, some of these species are threatened because they are heavily traded (Doc 2:6). Doc 1 also mentioned that overharvesting of fishing stocks and catching non-target species affects species such as birds, turtles, sharks and other fish species (Doc 1: 36).

Doc 2 mentioned that South Africa is a world leader in the Red Listing process which is an internationally recognised method for assessing the threat status of individual species, based on their likelihood of extinction (Doc 2: 48). The IUCN Red List aims to convey the urgency of conservation issues to the public, policy makers as well as the international community to curb species extinction.

Introduction of exotic species

Doc 1 specifically mentioned that invasive alien plants have dramatically increased their footprint in South Africa (Doc 1:11). Doc 2 then stated that in South Africa the most widely studied group of alien invaders are woody plants, partly because of the threat they pose to the water supplies which makes them a priority concern (Doc 2:44). The report further specifically mentioned the invaders in South Africa: the Australian wattles, gums, prickly pears, pines, poplars, weeping willows and mesquite (Doc 2: 44). Some of the main invaders threaten water security. By sucking up large amounts of water, they reduce how much water reaches the rivers, the impact of which ripples through the entire fresh water system (Doc 2: 44). According to the SANBI, invasive alien fish such as bass and trout introduced for recreational fishing and aquaculture can wipe out indigenous fish species and other marine life (Doc 2:23).

Some invasive species were introduced intentionally, to beautify gardens, as pets, recreation, to modernise agriculture or for aqua- or marine culture to bind sand dunes or for use as timber or biofuels (Doc 2:42). Others have “slipped into the country unbeknownst to us at

first, stowing away in the ballast water in ships, or clinging to ship hulls, or hidden away in agricultural products" (Doc 2:42).

Some invaders reduce farm grazing and some of the species may even kill or poison livestock (Doc 2: 44). If allowed to spread, these invaders could reduce the carrying capacity for large grazing animals by more than two thirds (Doc 2: 44). Doc 2 contextualised the concept of alien invasion through a case study about the place named 'bush of evil' before it was cleared in 2005. According to Doc 2, it was a council-owned site in Delft, Cape Town and became a notorious haven for criminals because of the dense invasion of Port Jackson trees where many rapes and murders took place (Doc 2: 44).

Pollution

According to Doc 1 agricultural practices cause water pollution and eutrophication (a process whereby excessive plant growth depletes oxygen in the water), air pollution (emissions of greenhouse gases) and soil degradation (off-site erosion damage, emissions of greenhouse gases (Doc1:6).

According to Doc 2 factors that threaten the ecosystem include water, soil and air pollution from mining, agriculture, manufacturing and cities which also disrupt ecosystems (Doc 2: 11). Pollution in rivers feeding into a wetland can cause harm (Doc 2:18). In South Africa, the Orange River mouth is heavily impacted by mining and access roads (Doc 2:18). Estuarine life is also polluted by deposited sand and silt (Doc 2:18). In South Africa some pollution comes from failing sewerage treatment plants and industrial waste which pours directly into wetlands and rivers. Other sources of pollution are agricultural pesticides and fertilisers running off farmlands. Consequently taking water out of a polluted system leads to even higher concentrations of pollutants (Doc 1:23). Pollution from fertilisers, herbicides and pesticides also damages estuarine life (Doc 2:30).

Over exploitation and mismanagement of resources

According to Doc 1 globally, overgrazing or poor crop management can lead to soil being flushed away and deposited in wetlands (Doc 1:18). Doc 2 indicated that in South Africa over-fishing and bait extraction (of prawns, for instance) can damage nurseries, and reduce or collapse fish stocks (Doc 2:18). Hence fishing is the greatest stress on South Africa's marine

ecosystems together with over-harvesting of fishing stocks (Doc 2:18). Doc 2 noted that in South Africa there is "catching non-target species, or 'by-catch', such as birds, turtles, sharks and other fish species, and damage occurring through the fishing process such as trawling of some parts of the seabed is as irreversible as ploughing up a grassland (Doc 2:18). Poaching is mentioned as another threat to the diversity of marine life in South Africa, the sustainability of resources and the livelihoods of legitimate fishers (Doc1:36). According to Doc 1, an increase in the demand for rhino horn in Southeast Asia since 2008 has sparked an increase in poaching which threatens to reverse the gains made (Doc 1:48).

4.2.3 Restorative actions

Restorative actions for the purpose of this study included positive practical activities or strategies (see Section 2.7.1.3). That includes actions that assist and restore ecosystems that have been degraded, damaged, or destroyed to recover (see Section 2.7.1.3). The following section will discuss restorative actions in both scientific documents.

Doc 1 stated that the restorations of ecosystem services are costly compared with the lesser cost of preventing the degradation of the ecosystem (Doc 1:23). According to Doc 1, many countries have taken actions to restore degraded services, though not all services can be restored, and heavily degraded services may require considerable time for restoration (Doc 1:23).

Doc 2 described how some of the damaged wetlands and estuaries in South Africa have been restored. In Bushbuckridge, Mpumalanga, the Manalana wetland in the Sand River was badly eroded, something which threatened its beneficial capacity. The Working for Wetlands programme which began rehabilitation in 2006 successfully rehabilitated them, and people living in the area can again use them for food, grazing and construction materials (Doc 2:16).

4.2.4 Conservation and sustainability of biodiversity

Doc 1 presented a framework of 74 response options that have been used internationally to address key obstacles for ecosystem services, integrated ecosystem management, conservation and sustainability of biodiversity. Also in Doc 1, the following five specific sectors were identified to address key obstacles through specific actions: Institutional and Governance Responses, Economics and Incentives Responses, Social and Behavioural

Responses, Technological Responses and Knowledge responses. According to Doc 1, many of these options hold significant promise for overcoming these barriers and conserving or sustainably enhancing the supply of ecosystem services (Doc 1:19). The sectors and the actions are summarised below in Table 4.1.

Table 4.1: Five sectors and their potential roles in actions for addressing key obstacles for ecosystem services (MEA, 2005, pp. 20-24)

SECTORS	ACTIONS
Institutions and Governance Responses	Institutional and environmental governance frameworks are sometimes required to create the enabling conditions for effective management of ecosystems.
Economics and Incentives Responses	Economic and financial interventions provide powerful instruments to regulate the use of ecosystem goods and services.
Social Behavioural Responses	Actions include population policy, public education, civil society actions, and empowerment of communities, women, and youth.
Technological Responses	The development and diffusion of technologies designed to increase the efficiency of resource use or reduce the impacts of drivers such as climate change and nutrient loading are essential.
Knowledge Responses	Providing knowledge and information about different aspects of ecosystems and ability to use adequately the information that exist in support of management decisions.

In addition, Doc 1 described how the process of integration of ecosystem management goals in various sectors such as agriculture, forestry, finance, trade, and health and increased transparency and accountability of government and private-sector performance could substantially lessen the severity of biodiversity loss in the next several decades (Doc1:2).

To support this management integration approach, Doc 2 emphasised actions that require inclusion of ecosystem management goals and coordination among multilateral environmental agreements and between environmental agreements and other international economic and social institutions within other sectors and within broader development planning frameworks (Doc 2:19).

In relation to conservation and sustainability, Doc 1 stated that there are various choices that exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-

offs (Doc 1:18). This document presents a procedural framework of four scenarios that look into sustaining future ecosystems and human well-being (Doc 1:15). These are: Global Orchestration which pays attention to future economic growth; Adapting Mosaic focused on regional watershed-scale ecosystems of political and economic activities (Doc 1:15); a Techno Garden scenario described a globally connected world which relies heavily on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and acknowledging the management of ecosystems in an effort to avoid future problems (Doc 1:15); lastly, the Order from Strength scenario represented a regionalised and fragmented world, concerned with security and protection.

Doc 2 also focused on policy responses to biodiversity loss. It presented South Africa's National Water Act, and Conservation of Agricultural Resources Act (Doc 2:19). MEA's other response options towards sustainability and conservation included the use of legal mechanisms to change the "rules of the game", changing social norms, values, and attitudes through communication and education about the consequences of management practices; research and development of new technologies for ecosystem management; and public and consumer action (Doc1:15). For example, the document suggested substitution of vinyl, plastics, and metal for wood (Doc 1:19). However, Doc1 stated that the availability of substitutes can reduce pressure on specific ecosystem services, but they may not always have positive net benefits for the environment as a whole (Doc 1:19).

According to Doc 1, most ecosystem services assessed are being degraded. However, the degree of that degradation would have been much greater without responses implemented in past decades (Doc 1:18). Those responses include "establishment of more than 100 000 protected areas globally (including strictly protected areas such as national parks as well as areas managed for the sustainable use of natural ecosystems, including timber or wildlife harvest) covering about 11.7% of the terrestrial surface; these play an important role in the conservation of biodiversity and ecosystem services (Doc 1:18-19).
In South Africa a quarter of land-based ecosystems are well protected including mountain Fynbos, Kruger National Park and iSimangaliso Wetland Park, wetland ecosystems in the lowveld region and in northern KwaZulu-Natal (Doc 2: 18). South Africa is also a signatory to the Ramsar Convention on Wetlands, which means we have to identify important wetlands which are then added to Ramsar's List of Wetlands of International Importance (Doc 1:19).

Still Bay and the Amatole Marine Protected Areas, both in the Agulhas bioregion, are two new stretches of coastline to get special protection in recent years (Doc 2:37). Doc 2 reported that the establishment of the Somkhanda Game Reserve brought the introduction of black rhino in the reserve, tourist lodges were refurbished, game numbers were supplemented and water has been secured and hunting is bringing in revenue (Doc 2:10).

Both documents mentioned the concept of resilience. Doc1 described resilience as "the amount of disturbance or stress that a system can absorb while still remaining capable of returning to its pre disturbance state" (Doc 1:88). Doc 1 recognised the fact that the loss of biodiversity decreases the resilience of ecosystems (Doc 1:91). Consequent to that fact, Doc 2 stated that it is important that places of resilience be considered in land use planning, environmental impact assessments, protected area expansion, and working with industry sectors to minimise their spatial footprint and other impacts (Doc 2:41).

4.3 Biodiversity Content in the Natural Sciences CAPS and the Textbooks: ORF and PRF

This section presents biodiversity content from the ORF, namely from the Natural Sciences CAPS Policy document and the three textbooks analysed for this study as with the analysis of the international and national scientific documents. This section presents extracts representing the following key features of biodiversity content: ecosystem services, threats to biodiversity and restorative actions and conserve and sustaining biodiversity also as with the analysis of the scientific documents. Factual, conceptual and procedural knowledge dimensions of biodiversity (Anderson & Krathwohl, 2001; also see Section 2.6.4) are included in the discussion. The section further adds details of how the knowledge has been contextualised through case studies and examples in the texts analysed.

The texts analysed here are the Life and Living content and concepts in the Grade 7 and 8 textbooks, and the Planet, Earth and Beyond content in Grade 9 (see Section 2.5.2). This section used labels codes 'CAPS' to refer to the CAPS policy document and grade, for example CAPS 7 and 'TB' for textbook, for example TB 7 (see Table 3.2)
The data in this section responds to sub-question 2 enabling me to relate the nature of biodiversity knowledge presented in the Natural Sciences curriculum and in the commonly used Grade 7-9 Natural Sciences textbooks?

4.3.1 Grade 7

4.3.1.1 Ecosystems services

This section discusses how ecosystems services are presented in the Grade 7 CAPS policy document and a Grade 7 textbook.

CAPS included foundational knowledge on biodiversity, namely that "plants, animals and microorganisms, and their habitats make up the total biodiversity of the Earth" (CAPS7: 17). The Grade 7 textbook extended this foundational knowledge to bring in an understanding of ecosystem services through the extract "survival of living organisms depends on ecosystems: access to water, air, food, space, favorable temperatures and protection from enemies" (TB 7:4). The textbook expanded this foundational knowledge by explaining and giving examples of aquatic and desert biomes and explained how animals and plants need to be physically and behaviorally adapted to survive in these biomes (TB 7:6). It explained and illustrated through pictures how seaweed such as kelp and fish survive in rivers and lakes (TB 7:6). Desert environments are habitats for animals such as the gemsbok which lives in the Kalahari Desert; camelthorn trees which also grow in the Kalahari and social weavers in the Kalahari are also discussed by the textbook (TB 7:7).

Through a "did you know box" in the Grade 7 textbook, a contextualising example illustrates provisioning services (see Appendix T). It describes how the seedpods of the camel thorn, Erioloba acacia are made into a nutritious porridge and eaten by local people (TB 7:7). CAPS introduced foundational knowledge of species diversity through the topic 'Classification of living things and diversity of plants and animals'; however, it does not distinguish between the three components (genetic diversity, species diversity and ecosystems diversity) of biodiversity (CAPS7:17). The textbook explained classification of living things such as animal classes and plant kingdoms (TB 7:11-22).

CAPS listed and provided foundational knowledge for understanding regulatory services through the topic of 'pollination' under 'sexual reproduction' and an important human-environment relationship covered in this section is how pollinators play an important role in the production of food crops (such as maize) for humans (CAPS 7:19). The textbook explained pollination and adaptations of wind and insects but did not highlight the human-environmental relations in terms of pollination of food crops (TB 7:33).

4.3.1.2 Threats to biodiversity

The CAPS policy document and the textbook presented conceptual knowledge foundational to understanding the significance of biodiversity loss, that is classification of the five main groups of living organisms (Kingdoms) which include Bacteria, Protista, Fungi, Plants and Animals (CAPS 7:17). According to CAPS, Kingdoms are further subdivided into Phyla/Divisions, then Classes, then Families, then Orders, then Genera, and the smallest group is species (CAPS7:17). In addition, the sub-topic 'diversity of animals' lists five vertebrate classes, namely Fish, Amphibians, Reptiles, Birds and Mammals. Without understanding the multitude of different types or living organisms on earth, learners might struggle to understand the significance of individual species and whole groups of organisms becoming extinct; hence the argument that this knowledge is fundamental to understanding biodiversity loss.

An important foundational concept important for understanding genetic biodiversity is the topic of 'variation'. Similarly, CAPS defines species as "a category within the classification system" CAPS 7:21). The textbook defined species as "a category within the biological classification system" (TB 7:57). CAPS and the textbook focus on variations within species. The textbook also explained how individuals within species reproduce (TB 7:56-60).

The textbook introduced and explained the term 'alien invaders' as a case study that explains that "sometimes exotic plants can become problematic and are called alien invaders" (TB 7: 37). This is important for understanding the relationship between humans and alien invasive species (TB 7: 37). The textbook also discussed the dispersal of seeds and fruits as one of the methods that increases alien invaders (TB7: 37). This concept was broadened by the case study on "Humans and Aliens and how Port Jackson, *Acacia saligna*, was introduced to the Western Cape from Australia and it resulted in habitat loss" (TB 7: 37).

4.3.1.3 Restorative actions

The CAPS policy document and the textbook presented knowledge foundational to understanding how degraded ecosystems can have missing species and be restored by introducing new groups of missing species, or even whole functional groups through the topic 'species variation'. It was also explained that members of the same species can reproduce

with one another and make more individuals (CAPS 7: 21 & TB 7:59). However restoration actions were not prescribed in the textbook.

4.3.1.4 Conservation and sustainability of biodiversity

The CAPS policy document and the textbook presented knowledge foundational to understanding healthy biological systems through listing and describing requirements for sustaining life (CAPS 7:17 & TB 7:4). Both stated factual knowledge listing what organisms need to live: energy, gases, water, soil and favorable temperatures (CAPS 7:17 & TB 7: 4).

In addition they presented knowledge about the evolutionary process of adaptation explaining that "living things are suited (adapted) to their environment. Understanding the uniqueness of different species and the basic requirements for life of all species is important for understanding ecological sustainability. (CAPS 7:17 TB 7: 6 -7). However in this Grade the curriculum does not engage in discussion about restoration (for example, of habitats threatened by alien species invasion), nor about conservation nor adaptation or mitigation against environmental threats.

4.3.2 Grade 8

4.3.2.1 Ecosystem services

In the CAPS and the textbook, relationships between humans and environment was highlighted in the main topic 'interactions and interdependence within the environment' (CAPS 8:36 & TB 8:11-13). Under the topic 'interactions and interdependence within the environment', the CAPS and the textbook presented conceptual knowledge for understanding ecology and ecosystems (CAPS 8:36 & TB 8:11-13). Both defined the concept of ecology as "the study of interactions of organisms with one another and with the physical and chemical environment" (CAPS 8:36). The relationship between humans and environment is noted in the CAPS and it lists humans as 'interfering' through the extract "identify any human interferences in the area (such as litter and pathways)" (CAPS 8:36). The textbook noted this relationship by explaining how learners can investigate this interference of humans in their area and illustrated this with a picture of littering by humans (TB 8:19)

The Grade 8 CAPS listed conceptual knowledge on four ecological level of interactions; populations, communities, ecosystems and the biosphere (CAPS 8:36). The textbook defined

each concept (TB 8:13). Population is defined as a group of one kind of organism all living together in the same place. A community is defined as a group of different populations that all share the same place. According to the textbook an ecosystem is a self-supporting community or group of communities in an area, together with the physical and chemical factors of the environment that affect them. Lastly the biosphere was defined as the total of all ecosystems on Earth (TB 8:13). Community was illustrated through a picture showing elephants and thorn trees as part of the community in the Kruger National Park (TB 8:13). The introduction to the topic of 'ecology' was followed by the topic 'ecosystems' which presented conceptual knowledge defining ecosystems and procedural knowledge on how ecosystems work (CAPS 8:36). According to the CAPS document, all ecosystems combined, making up the biosphere and an ecosystem consists of an ecological community that includes all living organisms (biotic) such as plants and animals, together with the non-living (abiotic) environment such as temperature, wind, water, interacting as a system (CAPS 8:36). In addition, the size of an ecosystem is not specifically defined with the explanation that it usually encompasses a specific, limited area although it can encompass the entire planet (CAPS 8:36). Furthermore, the CAPS explained that ecosystems are defined as a network of interactions among organisms, and between organisms and their environment (CAPS 8:36).

The CAPS and the textbook did not explicitly discuss resilience. However within the topic 'ecosystem', the CAPS and the textbook listed conceptual knowledge foundational to understanding ecosystem resilience through explaining that the survival of individual organisms and populations depends on their ability to cope with changes (adapt) in their habitat (the place where an organism lives) or in the ecosystem (CAPS 8:36). The CAPS explained adaptations which provide conceptual foundations knowledge for understandings ecosystem resilience. According to CAPS, "adaptation is the change in the structural, functional and behavioural characteristics of an organism" (CAPS 8:38). It stated further that adaptation allows the organism to survive as it adapts to changing conditions within the environment (CAPS 8:38). The textbook presented foundational knowledge on how structural and behavioural features of animals and plants enable them to survive in a place (TB 8:33-34).

Under the topic of adaptation, the textbook elaborated on the concept of the 'indigenous' and explained how indigenous animals are better suited for our environment naming South

African fauna and flora which are of value to humans, such as bat eared foxes which eat pests such as rats and white ants (TB 8:38).

The sub-topic ‘feeding relationships’ provided conceptual knowledge on feeding relationships between producers, consumers, herbivores, carnivores, scavengers, insectivores and decomposers (CAPS 8:37). Producers were defined as living organisms that make their own food consumers are all other living things consuming food. Herbivores are animals that get food from plants, carnivores are animals that feed on other animals, scavengers are animals feeding mainly on meat, insectivores are predators whose prey is always insects and lastly, decomposers break down the remains of dead plants and animals (CAPS 8:37). The textbook extended this conceptual knowledge listed in the CAPS into procedural knowledge about energy and nutrients flows. For example, producers transform light energy into chemical energy to make their own food, consumers are consumed by all living organisms, herbivores get nutrients from plants and food and they get energy from food, carnivores also get their energy from food, decomposers extract the useful minerals from the bodies of plants and animals and these go back to the soil (TB 8:21).

The topic on feeding relationships was followed by the sub-topic of ‘energy flow’ (CAPS 8:38). CAPS listed factual and foundational knowledge on how ecosystems maintain themselves and explains food chains and food webs (CAPS 8:38). The textbook presented procedural foundational knowledge on how ecosystems maintain themselves by cycling energy-flow food chains and food webs by explaining the role of producers, explains food chains and trophic levels and how they work (TB 8:22).
Procedural knowledge for understanding regulatory services was also evident in the textbook. This included how soil ecosystems work and the importance of different component species such as bacteria and micro-organisms (TB 8:21).

Furthermore, the textbook explained how some micro-organisms are used by people for making certain foods (such as yoghurt) and medicines such as penicillin (CAPS 8:38). This is an example of knowledge foundational to understanding provisioning services, although it did not explicitly place humans as integral to the ecosystem. It also gave examples of indigenous plants which often contain ingredients that can be used for medicines (TB 8:39).

The textbook expanded the understanding of ecosystems as offering cultural services and explained how nature reserves give people great pleasure and are tourist attractions (TB

8:39). The textbook also provided foundational knowledge for understanding provisioning services in that it explained the role of wetlands in filtering and cleaning water, and controlling its flow (TB 8:40). This explained the importance of wetlands in keeping our water fresh and clean and reducing the risk of serious floods (TB 8:40).

4.3.2.2 Threats to biodiversity

The CAPS prescribed both natural and human factors as disruptive to biodiversity as curriculum foci (CAPS 8:38). The CAPS provided examples of "litter and pathways as human interference and cutting of firewood (TB 8:19). The textbook guided learners to investigate examples of human interferences in their area and illustrated this through pictorial illustrations of littered areas (see Appendix U) (TB 8:19). It further explained that "plants and animals that are not naturally from the ecosystem are called aliens" and they are sometimes brought by humans (TB 8:38).Various examples of threats to biodiversity as a result of humans include the main cause of soil erosion: overgrazing, over cultivating and removing plants to expose soil (TB 8:38). Other forms of human interference presented by the CAPS are humans removing organisms from the ecosystem by processes such as poaching (CAPS 8:38). However the removal of organisms due to their value as 'ecosystem services' essential to human well-being was not listed as a topic of study. This is a significant difference to the perspective on biodiversity loss presented in the scientific documents presented in Section 4.2.

The textbook gave procedural knowledge on how pollution which is also created by humans harms the soil by damaging the plants and killing the soil organisms that make humus (TB 8:40). People also pollute the air, soil and water with chemical substances that are harmful to living things (TB 8:28).

The concept of acid rain was described as a threat that destroys life in many rivers and damages plants (TB 8:41). The textbook elaborated explaining that in South Africa power stations are the main source of acid rain (TB 8:38). Domestically, the textbook explained how coal, wood and charcoal fires in houses give out poisonous gases in rural areas. In towns, smoke from domestic fires and heaters can cause lung diseases (TB 8:41). This procedural knowledge was further illustrated through illustrations of a factory polluting the air (TB 8 41).

In the textbook, the energy flow sub-topic helped learners to evaluate the effect of removing an organism from a food web (TB 8:32). This helped them to gain procedural knowledge on biodiversity loss and to make judgements about the complex network of interactions in an ecosystem. For example, the question was posed "What will happen to the population of rats and mice if they are not being preyed upon by hawks"? (TB8:32). Other questions were what could happen to the population of mongoose because of the change in population size of the rats and mice, could the loss of hawks affect the population of hadeda ibis and what other populations might be affected by the loss of the hawks in this food web? (TB 8:32).

The CAPS included a focus on understanding that an ecosystem can only accommodate as many organisms as its resources (food, water and shelter) can carry, and it will fail if it does not remain in balance. The CAPS further listed knowledge foundational to understanding biodiversity loss through examples such as how natural factors which include extreme changes in patterns of weather and climate, such as floods, drought, extreme and sudden changes in temperatures can harm ecosystems (CAPS 8:38). The textbook explained the balance of ecosystems and provided procedural understanding on natural and human factors affecting ecosystems listed in the CAPS, such as floods, drought, very high and low temperatures, and unusual events such as volcanoes, tsunamis and meteorites (TB 8:28). Furthermore, the textbook provided procedural knowledge on human factors that causes disruption of the world's ecosystems. For example, people cause harm when they remove the natural animals and plants that were in balance with the ecosystem by hunting, poaching, burning and cultivating land (TB 8:28).

The concept of biodiversity threats was also broadened by discussions in the textbook through examples of research case studies that can be conducted by learners. The first research case was about lack of food in a game reserve due to drought in Tsavo National Park, Kenya. The second one covered habitat destruction due to farming. The third one involved conversion of Brazilian rain forest into grass for cattle ranching and reduced migration by fencing in game reserves. The fourth one was about the need to cull elephants in Kruger National Park. The fifth one considered the effect of hunting which brought extinction of the Quagga in the Karoo. The last one was about mining, specifically the effect of titanium mining on coastal sand dunes (TB 8:31).

The CAPS included a focus on how organisms that are "unable to adapt to changes within the environment die out and become extinct" (CAPS 8:38). The concept of extinction was broadened by the textbook which explained that species that are less well adapted in the environment do not reproduce, and disappear from the ecosystem and become extinct (TB 8:36).

The CAPS prescribed the topic "harmful micro-organisms" (CAPS 8: 39) with facts about TB (caused by bacteria), AIDS (caused by HI virus) and malaria (caused by a protist). Further it prescribed how waterborne diseases (such as cholera and diarrhoea) account for many child deaths (CAPS 8:39). The textbook then explained how progress in technology and medical science contribute to reduction of these diseases that kill many people (TB 8:38).

According to the textbook, fungi are useful decomposers though some cause diseases (TB 8:48). Protists live in animal bodies and cause disease, for example malaria and kills many thousands of people in Africa (TB 8:48). Pathogens were described as organisms that cause diseases, for example AIDS is a disease caused by a virus, tuberculosis is caused by a bacterium, malaria by a protist. The textbook contextualised this knowledge and indicated that almost 500 million people are infected with malaria from mosquitoes a year (TB 8:49). It added that waterborne diseases are very dangerous. Every year more than three and a half million people die from diseases carried in water. Diarrhoea is the most common (TB 8:48).

4.3.2.3 Conservation and sustainability of biodiversity

CAPS prescribed knowledge foundational to understanding the concept of conservation and sustainability that is, the impact of environmentalists (CAPS 8: 38). The textbook included a focus on how natural habitats that are conserved can generate money which can be used for the maintenance and development of protected areas (TB 8:39). It also described economic gains from conservation through explaining that "money generated from game reserves can be used for the maintenance and development of protected areas" (TB 8: 39). The textbook contextualised this by stating that one such area in South Africa is in the Drakensberg mountains. The Maloti /Drakensberg Transfrontier Conservation Area was established to protect the special ecosystems of the area and our water supply (TB 8:39).

Under the topic 'Conservation of ecosystems' the CAPS included procedural knowledge on managing ecosystems and preservation of wetlands (CAPS 8:38). For example, the policy

prescribed knowledge that "environmentalists and others work towards managing ecosystems, such as control of alien vegetation" (CAPS 8:38).

According to CAPS, "adaptation is the change in the structural, functional and behavioural characteristics of an organism" (CAPS8:38). It stated further that adaptation allows the organism to survive as it adapts to changing conditions within the environment (CAPS 8:38). The textbook presented procedural foundational knowledge on how structural and behavioural features of animals and plants enables them to survive in a place (TB 8:33-34). The CAPS also listed how individuals can contribute to conservation in various ways, such as appropriate waste disposal including recycling and re-using (CAPS 8:38).

The CAPS prescribed a focus on how environmentalists and others work towards managing ecosystems, such as control of alien vegetation and preservation of wetlands (CAPS 8:38). The textbook elaborated by explaining how environmentalists try to conserve places for different kinds of plants and animals in our planets and how wetlands are preserved (TB 8:39).

4.3.3 Grade 9

The Grade 9 CAPS policy document did not continue with the focus on ecosystem services content, restorative actions and conservation and sustaining biodiversity. The CAPS and the textbook presented threats to biodiversity and additional foundational knowledge on conservation and sustaining biodiversity.

4.3.3.1 Threats to biodiversity

The CAPS prescribed the topic of 'threats' caused by mining in South Africa' (CAPS 9:80). According to CAPS, there is large scale mining activity in South Africa which brings significant environmental impacts such as creation of mine dumps, pollution of water resources, damage to places with high tourist or cultural heritage value and loss of farming and wildlife environment (CAPS 9:80). While biodiversity loss was not explicitly discussed here, these environmental issues can be related to biodiversity loss. The textbook repeated lists of environmental issues associated with mining (TB 9:178-179).

Both the CAPS and the textbook presented knowledge on understanding the effects of climate change by explaining that too much ultraviolet radiation interferes with life on Earth – human health, photosynthesis, life cycles and sizes of populations of species (CAPS 9:80 and TB 9:179). CAPS stated the need for learners to know about layers in the atmosphere including the troposphere, stratosphere, mesosphere and thermosphere (CAPS 9:82). This provided knowledge foundational to understanding the greenhouse effect and global warming.

Then the CAPS prescribed knowledge on how global warming threatens biodiversity (CAPS 9:82). It further presented procedural knowledge on how greenhouse gases trap ultraviolet radiation which then warms the air closest to the surface of the Earth like inside a greenhouse (CAPS 9:82). The CAPS explained that the most common greenhouse gases are carbon dioxide, water vapour and methane and mentioned that an increase in greenhouse gases leads to global warming(CAPS 9:82). The textbook added further procedural knowledge by explaining that the greenhouse effect is a natural phenomenon and that it warms the atmosphere sufficiently to sustain life (TB 9:186) in a bit more detail than outlined in the CAPS. It also provided procedural knowledge by explaining how the natural greenhouse effects works. It stated that the greenhouse gases trap the ultraviolet radiation which then warms the air closest to the surface of the Earth (TB 9:187).

The textbook repeated the prescribed CAPS knowledge stating that "the most common greenhouse gases are carbon dioxide, water vapour and methane" (TB 9:187). It stated that an increase in greenhouse gases leads to global warming which is a potentially life threatening problem on Earth (TB 9:188). The CAPS and the textbook both stated that global warming could lead to climate change, rising sea levels, food shortages and mass extinctions (CAPS 9:82 &TB 9:188). Mass extinctions is one aspect of biodiversity loss, but this does not capture the nuances of the full range of aspects of biodiversity loss.

4.3.3.2 Conservation and sustainability of biodiversity

The CAPS did not prescribe conservation and sustainability with respect to biodiversity. However, the textbook presented procedural knowledge about the Department of Minerals and Energy regulations within the mining industry in South Africa (TB 9:178-179). The textbook included procedural knowledge on what can be done to slow global warming. It

stated that governments need to take drastic actions to cut back the use of fossil fuels, although this is not easy because the economy depends on electrical power (TB 9:189). Here the social-ecological complexity of sustainability was being implicitly addressed.

4.4 Recontextualisation Process in the ORF and PRF

This section describes recontextualisation from the perspective of significant individuals active in the recontextualisation processes by drawing on the five interviews undertaken with individuals active in the different stages of the Pedagogic Device: One Natural Sciences Provincial coordinator (who is involved in the ORF and PRF), two Senior Education Specialists (serving in the PRF) and one textbook publisher (serving in the PRF) (see Section 3.3.4).

The data in this section responded to sub-question 3: Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge?

4.4.1 Role players in the ORF and PRF and their roles in recontextualisation process.

Data presented in this section illustrates that recontextualisation of the Grade 7-9 Natural Sciences biodiversity knowledge in the CAPS curriculum involved different role players. Each role player had a responsibility/responsibilities towards the development and implementation of the CAPS in different phases which will be discussed after this section. Table 4.2 below outlines the different role players and their responsibilities.

Table 4.2: Table outlining role players in the Pedagogic Device and their roles in recontextualisation

Role players	What do they do?	Source
Provincial coordinators – NS(All 9 provinces)	Part of the National Curriculum Statement Review committee Train SESs and support CAPS implementation	PCint//7
Ministerial Project Committee	Appointed to oversee the development of Curriculum and Assessment Policy Statements for the National Curriculum Statement Grades R-12	PCint//4
National Core Training Team (NCTT)	Training of senior education specialists and other stakeholders	PCint//11
Wits University - Setlhare Trust Teacher Development	Part of development of CAPS and responsible for teacher training	PCint//12
Umalusi	Ensure quality of developed CAPS documents	PCint//18
Public	Comment on newly developed Draft National Curriculum and Assessment Policy Statements	PCint//12
Minister of Basic Education	Approval and gazetting of CAPS Declaration of CAPS as national education policy.	PCint//6
Ministerial Task Team	Review of the Implementation of the National Curriculum Statement, October 2009. Made several recommendations to improve the curriculum	PCint//7
Senior education specialists	Responsible for training teachers and support teachers to implement CAPS	PCint//7 (PCint//9 SES1int//22 SES2int//14
NGOs - SASOL	Part of development of CAPS	PCint//19 SES1int//23 SES2int//15
Members of political parties	Oversee development and implementation of CAPS and ensuring that CAPS is do-able	PCint//20

4.4.2 Phases of recontextualisation

The following section describes the phases of recontextualisation. It begins by first discussing development of the CAPS then implementation of CAPS, and is followed by training of education officials and lastly, textbook developers.

4.4.2.1 Development of CAPS Grade 7-9 Natural Sciences curriculum policy

According to the provincial coordinator, during the CAPS development, he was one of the National Curriculum Statement Review committee members who made recommendations to writers (PCint//7). He further mentioned that the role of the committee was to ensure that each grade was standardised and that there was content and conceptual progression in the CAPS from Grade 7-9 (PCint//12). He then explained how other stakeholders became part of the CAPS development by saying "thereafter the DBE called on all provincial coordinators to communicate the development of CAPS" (PCint//8). He spoke about how the Task Team was appointed by the minister for all subjects including Natural Sciences. He explained that provincial coordinators contributed to the content of each subject. He explained further that he has a good command of the Space Science and Environmental Physics specialisation (PCint//15).

When asked which sources were mainly used for the development of biodiversity knowledge, he said "the current Gr R - 12 CAPS for subjects does not have a section on references" (PCint//45). He further emphasised strongly that "there is no specific reference that can be disclosed as CAPS reference document for Natural Sciences" (PCint1//35).
Reflecting further on other stakeholders who were part of the process, he mentioned that the National Core Training Team (NCTT) had other partners in education, teacher unions and universities (PCint//9). He explained further that Wits University, Setlhare Trust Teacher Development and Umalusi all provided inputs with respect to content and assessment (PCint//4). He explained that Umalusi was established to ensure the quality of the CAPS during development and implementation (PCint//4).

When asked to comment on how the completed CAPS documents were handled, he explained that the first draft was completed and submitted to the minister. He further explained that the CAPS documents were sent out for public comment around September 2010. The comments were then collated and the documents revised in relation to the recommendations. In some cases, the writing teams were intensified to do this (PCint1//44). He explained further that the documents were then approved by the Ministerial Project Committee and sent to editors (PCint//45). The final step in the process involved a teacher union check on the do-ability of the curriculum (PCint//46).

When asked how the final documents were handled by the minister, he explained that after this process was complete, which was around the end of May, the CAPS was submitted again to the Minister for her approval and gazetting (PCint//48).Then he again mentioned that Umalusi ensured that the documents were of good quality (PCint//49).

4.4.2.2 Textbook development

Textbooks form an integral part of teaching and learning, thus one of the questions for the Provincial Coordinator was how they are involved in the process. He responded by saying, that textbook writers align their textbooks with CAPS to minimise workload for the teachers (PCint//23). The textbook publisher also spoke strongly about how they align their textbooks with CAPS first indicating in short "We are not part of the process, we just follow the CAPS document and it's a lead to how we write and organise content in textbooks" (TBint//8).

4.4.2.3 Training of education officials

In the ORF, the CAPS curriculum was cascaded to education officials (PCint//51).The provincial coordinator explained that the Minister of Basic Education declared the *CAPS Grades R – 12* as national education policy by the end of April 2011 to be implemented during the period 2012-2014 (PCint//52). The year 2014 was the first for Grade 7, 8 and 9 CAPS implementation at schools (PCint//52).

In reflecting on the training that took place, the Provincial Coordinator explained that the National Core Training Team trained the province's SESs and other partners such as teacher unions and universities (PCint//55). Reflecting on how they supported the SESs during and after training, the coordinator commented that they visited the training session to support them and report on challenges faced by teachers during implementation (PCint//13).
The training process was also mentioned by the two SESs that were interviewed. SES2 elaborated that a workshop was held for all Subjects Specialists by the National Team which were Provincial Coordinators of all provinces(SES1int//14). It was a workshop that lasted a week. Some of the stakeholders included the Labour Unions, politicians and other stakeholders such as Sasol (SES2int//14). This was also mentioned by SES1 who explained that a workshop was held for all Subjects Specialists by the National Team of Provincial Coordinators of all provinces.(SES1int//22).

Both SESs mentioned that after they had been trained by their Provincial coordinators, they were expected to train teachers in their respective districts. SES1 explained that then after "as subject specialists we had to train teachers in our districts" (SES1int//24). The other one said "I had to train my teachers in the district after we were trained" (SES2int//17). SES 1 further mentioned that as SESs they were to collate information regarding content gaps identified during the training process in different districts (SES1int//23).

4.5 Conclusion

This chapter presented biodiversity knowledge in the FOP – in international and national documents. It then discussed biodiversity knowledge presented in the ORF (Grade 7-9 CAPS Natural Sciences curriculum) and the PRF (three textbooks for Grades 7-9). In addition, recontextualisation phases, role players and their responsibilities were also discussed.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Introduction

Chapter 4 presented data representing biodiversity content in scientific documents, Grade 7-9 Natural Sciences curriculum policy, and textbooks. It also provided insights of who are the agents during the recontextualising process and their various responsibilities. This chapter discusses that data, and synthesises it in the light of the study's theoretical framework (recontextualisation across the pedagogic device) and conceptual framework (biodiversity concepts and perspectives on factual, procedural and conceptual nature of the biodiversity knowledge). This was done in order to directly address the main research question which is: How is biodiversity content presented in scientific documents and recontextualised in the Senior Phase Natural Sciences curriculum and supporting textbooks?

The discussions of findings in 5.2.1 - 5.2.6 are related to sub-question 1 and 2:

Sub-question 1: What is the nature of biodiversity knowledge presented in the Natural Sciences curriculum in relation to scientific documents in the field of production?

Sub-question 2: What is the nature of biodiversity knowledge in the Natural Sciences curriculum and in the commonly used Grade 7-9 Natural Sciences textbooks?

The discussions in finding 5.2.7 is related to sub-question 3: Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge?

5.2 Findings

5.2.1 Finding 1: MEA and SANBI documents

This finding is related to the first part of sub-question 1 which sought to understand what biodiversity knowledge is presented by the two scientific documents in the Field of Production. This is important for knowing what knowledge is available for uptake into the curriculum. That is from an international and national perspective.

Section 4.2 synthesised these two documents into key features of biodiversity content. This chapter discusses facts, concepts and procedures presented by the two scientific documents. It

also described different ecosystem services presented by the two documents; biodiversity loss and threats, concepts of cause/effect, loss/gain, trade-off and restorative actions to conserve and sustain biodiversity (see Section 2.7). There is substantial and comparable (in terms of emphasis) coverage of all five analytic themes in the national and international documents. This is in contrast to the relative emphasis in the curriculum and textbooks (as highlighted in the findings below).

Ecosystem services

Section 2.7.1.1 referred to ecosystem services as the range of conditions and processes through which natural ecosystems, and the species that they contain, help sustain and fulfil human life. The two scientific documents presented these services provided by ecosystems. As discussed in Chapter 2, ecosystem services are divided into four categories (MEA, 2005). All four categories are essential to human life.

Doc 1 pointed out that globally the rate of food production has increased and is still increasing at a higher rate over the past years to meet the demands of growing populations (see Section 4.2.1). The two documents presented factual knowledge on provisioning services such as the natural products being harvested or used by humans such as, timber, game, natural fibres and medicines (see Section 4.2.1). They showed procedural knowledge on how human beings depend on ecosystems for daily survival (see Section 4.2.1). Agricultural activities such as crop farming and fish harvesting were described as food source contributors to communities. Both documents also presented concepts and processes that bring understanding of functions of wetlands, estuaries, forests, rivers and natural veld and their contribution to provisioning services (see Section 4.2.1). In addition to the ecological functions of ecosystems, goods and services, the two documents provided factual knowledge about the economic value gained from these services (see Section 4.2.1). In the South African context, Manalana wetland in Bushbuckridge, Mpumalanga was reported to be of considerable value to the society in terms of employment and food security (see Section 4.2.1).

In addition to provisioning services, Harrison et al. (2014) recognised the ecosystem services that improve water quality and flow regulation. The two documents described regulating processes such as purification of air and water, moderating environmental conditions by stabilising climate, reducing the risk of extreme weather events, mitigating droughts and

floods and disease management (see Section 4.2.1). Both documents then presented procedural knowledge on how wetlands contribute to flood control, storm buffering and climate regulation and (see Section 4.2.1). Doc 2 provided examples of the Drakensberg mountains in KwaZulu-Natal and the Wolkberg in Limpopo Province which play an important role in gathering and channelling water (see Section 4.2.1).

Doc 2 provided procedural knowledge on pollination of crops and how it is considered to be an ecosystem service of enormous economic value by South Africa because in 2008 in the Western Cape alone, wild pollinators gave a service to the deciduous fruit industry amounting to between US$49 million (R400 million) and US$311 million (R2 500 million) every year (see Sections 4.2.1).

Alho (2008) supported the idea that humans seeks contact with nature and that wild landscapes are aesthetically pleasing. Both documents discussed how natural landscapes provide humans with recreational and exercise opportunities, and along with the biodiversity they contain, feed into many cultural, intellectual and spiritual traditions which contribute to human well-being (see Section 4.2.1). They also presented procedural knowledge on how cultural and recreational activities in the environment are an important source of revenue through tourism.

Both documents presented information about how ecosystems provide habitats for wild plant and animal species. The two documents provided facts and concepts around animal and plant habitats. They also provided procedural knowledge on how habitats protect animals and plants, for example, by maintaining the conditions which allow survival of the diverse species on the planet (see Section 4.2.1). The two documents also presented procedural knowledge on natural cycles such as hydrological and nutrient cycles.

Threats to biodiversity

Threats in this discussion focus on direct or indirect human activity that threatens the natural environment and affects genes, populations, species, ecosystems or biological diversity (Sechrest et al., 2002).

Biodiversity loss is increasing in all three spheres of biodiversity (IUCN, 2012). Doc 1 highlighted how degradation of ecosystems is threatening MDGs and capacity to achieve them. The two documents both present procedural knowledge on land degradation, habitat loss, species loss, introduction of exotic species, pollution and over exploitation of resources (see Section 4.2.1). Doc 1 presented facts about the degree of loss of coral reefs and mangrove areas. Doc 1 presented facts on the threatened biomes in South Africa which include Grassland, Fynbos and Indian Ocean Coastal Belt (see Section 4.2.1).

In these two documents the degraded status quo was expressed at international and local scales, and included description of erosion, desertification reduced soil fertility and reduced biodiversity, pollution of groundwater and eutrophication of lakes and rivers, and global changes in atmospheric composition and climate (see Section 4.2.1). Procedural knowledge presented in Doc 1 included the negative consequences of using fertilisers to gain more crop production and causing more land degradation which in turn will harm the poor (see Section 4.2.1).

According to the IUCN (2014), species extinction is also an increasing threat to biodiversity. Both documents described species extinction due to overharvesting, overgrazing and poor land management (see Section 4.2.1). Doc 1 presented procedural knowledge on how alien invaders such as Port Jackson affect biodiversity in South Africa.

Restorative actions

The two scientific documents cover the concept of restoration through presenting cases of re-establishment of habitats, landscapes and biodiversity that have been altered or destroyed. The two documents describe natural ecosystems in protected areas, national parks, biological reserves and other conservation sectors. Doc 1 highlighted that ecosystem restoration activities are now common in many countries (see Section 4.2.3). For example Doc 1 stated that in South Africa the Manalana wetland, which was a source of income for many households, was badly eroded and increased poverty. However, since Working for Wetlands began rehabilitation work in 2006, people living in the area can now gain benefits (see Section 4.2.3).

According to Doc 1 ecosystems can be restored and can provide some of the original ecosystem services they once provided (see Section 4.2.3). Doc 2 stated that South Africa has already reached this goal, since efforts are being put into the restoration and recovery of the Lake St Lucia system (see Section 4.2.3). However, Doc 1 recommended prevention of ecosystem degradation which is less costly compared to restoration of ecosystems and cautions that not all services can be restored, and severely degraded services may require time for restoration (see Section 4.2.3).

Conservation and sustainability of biodiversity.

Promoting a sustainable environment through international initiatives like the Belgrade Charter has been one of the responses by countries (UNESCO-UNEP, 1975). Doc 1 presented procedural knowledge on how the integration of ecosystem management goals in various sectors such as agriculture, forestry, finance, trade, and health, increased transparency and accountability of government and private-sector performance could substantially lessen the severity of biodiversity loss in the next several decades (see Section 4.2.1). These integrations can involve creating policies and laws to ensure the protection and proper use of ecosystem goods and services through sustainable management practices. Doc 2 presented procedural knowledge on the South African National Water Act, Biodiversity Act of 2004, Protected Areas Act, Conservation of Agricultural Resources Act and the National Environmental Management Act which aims to secure ecologically sustainable development and promote conservation (see Section 4.2.1).

The two documents also presented procedural knowledge on sustainable management practices which include enhancing specific ecosystem services in ways that reduce negative trade-offs and policy responses to address biodiversity loss (see Section 4.2.1). Doc 1 mentioned that most countries shows significant advances occurring in the development of environmental technologies to increase production of services, create substitutes, and reduce harmful trade-offs. Doc 2 pointed to the need for South Africa to have legal requirements, and the need for further work to make sure the right science is available so that the most well-judged choices can be made about the inevitable trade-offs between development and loss of ecological infrastructure (see Section 4.2.1).

On the concept of conservation and sustainability, both documents presented the concept of resilience (see Section 4.2.1). Doc 1 defined it as the amount of disturbance or stress that a system can absorb and still remain capable of returning to its pre-disturbance state, while Doc 2 urged that it is an aspect worth considering when doing land use planning, environmental impact assessments and protected area expansion (see Section 4.2.1).

Chapter 2 showed that it is clear that biodiversity loss is continuing to be a worrying factor worldwide hence we see organisations such as International Union for the Conservation of Nature (IUCN), the United Nations Environmental Programme (UNEP) and the World Wildlife Fund (WWF) drawing up strategic plans to address sustainability. Biodiversity is essential for sustaining the ecosystems that provided us with boundless benefits.

5.2.2 Finding 2: The Grade 7 CAPS and the textbook

This section is related to sub-question 1 and 2 which sought to understand the nature of biodiversity knowledge presented in the Grade 7 CAPS and textbook in relation to the knowledge in the two scientific documents.

This study found that the Grade 7 CAPS and textbook did not deal with ecosystem services nor actions to conserve, restore and sustain (see Section 2.7) explicitly. However, these documents introduce foundational knowledge important for understanding biodiversity and also implicitly introduce learners to these key features. The Grade 7 CAPS does not yet introduce the three types of biodiversity (species, ecosystem and genetic) but provides knowledge foundational to understanding species diversity through classification of living things. This knowledge is also foundational to understanding biodiversity loss.

The textbook presented two types of biomes, aquatic and deserts and discussed how they are useful to animals and plants living there (see Section 4.3.1). This is knowledge foundational to understanding ecosystem types. The MEA presented 14 major terrestrial biomes and SANBI indicated the most threatened biomes in South Africa which are Grasslands, Fynbos and the Indian Ocean Coastal Belt (see section 4.2.1).

CAPS highlighted pollination and its importance and human-environment relations through pollinators increasing production. This is foundational knowledge for understanding

regulatory services. This is an example of selective appropriation; in the process some potentially significant information regarding human-environment relations is 'left out' in the curriculum and it is important for the understanding of biodiversity. The textbook does not expand on this topic; however it presented the concepts of pollination and seed dispersal and provides knowledge on how humans contribute to dispersing alien invasive plants (see Section 4.31). The latter is important knowledge for understanding biodiversity threats. The concept of pollinators was presented in SANBI as of value to South African economy and it was highlighted how pollination by certain insects, birds and rodents increases crop production (see Section 4.2.1).

The textbook also presented adaptations of flowers, insects and birds which provide foundational knowledge for understanding resilience. The textbook explained how some alien plants have natural enemies where they are unwanted such as insects and diseases that might affect only them.

A case study on how alien invader Port Jackson trees in Delft-Cape Town became a haven for criminals was presented in the Grade 7 textbook and again in the SANBI document.

The scientific document presentation in Section 4.2.1 on the four broad categories of ecosystem services and how they benefit human well-being might provide a useful knowledge for understanding the value of biodiversity. The textbook could use the MEA figure on categories of ecosystem services and components of human well-being presented in Figure 2.2 to illustrate that humankind is dependent on nature and the services it provides. Each category can be explained separately to better understand the values humans gain from nature.

5.2.3 Finding 3: The Grade 8 CAPS and the textbook

This finding is related to sub-question 1 and 2 which sought to understand the nature of biodiversity knowledge presented by the Grade 8 CAPS and textbook, in relation to the knowledge in the two scientific documents.

In Grade 8, both CAPS and the textbook presented knowledge foundational to understanding interactions of organisms and environment. The MEA and SANBI presented how human beings are wholly dependent on nature (see Section 4.2.1). Significantly the CAPS and the

textbook did not present cases of humans as integral to ecosystems nor was the concept of ecosystem services evident either explicitly or implicitly. Both CAPS and the textbook presented knowledge foundational to understanding resilience of ecosystems through adaptations.

This could be considered to be knowledge foundational for understanding the notion of resilience with further development of the concept of adaptation. This could be extended by drawing on international and scientific documents. For example, the curriculum could include the relationship between adaptation and resilience in species. This could be further developed to help learners understand the relationship between species adaptation, resilience and ecosystem adaptation.

Feeding relationships, energy flow and balance in ecosystems knowledge was presented for developing understanding of biological systems. This is important foundational knowledge for understanding sustainability.
Knowledge foundational for understanding biomes and value of biomes from Grade 7 was not continued in Grade 8. This indicates the importance of the Grade 7 curriculum in developing understanding that is critical to understanding the complex relational understanding embedded in concepts such as sustainability, biodiversity loss, conservation and restoration.

The Grade 8 CAPS and the textbook discussed threats to biodiversity. While this topic has not been related to threats to biodiversity, a better understanding of waterborne diseases particularly could be achieved through relating the spread of these diseases to disruptions to ecosystem health.

Actions and conservation of biodiversity were not well developed, but the topic of how citizens can contribute to conservation in various ways such as recycling was raised. Both documents presented how environmentalists suggest managing ecosystems, alien vegetation and wetlands (see Section 4.3.2.3). Ecosystem management was presented by MEA as a framework which focused on conservation actions (see Table 4.1). Significantly absent in the CAPS and textbooks is an acknowledgement of the socio-ecological sustainability and emphasis on integrated ecosystem management as introduced in the international and national

scientific documents analysed in Section 4.2.4.The table illustrated how different stakeholders actions contribute towards conservation of biodiversity.

5.2.4 Finding 4: The Grade 9 CAPS document and the textbook

This finding is related to sub-question 1 and 2 which sought to understand the nature of biodiversity knowledge was presented by the Grade 9 CAPS and textbook in relation to the knowledge in the two scientific documents.

The Grade 9 CAPS document and textbook presented conceptual knowledge for understanding threats to biodiversity. Both documents presented the effects of mining in South Africa. They also presented procedural knowledge on the greenhouse effect and global warming which are foundational for understanding biodiversity loss. Ecosystem Assessment finding #1 in MEA noted that biodiversity is under serious threat as a result of human activities (see Section 4.2.2)

5.2.5 Finding 5: The textbooks contextualise foundational and core biodiversity concepts

This finding is related to sub-question 1 and sub question 2 which sought to understand nature of biodiversity knowledge presented by the CAPS document for Grade 7-9 and the three commonly used textbooks. In this study the CAPS document has been described as part of the ORF. As explained in Section 3.3.2, the CAPS policy document was the central focus in this study because it is the official guide to biodiversity knowledge in schools.

The study showed that the document lists foundational concepts in Grade 7-9 and also some core aspects of biodiversity knowledge such as human impact, conservation, restoration and sustainability. In Grade 7 the CAPS listed many different kinds of living things including plants, animals and micro-organisms. The textbook broadened concepts of different kinds of plants and animals by placing them in the relevant biomes and illustrated them through pictures (see Section 4.4.1). Erioloba acacia (Camelthorn) is given as an example of an important plant in the Kalahari Desert (see Section 4.4.1). The concept of alien invaders listed in CAPS is illustrated through a case study in the Grade 7 textbook (see Section 4.4.1).

The Grade 8 CAPS called for coverage of human interference and gave littering as an example. The Grade 8 textbook illustrated this with a picture of litter deposited by humans

(see Section 4.4.2). Further foundational concepts listed in the Grade 8 CAPS, are ecological interactions and their four levels: populations, communities, ecosystem and the biosphere. These concepts are broadened in the textbook through definitions and 'community' is illustrated through a picture showing elephants and thorn trees as part of the community in the Kruger National Park (see Section 4.4.2). The concept of adaptation listed in CAPS is contextualised by the textbook through providing examples of indigenous South African fauna and flora (see Section 4.4.2).

The Grade 8 CAPS prescribed conservation of ecosystems as a concept to be covered. Conservation was contextualised by the textbook through citing examples of South African conservation areas (see Section 4.4.2).

The Grade 8 textbook described how acid rain was a threat and also destroys life. The textbook contextualised this by mentioning that South African power stations are a main source of acid rain (see Section 4.4.2). In Grade 9 the CAPS listed threats caused by mining in South Africa. The textbook provided additional information that mining is regulated by Department of Minerals and Energy (see Section 4.4.3). In this way the textbook extended a focus on threats to a focus on positive action through regulation.

5.2.6 Finding 6: Selective appropriation

This finding is related to sub-question 1 and 2 which sought to understand the nature of biodiversity knowledge presented by the CAPS document for Grade 7-9 and the three commonly used textbooks.

Section 2.6.1 explained that the process of recontextualising involves the idea of delocation which involves selective appropriation of a discourse from the field of production (Bernstein, 1996).

Classification is presented in Grade 7 under the topic "biodiversity". Classification is foundational to species diversity. The Grade 8 CAPS stated that an ecosystem consists of an ecological community that includes living and non-living things. Therefore the curriculum lays the foundation for understanding species and ecosystem biodiversity. However genetic biodiversity does not feature explicitly in terms of foundational knowledge (see Section

4.4.1). This shows selective appropriation from the FOP to the ORF where the full definition of biodiversity as presented in scientific literature is not given.

The study showed how some concepts are reinforced from grade to grade, the concept of adaptation is introduced in Grade 7 as foundational knowledge to understanding why certain animals and plants are in certain environments. This was reinforced in Grade 8 where adaptation is to do with the change in the structural function and behaviour of an animal to survive in that environment (see Section 4.4.1).

This study recognised recontextualisation as a positive process which enabled the textbooks to choose relevant case studies to contextualise and illustrate biodiversity concepts. For example, the Grade 8 CAPS suggested research case studies that can be conducted by learners to investigate biodiversity threats in various ecosystems scenarios (see Section 4.3.2.2). This is also selective appropriation from FOP to ORF where a certain selection of cases are used in the curriculum. A specific example is the case study in SANBI on alien invasive Port Jackson which was appropriated in the Grade 7 textbook to explain biodiversity threats.

5.2.7 Finding 7: Recontextualisation involves various role players

This finding is related to sub-question 3: Who are the role players in the recontextualising fields and what roles did they play in the recontextualisation of biodiversity knowledge?

This sub-question seeks to understand stakeholders who are involved during the process of recontextualisation and how they are involved. In terms of Bernstein's theory, recontextualisation occurs within the recontextualising field and within those fields there are various stakeholders (Bernstein, 1996).

This study reported that there were various stakeholders involved in the recontextualisation of biodiversity knowledge. As indicated in Chapter 2, the process is not straightforward and cannot be treated in an indifferent manner (Moore, 2004). This study found that the process started with reviewing the previous curriculum. This was done by the Ministerial Task Team, which included the Provincial Natural Sciences coordinators (see Section 4.5). A reviewing process was undertaken with the emphasis on improving the CAPS curriculum.

According to Bernstein, in the ORF, the curriculum designers make selections about the knowledge, pedagogy and assessment that will become part of the official curriculum (Bernstein, 1990). In this study the focus is on the selection of knowledge. This study reports that the writing teams were appointed in January 2010 to develop CAPS for all approved subjects in each grade (see Section 4.5). A group of provincial Natural Sciences coordinators (role players in the ORF) were part of the writing teams and they were specifically responsible for Natural Sciences, However, not all the provincial coordinators were specialists in Environmental Education. This study confirmed that the experiences and knowledge of those in the ORF might influence the biodiversity knowledge included in the curriculum. For example, a participant in this study disclosed that he was an expert in Space Science and Environmental Physics (see Section 4.5.2).

Bernstein stated that the PRF engages educational professionals, teacher educators, NGOs and textbook authors and the process takes place in keeping with ideas developed through the direct and indirect influence of a range of agents (Bernstein, 2006). However, what this study noted was that textbook publishers are not engaged in the ORF. Textbook publishers follow the CAPS document and write and organise content in textbooks (see Section 4.5.2). An important role that textbook writers play in the PRF is that of enriching CAPS through elaborating, detailing and contextualising biodiversity concepts. This study also noted that the SESs are minimally involved during the ORF. They are largely involved in the PRF where they are to train teachers and guide teachers to teachers' biodiversity knowledge in the CAPS (see Section 4.4.2).

The study also discovered that the range of agents stated by Bernstein included government agents who also are involved in the PRF. Other major stakeholders within the PRF at the implementation of the curriculum are the SESs.

5.3 Summary of the Study

The overall aim of this research was to investigate how biodiversity knowledge is presented in the field of production, and then how it is recontextualised in the ORF and PRF, with specific reference to the Senior Phase Natural Sciences Curriculum and Assessment Policy Statement (CAPS).

The findings illustrated that the chosen international and national documents presented knowledge that helps us to understand the value of biodiversity in the environment as well as how human beings interact with it. The documents presented procedural knowledge, which shows the relationship between diversity and human well-being and the services we get from ecosystems. There is also coverage of how the loss of biodiversity may damage the earth's ecological balance-disturbing cycles of rain and drought, seasonal temperatures, and nutrient exchange. The concept of restoration was covered through illustrative cases studies of re-establishment of habitats, landscapes and biodiversity that have been altered or destroyed. The two documents described natural ecosystems in protected areas, national parks, biological reserves and other conservation sectors.

Literature reviewed for this study advocates that biodiversity loss awareness be part of education. This empowers people to deal with biodiversity issues, protect and restore our ecosystems, and live within the limits of nature. Similarly, international literature about biodiversity teaching emphasises that learners be taught biodiversity complexities and should have opportunities to ask questions, debate around biodiversity issues, find solutions to problems and examine cause and effect.

As evidenced in this study, the CAPS and textbooks focused on teaching knowledge foundational to understanding ecosystem services, threats to biodiversity and actions to conserve, restore and sustain biodiversity features. The documents included definitions of the main biodiversity concepts, classification of plants and animals and human nature relations. Grade 8 illustrated evidence of dealing with complexities around human and nature interactions.

Overall, the Senior Phase CAPS presented foundational to understanding all biodiversity key features. The textbooks aligned closely with the policy and thus broadened and developed knowledge foundational to understanding this biodiversity key features through pictures and case studies that were contextual and accessible to learners. There appears to be a uniformity, a prescribed, standardised way of representation of biodiversity key features across the Senior Phase curriculum documents and the textbooks align closely with the activities as prescribed in the CAPS.

The following section discusses the recommendations of the study.

5.4 Recommendations

Based on the findings of the study, the following recommendations regarding biodiversity knowledge in the Senior Phase Natural Sciences CAPS can be made.

Recommendation 1: The Grade 7-9 Natural Science CAPS should include and emphasise key biodiversity concepts within the curriculum, in addition to the foundational knowledge that is currently emphasised. One of these key biodiversity concepts is the relationship between ecosystems and well-being. If learners are given tools to be able to distinguish between supporting and regulatory services, they would be provided with concepts that they could use to deepen their understanding of biodiversity issues and complexities when they pick up these in Further Education and Training. This would help them to develop understandings of the complex relationships within natural systems and human society. Findings from the study also showed that the Grade 7 curriculum provides knowledge foundational to understanding species diversity through classification of living things but does not yet introduce the three types of biodiversity (species, ecosystem and genetic). To include this broad definition of biodiversity might help with the development of a deeper understanding of biological diversity in the CAPS.

Recommendation 2: Finding 5 showed that textbooks add value to recontextualisation of biodiversity knowledge by illustrating knowledge through pictorials and case studies. The Grade 7-9 Natural Science textbooks can also strengthen this value by not only aiming at enabling students to acquire knowledge about the concepts presented by the curriculum but also at inculcating positive attitudes and life skill development. The way the textbooks illustrate biodiversity knowledge, should provide learners ample opportunities to involve themselves in interactive experimental learning processes.

Recommendation 3: According to the 2015 NSC report … "*teachers might be neglecting to cover basic concepts effectively in the process of progressing to higher-order aspects of topics, and are not providing learners with sufficient practical experience in applying higher cognitive skills in class activities or in informal and/or formal assessment tasks*" (South Africa. DBE, 2015, p. 6). This suggest that we need to ensure that knowledge foundational to understanding ecosystem services, actions to restore, conserve and sustain biodiversity in

Grade 7-9 are well developed. They need to be well developed in order to support the higher order thinking required in later years (see Section 5.2).

Finding 2 showed that Grade 7 CAPS and textbook were strong in introducing biomes but weak in explaining biodiversity types. This might create a gap in the future in the Life Sciences subject which covers a considerable amount of biodiversity-related elements (DBE, 2011). And from this the recommendation is that Grade 7 CAPS can introduce the concept of biodiversity, and discuss the products and services that we get from nature. This can be clearly indicate in the curriculum that the concepts need to be introduced through interactive teaching and learning.

Finding 3 showed that the Grade 8 CAPS and textbook were strong in introducing basic concepts of how organisms interact with their environment, including both abiotic (non-living) and biotic (living) aspects of the environment interactions of organisms and environment. However they were weak in explaining the significance of these interactions. I recommend that this significance could be taught together with these basic concepts as they can provide a springboard into discussion about the value of biodiversity, which might be introduced in Grade 9.

The Grade 9 CAPS and textbook present threats to biodiversity from mining in South Africa. Finding 3 showed that the Grade 9 CAPS and textbook were strong in recognition of threats brought by humans. I recommend that Grade 9 CAPS and textbook can include an understanding and appreciation of the diversity of living organisms. Learners should also come to understand the connections between biodiversity and our economy (as represented by mining in South Africa), ecological sustainability, environmental quality, and quality of life.

Recommendation 4: Insights on conservation and sustainability in the scientific documents might provide useful frameworks for examining conservation actions in textbook activities. For example, textbooks could use the MEA framework presented in Table 4.1 to examine the different sectors involved in biodiversity conservation actions. Cases could alternatively be examined in terms of the four scenarios for examining sustainability practices presented in the MEA.

Recommendation 5: More integration of biodiversity concepts across the curriculum might enable better understanding of the complexity of biodiversity issues. The Senior Phase Natural Sciences Specific Aim 3 emphasises that learners need to know the subject content and make connections. The curriculum is designed to provide a "framework of knowledge for learners helps them make to connections between the ideas and concepts in their minds" (DBE, 2011, p. 10). This suggests a need for curriculum research that identifies any fragmentations in content outline. For example, this study identified how the Grade 7 textbook provides foundational knowledge regarding ecology and ecosystem balance other foundational knowledge regarding the adaptation of flowers pollinated by insects and birds. Such knowledge could be used, for example, to develop a deeper and more holistic perspective on the spread of alien invasives and how they can be controlled biologically.

5.5 Openings for Further Research

These findings have highlighted the biodiversity content knowledge presented in scientific documents and CAPS documents as well as the gaps, discontinuities and continuities. The findings raise challenges for all the stakeholders involved in the inclusion of biodiversity knowledge in curriculum formulation to shape a broader knowledge base for biodiversity. Biodiversity is an important area in the Senior Phase curriculum of Natural Science because education has been identified as a strategy to address biodiversity loss by developing citizens who will maintain and preserve our biodiversity.

Further research is required on how best to ensure that the knowledge in the international and national scientific documents became part of the biodiversity knowledge in the curriculum. More detailed research needs to be undertaken into the recontextualisation processes between the ORF and PRF, as this study discovered that the experiences and knowledge of those in the ORF might influence the biodiversity knowledge included in the curriculum.

Further research is also required to examine how the aims of Natural Science as expressed in the CAPS interconnect with teachers' pedagogical content knowledge, their preparedness to teach about biodiversity, and their overall orientation to biodiversity and its value.
The study may provide a useful foundation to do more work on reviewing the biodiversity discourses within the whole National Curriculum Statement Grades R-12 and how these are recontextualised in each field of the pedagogic device.

There is also an evidence of disconnection of biodiversity knowledge within the Grade 7-9 Natural Sciences strands (see Section 2.5.2). Biodiversity knowledge in Grade 7 and 8 is placed in Life and Living while for Grade 9 is placed in Plane, Earth and Beyond Strand (see Section 2.5.2). This disconnection can be examined in future research to find out how it affects knowledge progression of biodiversity knowledge.

Further research is also required to examine how biodiversity knowledge is recontextualised by teachers in the Field of Reproduction which was beyond the scope of this study.

5.6 Reflections on the Study

As indicated in Chapter 3 this study used interviews and document analysis. This generated a considerable amount of data which was not easy to manage. The process of data generation was not as smooth as it could have been. If I had been able to do this research again, I would revise a few aspects to make this process work better. Firstly, I would include a more expansive piloting of the questionnaire and the participants, to establish the suitability of the research questions in relation to the goals and aims of the research as I found some of the questions and participants unnecessary.

This study used a small part of the Bernstein framework developed biodiversity knowledge key features that could be regularly applied in the analysis of other available data from the different case studies such as lessons, workshops, seminars and conferences. The theoretical framework also provided a comprehensive vocabulary to describe, to discuss and to report all aspects of the study' (Short et al., 2000). By utilising the ideas/constructs of selective appropriation and ideological transformation, the study was able to inquire into each field and get a perspective of how to describe and organise the recontextualising process in each case. However, details of specific features of biodiversity were not established during the interviews. This was due to the complexity and difficulty of obtaining this kind of detail.

5.7 Conclusion

This chapter has discussed the data presented in Chapter 4. Findings were used for the discussion. This discussion drew on literature and past studies to gain a deeper understanding of what biodiversity knowledge was recontextualised and the recontextualisation processes.

This study contributes to the field of environmental education research, particularly focusing on the biodiversity content knowledge of the curriculum. Research indicated that past curricula have failed to develop deeper conceptual depth and understanding of biodiversity knowledge and other environmental knowledge. Recommendations suggested could be used to influence future curriculum engagement within the Fundisa for Change programme and to influence further curriculum review in South Africa. It could also be adapted for similar studies in other subject focus areas that deal with environmental knowledge.

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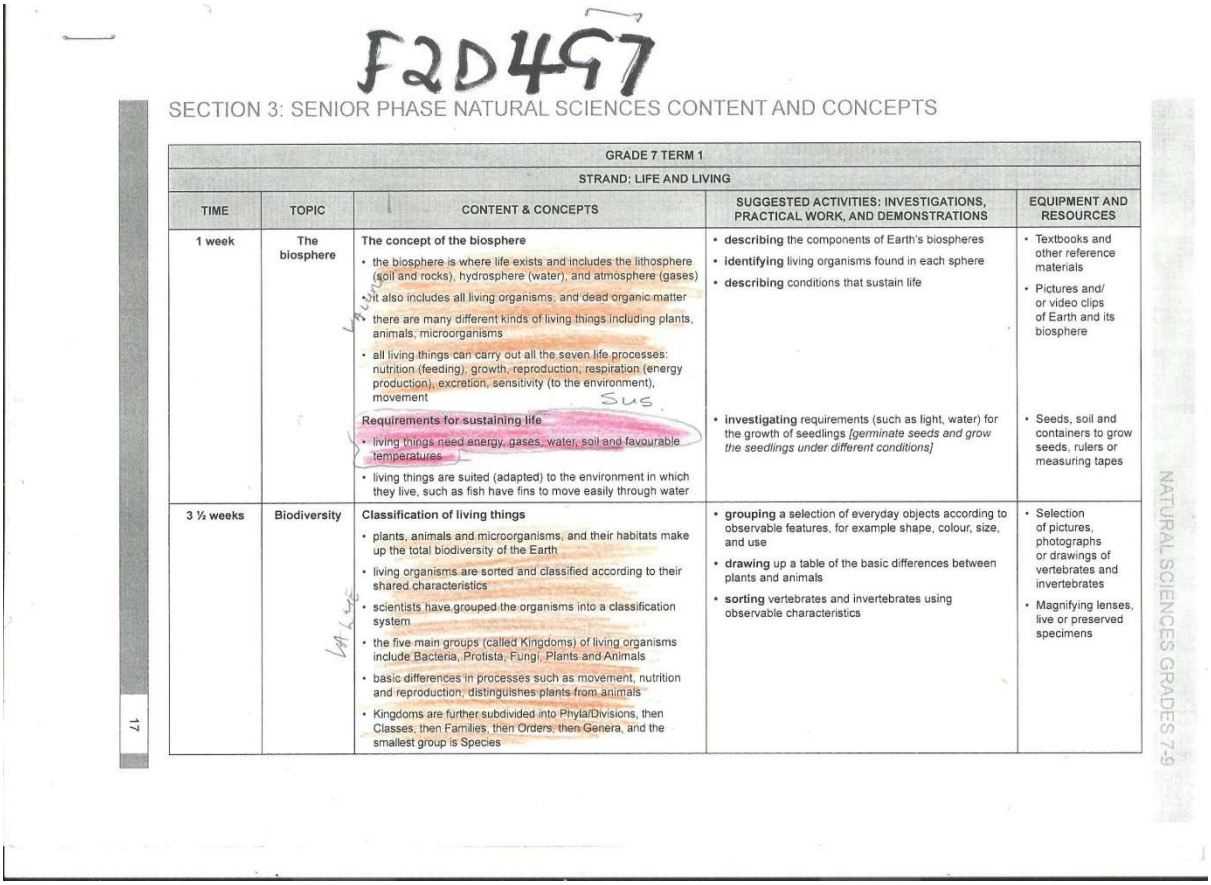
APPENDICES

Appendix A: Extract of Grade 7 content and concepts in CAPS document



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SECTION 3: SENIOR PHASE NATURAL SCIENCES CONTENT AND CONCEPTS

GRADE 7 TERM 1				
STRAND: LIFE AND LIVING				
TIME	TOPIC	CONTENT & CONCEPTS	SUGGESTED ACTIVITIES: INVESTIGATIONS, PRACTICAL WORK, AND DEMONSTRATIONS	EQUIPMENT AND RESOURCES
1 week	The biosphere	**The concept of the biosphere** • the biosphere is where life exists and includes the lithosphere (soil and rocks), hydrosphere (water), and atmosphere (gases) • it also includes all living organisms, and dead organic matter • there are many different kinds of living things including plants, animals, microorganisms • all living things can carry out all the seven life processes: nutrition (feeding), growth, reproduction, respiration (energy production), excretion, sensitivity (to the environment), movement **Requirements for sustaining life** • living things need energy, gases, water, soil and favourable temperatures • living things are suited (adapted) to the environment in which they live, such as fish have fins to move easily through water	• **describing** the components of Earth's biospheres • **identifying** living organisms found in each sphere • **describing** conditions that sustain life • **investigating** requirements (such as light, water) for the growth of seedlings *[germinate seeds and grow the seedlings under different conditions]*	• Textbooks and other reference materials • Pictures and/ or video clips of Earth and its biosphere • Seeds, soil and containers to grow seeds, rulers or measuring tapes
3 ½ weeks	Biodiversity	**Classification of living things** • plants, animals and microorganisms, and their habitats make up the total biodiversity of the Earth • living organisms are sorted and classified according to their shared characteristics • scientists have grouped the organisms into a classification system • the five main groups (called Kingdoms) of living organisms include Bacteria, Protista, Fungi, Plants and Animals • basic differences in processes such as movement, nutrition and reproduction, distinguishes plants from animals • Kingdoms are further subdivided into Phyla/Divisions, then Classes, then Families, then Orders, then Genera, and the smallest group is Species	• **grouping** a selection of everyday objects according to observable features, for example shape, colour, size, and use • **drawing** up a table of the basic differences between plants and animals • **sorting** vertebrates and invertebrates using observable characteristics	• Selection of pictures, photographs or drawings of vertebrates and invertebrates • Magnifying lenses, live or preserved specimens

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NATURAL SCIENCES GRADES 7-9

Appendix B: Interview Schedule for Provincial Coordinator

1. Brief description of your work.
2. How was the CAPS Curriculum cascaded to you by whom, how and how long?
3. What was your role during the formulation of the CAPS Curriculum and your role during cascading and implementation?
4. What other stakeholders are you working with in terms of ensuring the success of the curriculum? Name major ones and how do you work with them.
5. Do you think the topic biodiversity is relevant or important in Grade 7? Elaborate.
6. How do you support Subject Specialists on this topic? Elaborate.
7. Specific Aim 2 & 3 includes environmental knowledge as one of its important aspect. Do you think biodiversity knowledge that is represented in the NS CAPS Doc is sufficient to reach this aims successfully e.g. SA 2 expects a learner who will be able to apply the environmental knowledge in the new context.
8. Were you given the opportunity make changes on the final Curriculum Document? i.e. CAPS NS Policy document
9. Do you think the topic is represented in such a way that it teaches the deep complexities of environmental knowledge e.g. how biodiversity contribute to our economy, importance of preserving biodiversity, how a rich variety of plants and animals can contribute to our health. Give a reason for your answer.

Appendix C: Senior Education Specialists Interview Schedule

1. Brief description of your work.
2. How do you support teachers to teach Natural Sciences content topics e.g. biodiversity? Are there any specific teaching and learning activities/ practices or assessments that you recommend for the above topic and why?
3. Specific Aim 2 & 3 includes environmental knowledge as one of its important aspect. Do you think biodiversity knowledge that is represented in the NS CAPS Doc is sufficient to reach this aims successfully e.g. SA 2 expect a learner who will be able to apply the environmental knowledge in the new context.
4. How was the CAPS curriculum cascaded to you? In your response include who, how and time frames. Were you as Subject Specialists given the opportunity to have your inputs, suggestions etc. How were they handled by who and how?
5. Are there any challenges that you encounter with this topic? With teachers, with your colleague's e.tc how do you deal with them?
6. Are you satisfied with the way teachers teach this topic? Support your answer.
7. Is the topic represented in such a way that it teaches the deep complexities of environmental knowledge e.g. how biodiversity contribute to our economy, importance of preserving biodiversity, how a rich variety of plants and animals can contribute to our health. Give a reason for your answer.
8. Does the topic expose learners to different knowledge and cognitive skills relevant to it? Elaborate.
9. Tell me about your relationship with other stakeholders that assist you in supporting teachers with the CAPS Curriculum, include few of them, how they support and when (continuously or once-off).

Appendix D: Summarised Interview Transcript for NS Provincial Coordinator

ME: Tell me briefly about your work.

MR M: My work is to:

- Establish and maintain the National Curriculum policy pertaining to Natural Sciences in the GET sub directorate =1
- Liaise with National Department, other directorates in the department and other departments in the province on issues of curriculum development=2
- Train Natural Sciences trainers on new developments regarding the existing and incoming/future curriculum=3
- Enhance and expand the capacity of curriculum support teams (teachers and subject Advisors) at Districts and Area Offices=5
- Perform generic Curriculum management functions such as participation & presenting in science related conferences; seminars; workshops etc.=6

ME: How was the CAPS Curriculum cascaded to you by whom, how and how long?

MR M: I was fortunate to be part of the NCS review committee members, who made recommendations to CAPS writers =7

- Thereafter; DBE called on all Provincial Coordinators in communicating the developed CAPS to them=8
- I was part of the National Core Training Team (NCTT) which trained Provinces (subject Advisors and other partners in education (e.g. teacher unions and universities)=9
- Cascading periods: 2011 NCTT; 2012 PCTT and 2013 schools (orientation to Teachers)=10
- 2014 was the first year of Grade 7;8 & 9 CAPS implementation in schools=11

ME: What was your role during the formulation of the CAPS Curriculum and your role during cascading and implementation?

- MR M: As indicated in 2 above; my role as NCTT member was to ensure that the content for each grade is standardised and there is content & conceptual progression in the CAPS from Grade 7 – 9 =12

- Text book writers aligned their textbooks to CAPS to minimise workload for teachers
- To report on challenges faced by teachers during implementation phase=13
- And that Subject Advisors collate information and support schools with regard to content gaps identified by each district in our province=14
- The strand Earth and beyond for both three grades (Grade 7;8&9) was my core during formulation of CAPS as I had a good command of Space Science and Environmental physics specialization=15

ME: What other stakeholders are you working with in terms of ensuring the success of the curriculum? Name major ones and how do you work with them?

- Universities and teacher unions as partners in education
- Professional bodies such as SAARMSTE; SAASTE and the newly established ones;
- NGOs
- SAASTA in particular
- Department of Science and Technology
- We organize meetings with them for a targeted activity and invite them as well to our Subject Committee meetings. We are on the way of formulating Natural Sciences Subject Learning Communities in 2016 =16

ME: Do you think the topic biodiversity is relevant or important in Senior Phase? Elaborate

- MR M: Yes; Biodiversity is important and relevant in schooling as it is one of environmental the topics that you can easily put the content and concepts learnt in context. =17 Teachers can use their immediate environment to describe grasslands and different ecosystems.=18
- Grade 7 CAPS allocated the Biodiversity topic 3 ½ weeks as compared to other topics with the assumption that it will be taught to meet the broader aims of our South African Curriculum .(conservation and management of natural resources)=19
- Biodiversity aspects in Grade 7 makes Life and Living and health issues practicable
- And with biodiversity aspects; learners can become participating citizens and entrepreneurs at an early stage=19
- Self-actualization of a learner begins at the schooling age of this grade and better is to communicate the environmental issues at this stage of child development & schooling age=20

- Grade 8 allocated 5 weeks of introduction to ecology which somehow is closely related to biodiversity and the subtopics there under are: ecosystems, feeding relationships energy flow,balance in ecosystems and microorganisms=21
- Grade 9 it's a discontinuation or a gap or a break perhaps of the topic because now it dwells on human anatomy and to my knowledge biodiversity topic continues in Grade 10-12 again=22.

ME: How do you support Subject Specialists on this topic? Elaborate

- I requested that each Area office to have a profile of its teachers that will help us as a province on areas that need development (classification of living things; diversity of animals; and diversity of plants) were rated amongst the difficult topics that need training & intervention year by year to 75% of our teacher cohort=23
- There was provincial training of Subject Advisors on this topic in 2013 and 2014 respectively so as they can mind the gap=24
- Rigorous content support is needed for teachers. Provincial plans are in place for 2016/17=25

ME: Specific Aim 2 & 3 includes environmental knowledge as one of its important aspect. Do you think biodiversity knowledge that is represented in the NS CAPS Doc is sufficient to reach this aims successfully e.g. SA 2 expects a learner who will be able to apply the environmental knowledge in the new context.

ME: Not really; it depends on the subject teacher and the context of the school.

- Not all teachers are able to realize the need for contextual learning and this makes the biodiversity aspects difficult to realize in the CAPS teaching=26
- However; Former model C schools (and some quintile 1 schools) can better realize the need for contextual learning of this topic=27

Were you given the opportunity make changes on the final Curriculum Document? i.e. CAPS NS Policy document.

- Yes; I had an opportunity as Curriculum Developer, but public comments were also extended before the CAPS could be finalized=28. Public inputs were submitted in large numbers to National of which I'm not certain if all were considered=29

Do you think the topic is represented in such a way that it teaches the deep complexities of environmental knowledge e.g. how biodiversity contribute to our economy, importance of preserving biodiversity, how a rich variety of plants and animals can contribute to our health. Give a reason for your answer.

No; this is my personal opinion, CAPS only present the factual content with the assumption that teachers as practitioners will facilitate the aspects of biodiversity to address such issues related to economy and preservation=30. But for Grade 7 (see page 17 – 19 CAPS) the emphasis is on factual knowledge as part of constructing science knowledge in early Grades. E.g in Grade 7; we have that part which addresses Requirements for sustaining life; the SUGGESTED ACTIVITIES=31: INVESTIGATIONS , PRACTICAL WORK, AND DEMONSTRATIONS as suggested in our CAPS Grades that are meant to address your question are Grade 8 which tried to address just few aspects such as conservation, adaptation, balancing of ecosystems but this are just narrowly addressed, Grade 9 has a serious gap and I think it might somehow affect grade 10 continuation of biodiversity topic=32. My personal suggestion is that maybe biomes should have been introduced in Grade 9 and then continued deeper in grade 11, 12 but as I said I was in the Earth and beyond strand as it is my strength and maybe when time comes for CAPS review this might be looked at=33. Something musr be done to assist teachers to align their teaching in such a way that deep complexities of environmental knowledge are addressed=34.
Like I indicated, there is no specific reference that can be safely disclosed as CAPS reference document for Natural Sciences=35.

The Task team was appointed for NS including all other subjects by the minister. The CAPS frame work was developed which specified the CAPS structure and issues such as Subject Specific Aims (Three for us in Natural Sciences)=36

The CAPS writers together with the task team then consulted as many sources as they could. The first draft for NS CAPS was finalized and then submitted to the Minister=37. The Minister then extended the draft for public inputs and comments which were to be included for each grade=37. Parts of the inputs was to include such topics as bio diversity and issues of climate change and other environmental aspects for societal & global benefit=38.

The Content and Topics were taken partly from the previous NCS documents and other related material =39 .We had to critique' every aspect until the final CAPS product was as is now=40

Please note that both the Specific Aims and practical sciences process skills are the core to which the teaching and learning of every concept/topic in NS such as Biodiversity must focus on=42

Personally, the material on big Ideas of Science was consulted as well. And we had to discuss these with other partners in education such as

- Wits University (Setlhare Trust Teacher Development),

- Teacher Unions and many more others=43

With this background, and in the larger South African context, one can safely say that there is no specific documents/references that particularly informed the writing of each topic in the CAPS like Biodiversity in this case=44

That is why the current Gr R - 12 CAPS for subjects do not have that section on references=45

It is policy imperative=46

I'm attaching the NCS Review Report for you to read, which has led to the formulation of the CAPS for all subject. See Chapter on the previous NCS Documents which perhaps were consulted by the writers and which caused systemic confusion which culminated into the formulation of CAPS. (pardon me if this information is unnecessary for your work there)

Appendix E: Textbook Publisher Interview Schedule

1. What is your job description?

2. How did you receive information that assisted you to publish the Platinum Natural Sciences Senior Phase textbooks?

3. Describe the process/ path of how you take the curriculum documents and interpret them and write textbooks from them=3

4. How do you choose your authors who write the textbooks?

5. Do you offer training to your authors or require that they have certain qualifications?

6. Was your author's part of the CAPS Curriculum Working Group or you as a content developer?

7. What are the principles that underpin the NS textbooks? e.g. is there a greater focus on activities, and less on content, knowledge, cognitive skills etc.?

8. What is your experience of the provincial or national screening process of textbooks? (Probe: What type of comments do you receive? Are the comments often purely technical or reports based on reports such as DADA NCS 2009, learner performance etc?=9

9. How would you describe your relationship as a publisher with the Department of Basic Education?

10. Structure of the biodiversity content

11. Tell me about your relationship with other stakeholders such as teachers, subjects advisors etc.

Appendix F: Analytical Memo (MEA, 2005)

ECOSYSTEM SERVICES VALUING	
EXTRACT	SOURCE
"Everyone in the world depends completely on Earth's ecosystems and the services they provide, such as food ,water, disease management, climate regulation, spiritual fulfillment, and aesthetic enjoyment"	Doc 1 page 1 prg1
Between 1960 and 2000, the demand for ecosystem services grew significantly as world population doubled to 6 billion people and the global economy increased more than six fold".	Doc 1 page 5
To meet this demand, food production increased by roughly two-and-a half times, water use doubled, wood harvests for pulp and paper production tripled, installed hydropower capacity doubled, and timber production increased by more than half.	Doc 1 page 5
Ecosystem services that have been used over the past 50 years include capture fisheries, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, hand regulation of erosion, spiritual fulfillment, and aesthetic enjoyment.	Doc 1 page 6 prg 23
Ecosystem services (such as fresh water in aquifers and the use of the atmosphere as a sink for pollutants) are available freely to those who use them.	Doc 1 page 9 prg 32
Ecosystem services met by increasing available supply such as diverting some land water for irrigation.	Doc1 page 5 prg 20
"Many of the most significant changes to ecosystems have been essential to meet growing needs for food and water"	Doc 1page 5 prg21
"In most countries, the marketed values of ecosystems associated with timber and fuel, wood production are less than one third of the total economic value, including non, marketed values such as carbon sequestration, watershed protection, and recreation"	Doc 1 page 9 Fig 8
Degradation of some services sometimes produce a gain in others eg. "Although people benefit from ecosystem services such as the regulation of air and water quality or the presence of an aesthetically pleasing landscape, there is no market for these services and no one person has an incentive to pay to maintain the good though when a service like this degrade other individuals suffers and may not be compensated for suffering"	Doc 1 page 10 prg 34
"Ecosystems services provided by freshwater resources (such as aquatic habitat, fish production, and water supply for households, industry, and agriculture are degraded.	Doc1 page17 prg 72
Ecosystems are to meet a dramatic growth in the demand for food, water, timber, fiber, and fuel.	Doc 1 page 4 prg 19
Changes made to ecosystems benefit human development and national development and was essential for providing food and water.	Doc1 page 5 prg 21
Ecosystems increase food production.	Doc 1page 6 prg 23
Global Status of Provisioning, Regulating, and Cultural Ecosystem Services Evaluated in the MEA shows degradation of most ecosystem services. Enhanced categories in services; crops, livestock, aquaculture, global climate regulation.	Doc 1 page7 Table 1
The net benefits from the more sustainably managed ecosystem are greater than those from the converted ecosystem, even though the private (market) benefits would be greater from the converted ecosystem	Doc 1 page 10
Some soil nutrients, and fossil fuels are capital assets	Doc 1 page 9
The creation of a market in the form of a nutrient trading system may also be a low-cost way to reduce excessive nutrient loading in the United States.	Doc 1 page 22

SUSTAINABILITY AND CONSERVATION	
The MEA developed the following four scenarios to explore plausible futures for ecosystems and human well-being.	Doc 1 page 15 Box 1 MEA Scenarios
Scenario 1: Global Orchestration – This scenario pays attention to future economic growth. **Scenario 2: Order from Strength** – This scenario pays attention to security and protection, emphasizing primarily regional markets, paying little attention to public goods, and acknowledges ecosystem problems. Economic growth rates are the lowest of the scenarios **Scenario 3: Adapting Mosaic** – In this scenario, regional watershed-scale ecosystems are the focus of political and economic activity" **Scenario 4: Techno Garden** – This scenario depicts a globally connected world relying strongly on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and taking a proactive approach to the management of ecosystems in an effort to avoid problems. Economic growth is relatively high. Past actions to slow or reverse the degradation of ecosystems have yielded significant benefits, but these improvements have generally not kept pace with growing pressures and demands.	
Three of the scenarios – Global Orchestration, Adapting Mosaic, and Techno Garden incorporate significant changes in policies aimed at addressing sustainable development challenges.	Doc 1 page 15 Box 1 MEA Scenarios
Biodiversity continues to be lost and thus the long-term sustainability of actions to remedy degradation of ecosystem services remains uncertain.	Doc1 page 19 prg 77
Establishment of protected areas such as National Parks as well as areas managed for sustainable use of ecosystems.	Doc 1 page 18- 19 prg 77
Advance in technology decreased pressure on ecosystems by providing certain ecosystem services.	Doc 1 page 19 prg 78
Substitution also to meet certain ecosystem services. Example Substitution of fuel-wood by fossil fuels, for example, reduces pressure on forests and lowers indoor air pollution.	Doc 1 page 19 prg 78
Inclusion of ecosystem management goals within other sectors and within broader development planning frameworks.	Doc 1 page 20 prg 84
Coordination among multilateral environmental agreements and between environmental agreements and other international economic and social institutions.	Doc 1 page 20 prg 85
Transparency , accountability of government and private-sector performance on decisions that have an impact on ecosystems, including through greater involvement of concerned stakeholders in decision-making	Doc 1 page 20 prg 86
Agricultural, Fisheries and Aquaculture, Water, Forestry Sectors Promising and Effective Responses that work towards sustainable use.	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Specific Sectors
Agriculture ■ Dealing away with production subsidies that has negative impacts on economic, social, and environmental	Doc 1 page 21 Box 2 Examples of Promising and Effective

■ Investment in, and diffusion of, agricultural science and technology that can sustain the necessary increase of food supply without harmful tradeoffs involving excessive use of water, nutrients, or pesticides. ■ Implement policies that values the role of women in the production and use of food and that are designed to empower	Responses for Agricultural Sectors
Fisheries and Aquaculture ■ Reduction of marine fishing capacity. ■ Strict regulation of marine fisheries both regarding the establishment and implementation of quotas and steps to address unreported and unregulated harvest. Individual transferable quotas may be appropriate in some cases, particularly for cold water, single species fisheries. ■ Establishment of appropriate regulatory systems to reduce the detrimental environmental impacts of aquaculture. ■ Establishment of marine protected areas including flexible no-take zones.	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Fisheries and Aquaculture Sectors

THREATS TO BIODIVERSITY	
Degradation and unsustainable use of ecosystems threatens ecosystem services.	Doc 1 page 1 prg 2, 3 Doc 1 page 6 prg 24-26
Flows of reactive (biologically available) nitrogen in terrestrial ecosystem tripling.	Doc 1 page 2
Increasing cultivated areas to increase food production.	Doc 1 page 2 prg 4 and Fig 2 pg 3
Rate of conversion of terrestrial biomes from 1950 and 2050 projected to 70% by 2050.	Doc 1 page 4 Fig 3
Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre, and fuel.	Doc 1 page 1 Finding 1
The full value of the loss and degradation of these ecosystem services are difficult to measure, but the available evidence demonstrates that they are fundamental and growing.	Doc 1 page 1 prg 3
Degradation of ecosystem services is already a significant barrier to achieving the Millennium Development Goals agreed to by the international community in September 2000 and the harmful consequences of this degradation could grow significantly worse in the next 50 years.	Doc 1 page 2 prg 5
20% of the world's coral reefs were lost and an additional 20% degraded in the last several decades of the twentieth century, and approximately 35% of mangrove area was lost during this time (in countries for which sufficient data exist, which encompass about half of the area of mangroves).	Doc 1 page 2 prg 11
Nitrogen in terrestrial ecosystems have doubled, and flows of phosphorus have tripled. More than half of all the synthetic nitrogen fertilizer.	Doc 1 page 4 prg 14
The atmospheric concentration of carbon dioxide has increased by about 32% (from about 280 to 376 parts per million in 2003), primarily due to the combustion of fossil fuels and land use changes.	Doc 1 page 2 prg 11

The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals.	Doc 1 page 1 prg Finding 3
Human changing diversity of life on Earth including them as threats.	Doc 1 page 4 prg 14
Invasive alien plants dramatically increased their footprint in South Africa.	Doc 1 page 6 prg 11
More than two thirds of the area of 2 of the world's 14 major terrestrial biomes and more than half of the area of 4 other biomes had been converted by 1990, primarily to agriculture.	Doc 1 page 4 prg 15
Across a range of taxonomic groups, either the population size or range or both of the majority of species is currently declining.	Doc 1 page 4 prg 16
The distribution of species on Earth is becoming more homogenous; in other words, the set of species in any one region of the world is becoming more similar to the set in other regions primarily as a result of introductions of species, both intentionally and inadvertently in association with increased travel and shipping.	Doc 14 prg 17
The number of species on the planet is declining. humans have increased the species extinction rate by as much as 1,000 times over background rates typical over the planet's history.	Doc 1 page 4 prg 18
Mammal, bird, and amphibian species are currently threatened with extinction.	Doc 1 page 4 prg 18
Freshwater ecosystems tend to have the highest proportion of species threatened with extinction.	Doc 1 page 4 prg 18
Genetic diversity has declined globally, particularly among cultivated species.	Doc 1 page 4 prg 19
Current and future loss of species as a result of habitat changes taking place over the period of roughly 1970 to 2050.	Doc 1 page 5 Figure 4
Actions to increase one ecosystem service often cause the degradation of other services. example, actions to Increase food production usually involves increased use of water and fertilizers or expansion of the area of cultivated land these same actions often degrade other ecosystem services, including reducing the availability of water for other uses, degrading water quality, reducing biodiversity, and decreasing forest cover (which in turn may lead to the loss of forest products and the release of greenhouse gasses)	Doc 1 page 6 prg 29
Collapse of the Newfoundland cod fishery due to overfishing.	Doc 1 page 6 prg 29
Agricultural practices cause water (pollution and eutrophication, a process whereby excessive plant growth depletes oxygen in the water), air (emissions of greenhouse gases), soil (off-site erosion damage, emissions of greenhouse effect.	Doc 1 page 6 prg 29
The incidence of diseases of marine organisms and the emergence of new pathogens is increasing, and some of these, such as ciguatera, harm human health.	Doc 1 page 6 prg 30
Episodes of harmful (including toxic) algal blooms in coastal waters are increasing in frequency and intensity, harming other marine resources such as fisheries as well as human health.	Doc 1 page 6 prg 30
Frequency and impact of floods and fires has increased significantly in the past 50 years in part due to ecosystem changes.	Doc 1 page 6 prg 30
Changes in ecosystems that contribute to greenhouse gas emissions contribute to global climate changes that affect all countries.	Doc 1 page 7 prg 38
For example, phosphorus is accumulating in large quantities in many agricultural soils, threatening rivers, lakes, and coastal oceans with increased eutrophication.	Doc 1 page 11 prg 44
Changes in upstream catchments affect water flow and water quality in downstream regions; similarly, the loss of an important fish nursery area in a coastal wetland may diminish fish catch some distance away.	Doc 1 page 11 prg 45

During the 1997–98 El Niño, excessive flooding caused cholera epidemics in Djibouti, Somalia, Kenya, Tanzania,and Mozambique	Doc 1 page 11 prg 44
Warming of the African Great Lakes due to climate change may create conditions that increase the risk of cholera transmission.	Doc 1 page 11 prg 45
Once a threshold of nutrient loading is achieved, changes in freshwater and coastal ecosystems can be abrupt and extensive, creating harmful algal blooms (including blooms of toxic species) and sometimes leading to the formation of oxygen-depleted zones, killing most animal life	Doc 1 page 11 prg 45
Species introductions and losses are threat to biodiversity.	Doc 1 page 12 prg 47
Deforestation generally leads to decreased rainfall	Doc 1 page 12 prg 47
Bush meat trade involves relatively high levels of interaction between humans and some relatively closely related wild animals that are eaten(over hunting)	Doc 1 page 12 prg 48
The degradation of ecosystem services is harming many of the world's poorest people and is sometimes the principal factor causing poverty.	Doc 1 page 12 prg 52
The declining state of capture fisheries is reducing an inexpensive source of protein in developing countries.(malnutrition)	Doc 1 page 12 prg 54
Desertification affects the livelihoods of millions of people, including a large portion of the poor in dry lands.	Doc 1 page 13 prg 54
Habitat transformation threat to biodiversity.	Doc 1 page 14 prg 48
Overexploitation, especially overfishing threat to biodiversity.	Doc 1 page 15 prg 62
"The spread of invasive alien species and disease organisms continues to increase because of both deliberate translocations and accidental introductions related to growing trade and travel, with significant harmful consequences to native species and many ecosystem services".	Doc 1 page 15 prg 62
Pollution, particularly nutrient loading: Humans have already doubled the flow of reactive nitrogen on the continents.	Doc 1 page 15 prg 63
"Excessive flows of nitrogen contribute to eutrophication of freshwater and coastal marine ecosystems and acidification of freshwater and terrestrial ecosystems (with implications for biodiversity in these ecosystems"	Doc 1 page 24 prg 105 and page 15 prg 64
"Nitrogen also plays a role in creation of ground-level ozone (which leads to loss of agricultural and forest productivity), destruction of ozone in the stratosphere (which leads to depletion of the ozone layer and increased UV-B radiation on Earth, causing increased incidence of skin cancer), and climate change".	FID2 page 15 prg 64
Asthma and respiratory function, increased allergies and asthma due to increased pollen production, the risk of blue-baby syndrome	Doc 1 page 15 prg 64
Habitat loss and other ecosystem changes are projected to lead to a decline in local diversity of native species in all four MEA scenarios by 2050.	Doc 1 page 17 prg 64

RESTORATIVE ACTIONS	
"Actions such as the integration of ecosystem management goals in various sectors (such as agriculture, forestry, finance, trade, and health), increased transparency and accountability of government and private-sector performance in ecosystem management, elimination of perverse subsidies, greater use of economic instruments and market-based approaches, empowerment of groups dependent on ecosystem services or affected by their degradation promotion of technologies enabling increased crop yields without harmful environmental impacts, ecosystem restoration, and the incorporation of nonmarket values of ecosystems and their services in management decisions all could substantially lessen the severity of these problems in the next several decades".	Doc 1 page 2 prg 8
Actions needed to enhance the conservation and sustainable use of ecosystems.	Doc 1 page 2 prg 9
Action to address or increase one ecosystem service affects other services for example for actions to increase food production increased use of water and fertilizers.	Doc 1 page 6 prg 26
Advance in technology decreased pressure on ecosystems by providing certain ecosystem services	Doc 1 page 19 prg 78
Substitution also to meet certain ecosystem services. Example Substitution of fuel wood by fossil fuels, for example, reduces pressure on forests and lowers indoor air pollution. Substituting vinyl, plastics, and metal for wood.	Doc 1 page 19 prg 78
Some actions management is influenced more strongly by actions outside for example the forest sector will be influenced by its trade policies and institutions, macroeconomic policies, and policies in other sectors such as agriculture, infrastructure, energy, and mining, than by those within it	Doc 1 page 19 prg 79
Inclusion of ecosystem management goals within other sectors and within broader development planning frameworks	Doc 1 page 20 prg 84
Increases and improves coordination among multilateral environmental agreements and between environmental agreements and other international economic and social institutions.	Doc 1 page 20 prg 85
Thus promoting transparency , accountability of government and private-sector performance on decisions that have an impact on ecosystems, including through greater involvement of concerned stakeholders in decision-making	Doc 1 page 20 prg 86
Promising and effective responses for Agricultural, Fisheries and Aquaculture, Water and Forestry that work towards sustainable use.	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Specific Sectors
Agriculture ■ Dealing away with production subsidies that has negative impacts on economic, social, and environmental ■ Investment in, and diffusion of, agricultural science and technology that can sustain the	Doc 1 pg 21 Box 2 Examples of Promising and Effective

necessary increase of food supply without harmful tradeoffs involving excessive use of water, nutrients, or pesticides. ■ Implement policies that values the role of women in the production and use of food and that are designed to empower	Responses for Agricultural Sectors
Fisheries and Aquaculture ■ Reduction of marine fishing capacity. ■ Strict regulation of marine fisheries both regarding the establishment and implementation of quotas and steps to address unreported and unregulated harvest. Individual transferable quotas may be appropriate in some cases, particularly for cold water, single species fisheries. ■ Establishment of appropriate regulatory systems to reduce the detrimental environmental impacts of aquaculture. ■ Establishment of marine protected areas including flexible no-take zones.	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Fisheries and Aquaculture Sectors
Water ■ Payments for ecosystem services provided by watersheds.■ Improved allocation of rights to freshwater resources to align incentives with conservation needs. ■ Increased transparency of information regarding water management and improved representation of marginalized stakeholders. ■ Development of water markets. ■ Increased emphasis on the use of the natural environment and measures other than dams and levees for flood control. Investment in science and technology to increase the efficiency of water use in agriculture.	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Water Sector
Forestry ■ Integration of agreed sustainable forest management practices in financial institutions, trade rules, global environment programs, and global security decision-making. ■ Empowerment of local communities in support of initiatives for sustainable use of forest products; these initiatives are collectively more significant than efforts led by governments or international processes but require their support to spread. ■ Reform of forest governance and development of country-led, strategically focused national forest programs negotiated by stakeholders	Doc 1 page 21 Box 2 Examples of Promising and Effective Responses for Forestry sector
Then the promising options for specific sectors and cross-cutting responses addressing key obstacles were also described. Key obstacles included Institutions and Governance, Economics and Incentives, Social and Behavioural Responses, Technological Responses and knowledge responses. They had the following actions to be effective:	Doc 1 page 20 prg 81
Elimination of subsidies that promote excessive use of ecosystem services (and, where possible, transfer of these subsidies to payments for non-marketed ecosystem services).	Doc 1 page 21 prg 88
Greater use of economic instruments and market-based approaches in the management of ecosystem services.	Doc 1 page 21 prg 89
Communication and education	Doc 1 page 22 prg 93
Empowerment of groups particularly dependent on ecosystem services or affected by their degradation, including women, indigenous peoples, and young people.	Doc 1 page 22 prg 94
Promotion of technologies that enable increased crop yields without harmful impacts related to water, nutrient, and pesticide use .	Doc 1 page 22 prg 98
Restoration of ecosystem services	Doc 1 page 23 prg 99
Promotion of technologies to increase energy efficiency and reduce greenhouse gas emissions.	Doc 1 page 23 prg 100

Incorporation of nonmarket values of ecosystems in resource management and investment decisions	Doc 1 page 23 prg 103
Use of all relevant forms of knowledge and information in assessments and decision-making, including traditional and practitioners' knowledge.	Doc 1 page 24 prg 104
Enhancing and sustaining human and institutional capacity for assessing the consequences of ecosystem change for human well-being and acting on such assessments.	Doc 1 page 24 prg 105
"However MEA realized that, many research needs and information gaps were identified in this assessment, and actions to address those needs could yield substantial benefits in the form of improved information for policy and action. Due to gaps in data and knowledge, this assessment was unable to answer fully a number of questions posed by its users. Some of these gaps resulted from weaknesses in monitoring systems related to ecosystem services and their linkages with human well-being"	Doc 1 page 24 prg 106-107
Various choices exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs	Doc 1 page 18 prg 76
Ecosystem restoration activities are now common in many countries. Ecosystems with some features of the ones that were present before conversion can often be established and can provide some of the original ecosystem services. However, the cost of restoration is generally extremely high compared with the cost of preventing the degradation of the ecosystem. Not all services can be restored, and heavily degraded services may require considerable time for restoration"	Doc 1 page 23 prg 99
Resilience: The loss of species and genetic diversity decreases the resilience of ecosystems.	Doc 1 page 12 prg 45
Despite these tremendous challenges people living in drylands and their land management systems have a proven resilience and the capability of preventing land degradation.	Doc 1 page 14 prg 49

Appendix G: Analytic Memo (SANBI, 2013)

EXTRACT	SOURCE
ECOSYSTEM SERVICES VALUING	
Ecological structure gives us give us a whole suite of services, sometimes called ecosystem services: fresh water, firewood and fertile soils for agriculture; they regulate water flows and help to protect us from extreme events associated with climate change, like floods, droughts and fires. Ecosystem services like municipal services includes which supports social development and economic prosperity.	Doc 2 unpaged – prg 4
South Africa has an extraordinary diversity of life and ecosystems which give us goods and services that we could not live without.	Doc2 pg3 prg 10
Biodiversity is important for our well being	Doc 2 pg3 prg 11
Water factories: areas with high natural runoff, such as the Drakensberg Mountains, the Soutpansberg and the Wolkberg in Limpopo Province, are critical for gathering and channeling the water which this semi-arid country depends on.	Doc 2 pg 5
Wetlands support agriculture, filter pollution from water, trickle-feed water into rivers even during the dry season	Doc 2 pg 15
Services we get from wetlands include water purification and slowing down flood waters.	Doc 2 pg 5 prg 17
People use many different kinds of raw materials in estuaries: reeds and sedges for craft work; saltmarshes for grazing; firewood, timber and poles from mangrove forests. The rural poor are particularly reliant on this sort of 'free' service in order to make ends meet.	Doc 2 pg 28 prg 128
Because of their natural beauty, we build coastal settlements on or near estuaries and use them extensively for our leisure.	Doc 2 pg 28 prg 129
Agriculture, hand the entire nation's food production, is dependent on a healthy natural environment.	Doc 2 pg 9 prg 38
Good soils allow us to grow crops. The natural veld gives us grazing for livestock ,something which was valued at over R8 000 for every square kilometer annually in 2008.	Doc 2 pg 9 prg 38
If it wasn't pollination of certain insects, birds and rodents, many crops would be impossible to grow.	Doc 2 pg 9 prg 38
In the Western Cape alone, wild pollinators give a service to the deciduous fruit industry amounting to between US$49 million (R400 million) and US$311 million (R2 500 million) every year, according to a 2008 study	Doc 2 pg 9 prg 38
"Good news! While these pressures are serious, we can continue to benefit enormously from the many ecosystem services that are given to us freely by our marine and coastal ecosystems."	Doc 2 pg 36 prg 168
Healthy lands, healthy waters: healthy land-based environments also protect people from natural hazards, slow down floods and store water to help see us through times of drought	Doc 2 pg 9 prg 38
Creatures living in wild places also offer pest control for agriculture	Doc 2 pg 9 prg 38
Nature used as playground and get pleasure from that(recreational ecosystem service)	Doc 2 pg 9 prg 38
Tourist attraction to beaches	Doc 2 pg 9 prg 40

Tourists, many of whom are drawn to our beaches, natural spaces and wild animals	Doc 2 pg 9 prg 40
"... Many of us feel a profound connection with the ocean's haunting beauty..."	Doc 2 pg 32 prg 150
"The family heirloom"	Doc 2 pg 3 prg 8
Tourism brought an estimated R251 billion into the country's gross domestic product (GDP) in 2011 which is more or less equivalent to mining sector	Doc 2 pg 9 prg 40
"The wealthy countryside: many rural communities use Forest, Albany Thicket and Savanna systems for fire wood, wild fruits, and to make wooden utensils. Others gather traditional medicines from the natural environment"(regulating services-health)	Doc 2 pg 9 prg 41
The value of the land cannot be only reduced to mere rands and cents. The diversity of life found in the bushveld and the cultural meaning to people who have returned to the lands due to land reform and restitution cannot be measured in monetary units.	Doc 2 pg 10 prg 44- 45
When you walk on the land you respect ancestors, *abaphansi* meaning those that are underground.	Doc 2 pg 10 prg 46
Game farming and hunting becoming a growing industry and creating 100 000 jobs.	Doc 2 pg9 prg 42
Some of these wetland species are used for food, craft manufacture, medicines, grazing, building material and fuel, for both subsistence and commercial use.	Doc 2 pg 15 prg 69
"our precious wetlands"	Doc 2 pg 15 prg 66
Our natural water infrastructure, in the form of wetlands, streams, rivers, lakes, aquifers and estuaries, complements and protects our dams, pipelines and water treatment plants.	Doc 2 pg 16 prg 74
Wetlands around Kliprivier in Southern Johannesburg clean water released by gold mines.	Doc 2 pg 15 prg 76
Manalana wetland in Bushbuckridge , Mpumalanga is the only source of food and income to quarter of the surrounding community.	Doc 2 pg 17 prg 76
Treasuring the small tributaries, all those small rivers which feed into SA main rivers. They keep our water supplies in good health.	Doc 2 pg 5 prg 19
Healthy rivers also support a wide diversity of life, which helps to process pollutants and clean our water, and supports the people living in and around them.	Doc 2 pg 21 prg 101
St Lucia supports many of the fish species of the offshore Thukela Bank and Richards Bay area. Making it the most important nursery for young fish on the Southeast African coastline.	Doc 2 pg 27 prg 124
Fresh water pouring out from rivers is not wasted as it plays a vital part in keeping estuaries and nearby ocean ecosystems healthy.	Doc 2 pg 22 prg 105
Estuaries are hardworking systems. They're often close to build up economic hubs, and a focal point for all the environmental stresses happening upstream of the mouth.	Doc 2 pg 29 prg 133
And yet many of us feel a profound connection with the ocean's haunting beauty, and take immeasurable pleasure from its bounty.	Doc 2 pg 32 prg 151
Unseen wealth in the ocean: The value of services from ocean ecosystems across the globe was a staggering US$21 trillion in 1994.	Doc 2 pg 33 prg 154
"In South Africa, the value of our coastal resources is equivalent to nearly 4% of the country's gross domestic product (GDP), some R85 billion in 2011, including from fishing, coastal tourism, and ports and harbours, according to a recent study".	Doc 2 pg 35 prg 155
"Making a haul: The shoals of fish that tack back and forth in our coastal waters are immensely valuable. Each year, we haul R6 billion worth of fish out of the water – a fresh, healthy source of wild food. The fishing industry gives 27 000 jobs to people in the commercial sector, and another 28 000 households are involved in subsistence fishing."	Doc 2 pg 33 prg 155

Safe house for spawning fish: The Garden Route's marine protected area provides a breeding ground for fish which are valued at around R33 million per year.	Doc 2 pg 33 prg 155
"Beachfront playground: More and more tourists are flocking to our beaches every year. The money they spend drives local economic growth. The beaches around Cape Town have a recreational value of between R70 and R86 million per year, according to a 2009 report by the city. Meanwhile the beaches along the Garden Route attract some R950 million worth of tourist spend annually".	Doc 2 pg 33 prg 155
Buffering effects of dunes help us cope with the sometimes unpredictable nature of the sea like storms which can damage coastal property.	Doc 2 pg 34 prg 156
Where our food grows: agriculture, and by association the entire nation's food production, is dependent on a healthy natural environment. Good soils allow us to grow crops.	Doc 2 pg 9
South Africa's marine eco regions to six distinct ones and within that, they've identified 136 different habitat types, falling within 14 distinct ecosystem groups.	Doc 2 pg 34
THREATS	
Loss of wetlands, remaining ones are in critically endangered.	Doc 2 pg 5 prg 17
For six decades St Lucia received too little fresh water, due to human interventions and drought.	Doc 2 pg 5 prg 20
Nature's buffers against storm surges and rising seas may have been stripped away and paved over in parts. This puts people and property at risk in the face of climate change. Our coastal and inshore ecosystems are more threatened than offshore marine ecosystems.	Doc 2 pg 5 prg 21
Lost at sea: further out to sea, offshore ecosystems are the most poorly protected of all our ecosystems.	Doc 2 pg 5 prg 22
Ecosystem threat status: This tells us whether an ecosystem is still intact, or if it's losing vital aspects of its structure, function or composition.	Doc 2 pg 7 prg 30
Our threatened land-based ecosystems: Most of our threatened ecosystems are found near big cities, productive croplands and coastal areas, where large amounts of natural habitat have been lost.	Doc 2 pg 11 prg 47
Most threatened biomes: Grassland, Fynbos and Indian Ocean Coastal Belt.	Doc 2 pg 11 prg 47
Change in land cover is the greatest driver of habitat loss across South Africa. Nearly a fifth of the land surface has been lost, mostly due to natural vegetation being ploughed up for crop farming (like maize, wheat and sugar cane), and to a lesser extent to mining, forestry and urban sprawl. The greatest losses are around hubs of economic activity.	Doc 2 pg 12 prg 49
Pollution from mining, agriculture, manufacturing and cities into the water, soil or air also disrupt ecosystems, how well they function, or the species living in them.	Doc 2 pg 12 prg 50
KwaZulu-Natal, Gauteng and the North West are amongst the provinces that have had the greatest loss of natural habitat.	Doc 2 pg 12 prg 54
Natural areas continue to be transformed into crops and forestry or turned over to mining or urban sprawl at the current rate, there will be little to no natural vegetation left in these provinces by 2050.	Doc 2 pg 12 prg 56
Cost to the soul: it's easy to keep measuring the loss of habitats and the services they give us purely in scientific or economic terms. But how does one measure the social and psychological consequences of losing these wild iconic spaces.	Doc 2 pg 12 prg 57
When wetlands are damaged, the consequences ripple out across a system that reaches far beyond that little marsh or vale.	Doc 2 pg 15 prg 71
Putting on the squeeze: Wetlands are our most threatened ecosystems.	
Damaged when cities, dams and mines paved over or swallowed up wetlands, but we know it's considerable.	Doc 2 pg 17 prg 78

Damming, draining, mining or bulldozing are threats to wetlands	Doc 2 pg 17 prg 79
The most threatened wetland types are floodplain wetlands, because they are often found in highly productive land where people drain or bulldoze them to make way for agriculture.	Doc 2 pg 17 prg 78
Caution, caution! Nearly half of all our wetland ecosystem types are critically endangered, making wetlands the most threatened of all ecosystems in South Africa.	Doc 2 pg 18 prg 81
Economic pursuits are a threat to our wetlands	Doc 2 pg 18 prg 83
Wetlands are lost or degraded because of cultivation (for instance, for sugar cane or orchards), for urban development, for mining, to build dams, or because of poor grazing management which causes erosion.	Doc 2 pg 18 prg 84
Disrupting the timing and the way water flows into the wetland through activities like building a dam or over-extracting water upstream of the wetland or extracting too much groundwater can cause damage.	Doc 2 pg 18 prg 85
Pollution in rivers feeding into a wetland can cause harm. Similarly overgrazing or poor crop management can lead to soil being flushed away and deposited in wetlands.	Doc 2 pg 18 prg 85
Wetlands are not protected hence they are exposed to threats.	Doc 2 pg 18 prg 85
But we're putting huge pressure on our rivers – taking more and more water out of them, and dumping greater amounts of pollution into them	Doc 2 pg 21 prg 98
Anything that alters the way water flows through a river system can have a serious impact on the health of riverine life.	Doc 2 pg 23 prg 107
Pollutants can come from failing sewerage treatment plants, industrial waste water with harmful chemicals poured directly into wetlands and rivers, and agricultural pesticides and fertilisers running off farmlands. Taking water out of a polluted system leads to even higher concentrations of pollutants.	Doc 2 pg 23 prg 108
Destruction of river banks: bulldozing banks or planting crops along river edges can cause permanent damage to a river system and the ecological services it provides.	Doc 2 pg 23 prg 109
Invasive alien plants: thirsty invaders drink up an estimated 7% our total annual runoff, which then deprives rivers, dams and people.	Doc 2 pg 23 prg 111
Invasive alien fish: fish introduced for recreational fishing and aquaculture, like bass and trout, can wipe out indigenous fish species and other life.	Doc 2 pg 23 prg 111
Climate change: rising temperatures and changing rainfall patterns will impact on how much water makes it into river systems.	Doc 2 pg 23 prg 112
Threat alert at the estuary; The estuary is the body of water where fresh and sea water mix, which is influenced by the tides, creating a unique habitat for life in the estuary	Doc 2 pg 29 prg 133
The Orange River mouth is heavily impacted by mining and access roads.	Doc 2 pg 29 prg 137
It's the damming and extraction of water upriver for irrigation, combined with increased flows in winter as a result of hydro-electric power schemes, which has disrupted this mouth's natural opening and closing action.	Doc 2 pg 29 prg 138
Changing the catchment: land use change in catchments feeds into rivers and ultimately impacts on estuarine health.	Doc 2 pg 30 prg 140
Turning off the tap: anything upriver that changes the fresh water flowing into an estuary adds to the pressure our estuaries face. Dams, irrigation, thirsty invasive plants, and forestry upstream take fresh water away from a system which needs it for supporting fish nurseries, coastal habitats, marine productivity, and food webs.	Doc 2 pg 30 prg 141
Changing the tides; any inappropriate development or land use near the estuary – be it mining, land reclamation, building harbours and marinas, channelizing or artificially breaching the mouth – changes the habitat, tidal flow and flooding behavior of the estuary.	Doc 2 pg 30 prg 142

Becoming a sand trap: sand and silt get deposited in estuaries when overgrazing or ploughing farmlands upstream causes erosion. This is nothing less than a form of pollution for estuarine life.	Doc 2 pg 30 prg 142
Over-fishing and bait extraction (of prawns, for instance) can damage nurseries, and reduce or collapse fish stocks.	Doc 2 pg 30 prg 143
Pollution from fertilizers, herbicides and pesticides flushed from farmlands by irrigation runoff; waste water treatment works discharged into rivers and estuaries; heavy metals and oils from industrial effluent, and storm water runoff; too many nutrients flushing out of marine culture operations, or even genetic contamination. These can all damage estuarine life.	Doc 2 pg 30 prg 144
The more coastal ecosystems are built up and paved over, the less they are able to help us cope with the sometimes unpredictable nature of the sea, like strong storms which can damage coastal property.	Doc 2 pg 34 prg 156
Fishing is the greatest stress on our marine ecosystems. This comes mainly from over-harvesting of fishing stocks; catching non-target species, or 'bycatch',such as birds, turtles, sharks and other fish species; and damage to the habitat through the fishing process (trawling of some parts of the seabed, for instance, is about as damaging and irreversible as ploughing up a grassland.	Doc 2 pg 36 prg 165
South Africa has over 2 000 plant species that are used for medicinal purposes, about a third of which are traded commercially. But some are threatened such as the Natal ginger which is used for asthma and other respiratory conditions.	
Poaching is another threat to the diversity of marine life, the sustainability of resources and the livelihoods of legitimate fishers	Doc 2 pg 36 prg 165
Coastal development is the greatest pressure on our coastal systems	Doc 2 pg 36 prg 166
Other serious pressures come from invasive alien species like the Mediterranean mussel; mining off the coast for diamonds, oil or gas, or dune mining for heavy metals and phosphate; shipping, which can introduce invasive alien species or oil pollution; agricultural, industrial or municipal pollution from rivers washing out to sea; and over abstraction from rivers pinches off fresh water flowing out to sea, with associated changes in nutrient and sediment deposits.	Doc 2 pg 36 prg 167
The most threatened coastal and inshore habitats tend to be rocky zones, like reefs and rocky shores, because of fishing, invasive species and climate change.	Doc 2 pg 36 prg 170
The most threatened habitats are in the Southern Benguela and Agulhas ecoregions (especially the shelf edge, which is highly productive for fishing	Doc 2 pg 36 prg 172
Rising temperatures will push the country's long-term weather trends into a less predictable and more variable state, the region will experience more severe and more frequent extreme weather events such as droughts, floods, heat waves and storms.	Doc 2 pg 40 prg 187
The climate envelopes which shape our biomes will change, but change will happen too fast for most species to adapt in time. This will amplify the stress caused by other pressures on the natural environment, such as invasive alien species, loss or fragmentation of natural habitat, resource extraction and pollution. Working together, all of these pressures will have a serious impact on the healthy functioning of our ecosystems and the species living in them	Doc 2 pg 40 prg 180
Grassland will shrink significantly due to hotter climate conditions.	Doc 2 pg 40 prg 190
In the Nama-Karoo if temperatures rise only moderately, then large areas might begin to look like what we know today as arid Savanna; in the worst case scenario, it might become outright Desert.	Doc 2 pg 40 prg 191
Best case scenario sees the warm moist conditions of the Indian Ocean Coastal Belt biome expanding inland and south along the coast; but as things tip towards the worst case scenario, and conditions dry, the climate here will be more suited to Savanna.	Doc 2 pg 40 prg 192

Fynbos: the core south-western Fynbos is most stable, while the climate in the eastern and northern reaches of Fynbos may resemble that of the Succulent Karoo or Albany Thicket.	Doc 2 pg 40 prg 194
Succulent Karoo: possibly the most stable biome in the medium term; but significant impacts might be seen towards the end of the century.	Doc 2 pg 40 prg 193
Albany Thicket: remains fairly stable; in the worst-case scenario climate conditions may begin to resemble those of the Nama-Karoo and Savanna	Doc 2 pg 40 prg 195
Desert are likely to expand, particularly into the Nama-Karoo envelope.	Doc 2 pg 40 prg 196
Water shortages and fires could threaten pockets of Forest.	Doc 2 pg 40 prg 197
In the Savanna the climate envelope will expand to the benefit of specific species, but the overall habitat and groups of species may still suffer.	Doc 2 pg 40 prg 198
Over the past 350 years, many different kinds of plants, animals, and disease organisms have found their way into South Africa from abroad. Some were introduced intentionally, to beautify gardens, as pets, or for recreation (trout fishing, for instance). Some were brought in to modernize agriculture or for aqua- or mariculture. Some were brought in to bind sand dunes or for timber or biofuels. Others have slipped into the country unbeknownst to us at first, stowing away in the ballast water in ships, or clinging to ship hulls, or hidden away in agricultural products.	Doc 2 pg 42 prg 204
The social and economic impacts are clear and measurable: they threaten our water security, reduce productivity of rangelands, increase fire risk, and can impact on crop agriculture.	Doc 2 pg 43 prg 205
The most widely studied group of alien invaders are woody plants, partly because of the threat they pose to our water supplies which makes them a priority concern.	Doc 2 pg 44 prg 208
By 2010, these plants had spread over 16% of South Africa's land area – some 20 million hectares – which is dramatically greater than the estimated footprint from 15 years earlier.	Doc 2 pg 44 prg 209
The big guns of the invaders are the Australian wattles, gums, prickly pears, pines, poplars, weeping willows and mesquite.	Doc 2 pg 44 prg 210
Some of the main invaders threaten our water security. By sucking up large amounts of water, they reduce how much water reaches the rivers, the impact of which ripples through the entire fresh water system.	Doc 2 pg 44 prg 211
Some invaders out-compete fodder plants, which reduces farm grazing. Some species may even kill or poison livestock. If allowed to spread, these invaders could reduce the carrying capacity for large grazing animals by more than two thirds.	Doc 2 pg 44 prg 213
Invasive trees and grasses increase the amount of fuel for fires, making them burn hotter and faster than fires in indigenous vegetation. This damages soil, leading to erosion. The increased risk to life and property can push up insurance premiums.	Doc 2 pg 44 prg 214
The pest problem: many agricultural pests are invasive species. Controlling them with pesticides increases the cost of agricultural production. Attempts by other countries to quarantine invaders can limit export opportunities for South African farmers.	Doc 2 pg 44 prg 215
The 'bush of evil': before it was cleared in 2005, a council owned site in Delft, Cape Town, became a notorious haven for criminals because of dense invasion of Port Jackson trees where many rapes and murders took place.	Doc 2 pg 44 prg 216
Terrible escalation in the rate of poaching of the country's rhinos in recent years puts a spotlight on those individual species that are edging perilously close to extinction because of the pressure brought to bear on them for various reasons.	Doc 2 pg 48 prg 236
A sudden rush for rhino horn in Southeast Asia since 2008 has sparked an increase in poaching which threatens to reverse the gains made.	Doc 2 pg 48 prg 236
South Africa is a world leader in the Red Listing process which is an internationally recognized method for assessing the threat status of individual species, based on their likelihood of extinction.	Doc 2 pg 48 prg 237

SUSTAINABILITY AND CONSERVATION	
Protect our water factories	Doc 2pg 5 prg 18
Protecting our natural medicines: South Africa has over 2 000 plant species that are used for medicinal purposes, about a third of which are traded commercially. We need to manage these species better, and monitor how other heavily traded medicinal plant species are used, so that they don't become over-exploited too. "Natal ginger" is a threatened species.	Doc 2 pg 6 prg 26
Ecosystem protection level: This tells us whether an ecosystem is well represented in protected areas, based on the proportion of the ecosystem that falls into an area that is formally protected under national legislation, namely the Protected Areas Act.	Doc 2 pg 7 prg 31
Gumbi people needed land to farm and sustain themselves; and thirdly they decided to dedicate most of the land (16 000 hectares in all) to conservation. This meant they could generate an income for the community through ecotourism while being custodians of the environment.	Doc 2 pg 8 prg 35
After the land was returned to the Gumbi people in northern KwaZulu-Natal, and they were able to build their settlements and re-establish their farms, work began on establishing the protected area.	Doc 2 pg 10 prg 44
The establishment of the Somkhanda Game Reserve has seen black rhino introduced to the reserve, tourist lodges refurbished, game numbers supplemented, water has been secured and hunting is bringing in revenue.	Doc 2 pg 10 prg 44
Nearly a quarter of land-based ecosystems are well protected. Mountain Fynbos is well protected.	Doc 2 pg 15 prg 63
The most well protected: because of the Kruger National Park and iSimangaliso Wetland Park, wetland ecosystems in the lowveld region and in northern KwaZulu-Natal are relatively well protected.	Doc 2 pg 18 prg 87
The priority now should be the conservation of a representative spread of different wetland ecosystem types, through protecting wetlands themselves.	Doc 2 pg 18 prg 89
Of the country's river ecosystem types, only 14% are well protected.	Doc 2 pg 25 prg 118
At first glance, South Africa's estuaries seem relatively well protected. The Lake St Lucia system is a case in point – it's legally protected, making up the majority of our protected estuarine footprint.	Doc 2 pg 37 prg 145
The marine protected area (MPA) is the legal mechanism that best protects ocean and coastal ecosystems and is key to keeping both the ecosystems and the fisheries safe.	Doc 2 pg 37 prg 1174-175
'No fishing, please!' providing for 'no-take zones' in MPAs allows for a greater level of protection for some areas.	Doc 2 pg 37 prg 175
Two new safe spaces: Still Bay and the Amatole Marine Protected Areas, both in the Agulhas bioregion, are two new stretches of coastline to get special protection in recent years.	Doc 2 pg 37 prg 178
Scientists have also identified features in the landscape that are likely to help build resilience for biodiversity in an area, which in turn helps to maintain stable landscapes for people living there.	Doc 2 pg 41 prg 201
Places of resilience: These areas need to be considered in land-use planning, environmental impact assessments, protected area expansion, and working with industry sectors to minimise their spatial footprint and other impacts.	Doc 2 pg 41 prg 202
The priority now should be the conservation of a representative spread of different wetland ecosystem types, through protecting wetlands themselves.	Doc 2 pg 18 prg 89
The National Water Act, complemented by other laws such as the Conservation of Agricultural Resources Act and the National Environmental Management Act, calls for precisely this sort of integrated approach to resource management: protecting the ecological reserve (the amount of water that needs to stay in the natural environment in order for it to be healthy), classifying water resources and maintaining our water quality.	Doc 2 pg 19 prg 90

South Africa is a signatory to the Ramsar Convention on Wetlands, which means we have to identify important wetlands which are then added to Ramsar's List of Wetlands of International Importance. Our obligation under Ramsar is to promote the wise use of all wetlands, create protected areas for wetlands, and cooperate with other member states when it comes to managing wetlands which straddle national borders.	Doc 2 pg 19 prg 93
keeping our rivers healthy, and rehabilitating damaged rivers, is an excellent investment in future water security and river services	Doc 2 pg 24 prg 117
Actions to take care of river ecosystems. ■ Don't make rivers the boundaries of National Parks or Nature Reserves, make them part of the protected area. ■ Extend protected areas along greater lengths of rivers that are only partly protected. ■ Include river catchment areas into protected areas. ■ Don't place developments, like chalets or lodges, on or near priority freshwater ecosystems inside protected areas. ■ Push for the last remaining rivers that are undisturbed from source to sea, so-called 'free flowing' rivers, to be incorporated into protected areas.	Doc 2 pg 25 prg 119
Managing the flow and quality of the water that reaches the estuary; and make the estuary 'no-take'(not allowing fishing or other forms of harvesting).	Doc 2 pg 31 prg 146
Estuaries are often quite resilient systems and many need only partial protection to stay in good health This can include, for example, having some fishing restrictions (such as no-take zones, closed seasons, and bag limits or restrictions on fishing gear), managing for improved fresh water flow, and keeping natural vegetation intact along the estuary perimeter.	Doc 2 pg 31 prg 147
The NBA 2011 identified 120 priority estuaries for South Africa. Fifty-eight of these need full protection, and 62 of them require partial protection	Doc 2 pg 31 prg 148
Using an integrated approach to managing the coastal environment is critical to keeping these spaces healthy: ■ The boundaries of coastal protection zones and coastal public property need to be refined to account for ecological factors. ■ Priority coastal ecosystems that should be kept natural need to be identified, in order to guide decisions about where best to locate future coastal development.	Doc 2 pg 36 prg 173
Providing for 'no-take zones' in MPAs allow for a greater level of protection for some areas. Without this, MPAs can actually become a focal point for recreational, subsistence or even commercial fishing	Doc 2 pg 37 prg 175
In the mid-1990s, a ground breaking concept was born: tackle the country's rampant and water-greedy invasive alien plant problem, at the same time as tackling unemployment. Since then, the success of the Working for Water programme has become globally recognized.	Doc 2 pg 45 prg 217
Scientists here have a solid track record in the use of such biological control methods on invasive alien plants, an approach which can be more cost effective than mechanical clearing	Doc 2 pg 45 prg 223
The aim of Working for Water's Early detection and Rapid Response programme is to identify potentially invasive plants that are beginning to establish themselves here, and get rid of them quickly before they become widely established	Doc 2 pg 45 prg 224
Globally recognised best practice approaches to actions to deal with alien invasive: • first, prevent new species arriving in the country, • second, if they're here, eradicate early on, • third, if they're beyond eradication, at least contain their spread, • fourth, if they're widespread, then try to manage, restore and protect highly valued ecological assets in the area of the invasion ;	Doc 2 pg 45 prg 225
Fish stocks seem to be recovering slowly after careful management decisions were made to monitor fish numbers, reduce quotas and limit the quantity of fish being pulled up from the deep sea	Doc 2 pg 47 prg 232

We need to strengthen our long tradition of managing the country's fishing stocks using good science to support appropriate policy if we're to continue benefiting from the 630 ocean species which our commercial, subsistence and recreational fisheries depend on.	Doc 2 pg 47 prg 233
To arrest decline in fish we need to: Fish within limits: ensure that fishing quotas are drawn up using accurate scientific information which reflects the real parameters of our fish stocks.	Doc 2 pg 47 prg 234
Create safe spaces: protect important spawning, nursery and foraging areas	Doc 2 pg 47 prg 234
The wasteful catching of non-target species, by-catch, needs to be reduced.	Doc 2 pg 48 prg 234
Management of fisheries needs to allow for the needs of competing species and predators.	Doc 2 pg 48 prg 235
Eco-certification is a way to get the whole food value chain to push for responsible fishing practices.	F1D3 pg 48 prg 235
The Red List system of the International Union for Conservation of Nature, the IUCN.	Doc 1 pg 49 prg 240
A call to action, in three parts; This three-way action plan, used together with maps of biodiversity priority areas, will help prioritise the often limited resources available for managing and conserving our precious terrestrial and aquatic environments.	Doc 2 pg 51 prg 245
Actions must focus on preventing loss and degradation of natural habitat in biodiversity priority areas that are still healthy, working well and in good ecological condition.	Doc 2 pg 51 prg 247
The discipline of identifying and classifying species – be they big mammals, little butterflies or succulent plants in the Karoo – is known as 'taxonomy' and we have a huge shortage of scientists who are trained in this area, and many gaps in knowledge still to be filled	Doc 2 pg 53 prg 250
The discipline of mapping and classifying ecosystems is essential for monitoring, assessing and managing biodiversity, and yet this field is even less well-developed than the arena of taxonomy	Doc 2 pg 53 prg 252
We need many more scientists who are trained in a number of different disciplines in the natural sciences, so that the country can continue to produce world-class biodiversity science	Doc 2 pg 53 prg 251
Having skills like this within different spheres of society – in government, in non-governmental organisations (NGOs),and in the academic community – is imperative to us	Doc 2 pg 53 prg 253
We need many more scientists who are trained in a number of different disciplines in the natural sciences, so that the country can continue to produce world-class biodiversity science, the kind which can inform the wise management and sustained use of our natural world	Doc 2 pg 53 prg 256
For example, we need people to who are equipped to continue the work of updating the countrywide data on the condition of our ecosystems, and who can do further research on the links between biodiversity and human wellbeing. With these skills in place, we can manage ecosystems appropriately and plan future developments in a way that allows us to meet the country's development needs without undermining the critical natural infrastructure that we all depend on.	Doc 2 pg 54 prg 257
"Career opportunities: where better to follow a natural science career than right here in South Africa, a global powerhouse of biodiversity? Career options range from scouring the oceans floors for clues to life in the deep, to game ranging in the Savanna; from managing teams of people, to developing multi-media communication tools; from undertaking university-based research to pursuing biodiversity-based business opportunities. And that's just for starters. There's work to be done, careers to be built, and a host of passionate people to do it with"	Doc 2 pg 54 prg 259

RESTORATIVE ACTIONS	
The wetland was badly eroded, something which threatened to destroy these benefits. However, since Working for Wetlands began rehabilitation in 2006, people living in the area can again use it for food, grazing and construction materials.	Doc 2 pg 17 prg 77
Bouncing back: Wetlands tend to be more resilient than many other ecosystems, meaning that even if they are in poor condition they can be rehabilitated. For example, this wetland has been cultivated, but its functioning could be restored, albeit at considerable effort and expense.	Doc 2 pg 19 prg 91
If a concerted effort is made to restore these estuaries to a healthier state, it would go a long way towards helping the country realise our goal of protecting a representative spread of estuaries. We are already on our way towards achieving this goal, since enormous efforts are being put into the restoration and recovery of the Lake St Lucia system.	Doc 2 pg 31 prg 148
Biodiversity is like infrastructures like roads and railway lines that we have. We need to care for this infrastructure because every South African – rural and urban, rich and poor – needs it in order to live a full, rich, abundant life.	Doc 2 pg no prg 6
Bringing together world class science and pioneering research to steer policy and action.	Doc 2 pg 3 prg 13
The National Biodiversity Assessment 2011 brought together world class science with pioneering mapping methods to give policymakers, decision makers and managers a powerful tool as they care for the country's natural assets, be they land-based, riverine, wetland, estuarine, coastal or open ocean.	Doc 2 pg 3 prg 14
Programmes like Working for Water give us a chance to create jobs and reclaim nature's valuable services.	Doc 2 pg 6 prg 27
After the land was returned to the Gumbi people in northern KwaZulu-Natal by the and they were able to build their settlements and re-establish their farms, work began on establishing the protected area.	Doc 2 pg 10 prg 44
Gumbi people proclaimed a portion of their land as a Nature Reserve through the province's biodiversity stewardship programme.	Doc 2 pg 10 prg 44

Appendix H: Analytical memo Senior Phase Natural Sciences CAPS Document Grade 7-9			
CATEGORIES	GRADES		
	GRADE 7	GRADE 8	GRADE 9
ECOSYSTEM SERVICES	1. Under the topic sexual reproduction in Angiosperms CAPS explains that pollination and fertilization are essential processes for flowers to produce seeds and what is pollination, and explain it is as the transfer of pollen between plants of the same species for the purpose of fertilization. Then how pollinations occurs- wind and water can facilitate pollination and pollination can also be aided by pollinators such as insects, birds, mammals. Importance of pollination: pollinators play an important role in the production of food crops (such as maize) for humans. 2. Variation of species-Start with subtopic variations exists within a species explains that differences between living things of the same species is called variation and that individuals of the same species can reproduce to make more individuals of the same species.	1. Photosynthesis CAPS states that interactions and interdependence in an ecosystem are driven by the need for energy to sustain life and respiration topic it state that food contains energy (potential energy). This energy can be released from food by a series of chemical reactions. This process is called respiration. 2.CAPS topic- Introduction to ecology and explained as "ecology is the study of interactions of organisms with one another and with the physical and chemical environment" and that "scientists usually classify the study of ecological interactions into four levels; populations, communities, ecosystem and the biosphere" 3.Topic on CAPS is Ecosystems; -all ecosystems combined make up the biosphere -biotic and abiotic aspects - the size of an ecosystem is not specifically defined and ecosystems are defined by the network of interactions among organisms, and between organisms and their environment In the ecosystem plants (and algae) play an important role. As they capture energy from the Sun by the process of photosynthesis. Balance in an ecosystem - An ecosystem can only accommodate as many organisms as its resources (food, water and shelter) can carry, and it will fail if it does not remain in balance - Useful micro-organisms some micro-organisms play an essential role in ecosystems,	No evidence ecosystem valuing content.

		such as decomposing dead plant and animal matter, thereby recycling nutrients in the soil • some micro-organisms are used by people for making certain foods (such as yoghurt) and medicines (such as penicillin -describe the relationship between the biotic factors (such as feeding and shelter) in the ecosystem	
THREATS TO BIODIVERSITY	1. CAPS states that plants, animals and microorganisms, and their habitats make up the total biodiversity of the Earth 2. States the five main groups (called Kingdoms) of living organisms include Bacteria, Protista, Fungi, Plants and Animals 3. Explains diversity of animals(Fish, Amphibians, Reptiles, Birds Mammals) and plants diversity (Angiosperms and Gymnosperms monocotyledons and dicotyledons(Note from CAPS [Note: Emphasize local and other South African examples]	Under the topic ecosystems CAPS state that survival of individual organisms and populations depends on the its ability to cope with changes (adapt) in its habitat (the place where an organism lives) or in the ecosystem)-foundational knowledge to resilience Under the topic adaptation there is resilience foundational knowledge: adaptation allows the organism to survive as it adapts to changing conditions within the environment On the topic balance of ecosystems CAPS explains that: An ecosystem can only accommodate as many organisms as its resources (food, water and shelter) can carry, and it will fail if it does not remain in balance. -Identify any human interference in the area (such as litter and pathways. - This balance can be disrupted by natural and human factors. - Human factors include removing organisms from the ecosystem (such as poaching), human induced pollution. - Writing about irresponsible human practices (such as inappropriate waste disposal) and their impact on ecosystems. -Suggest possible solutions: Organisms that are unable to adapt to changes within the environment die out (become extinct. - Evaluate disruptions to an ecosystem; giving causes, effects and solutions. Under the topic micro-organisms CAPS states that some micro-organisms cause diseases, such as TB (caused by bacteria), AIDS (caused by HI virus), malaria (caused by a protest) and how waterborne diseases (such as cholera and diarrhoea) account for many child deaths.	CAPS: the greenhouse effect is a natural phenomenon – it warms the atmosphere sufficiently to sustain life • greenhouse gases trap the ultraviolet radiation which then warms the air closest to the surface of the Earth (like inside a greenhouse) • the most common greenhouse gases are carbon dioxide, water vapour and methane • an increase in greenhouse gases leads to global warming • global warming is an increase in the average temperature of the atmosphere • global warming is a potentially life threatening problem on Earth. It can lead to: -- climate change -- rising sea levels -- food shortages -- mass extinctions

RESTORATIVE ACTIONS	**Topic :Variations exists within a species** Definition: a species is a category within the classification system. Living things of the same type belong to the same species. For example, humans are one species and dogs are another Species. Individuals of the same species can reproduce to make more individuals of the same species.	- environmentalists and others work towards managing ecosystems, such as control of alien vegetation and preservation of wetlands	No evidence of actions and restoring content.
SUSTAINABILITY AND CONSERVING	-Describing conditions that sustain life as suggested activities: investigations, practical work and demonstrations -Requirements for sustaining life - living things need energy, gases, water, soil and favorable temperatures, living things are suited (adapted) to the environment in which they live, such as fish have fins to move easily through water -investigating requirements (such as light, water) for the growth of seedlings [germinate seeds and grow the seedlings under different conditions] - individuals of the same species can reproduce to make more individuals of the same species	- Conservation of the ecosystem • environmentalists and others work towards managing ecosystems, such as control of alien vegetation and preservation of wetlands • individuals can contribute to conservation in various ways, such as appropriate waste disposal (including recycling, reusing. -writing about the importance of maintaining biodiversity and sustainable use of natural resources. - discussing about the many careers that require knowledge of environmental studies, nature, conservation, zoology, botany, entomology, the study of micro-organisms, including agriculture, food industry, medicine.	No evidence of conserving and sustainability content.

Appendix I: Analytical Memo Grade 7 Textbook

EXTRACT	SOURCE
ECOSYSTEM SERVICES VALUING	
Survival of living organisms depend on ecosystems services: access to water, air, food, space, favourable temperatures and protection from enemies.	TB7 pg 1
Living things get shelter, air, water and food from the environment they live in.	TB7 pg 1
Biosphere includes air, water and land (life on earth-biodiversity).	TB7 pg 2
Scientist estimates that there are between 10 and 50 million living organisms on earth.	TB7 pg 3 (pictorial illustrations in text book; fig 4-6)
Ecosystem services: Energy - allows living organisms to move or grow.	TB7 pg 4 prg 14
Gases - most organisms need oxygen for respiration and plants need carbon dioxide to make food.	TB7 pg 4 prg 15
Water - living organisms need it to survive.	TB7 pg 4 prg 16
Soil - for survival of some organisms, it is a shelter for organisms such as earthworms.	TB7 pg 4 prg 17
Favorable temperatures - earth's stable temperatures sustain life.	TB7 pg 18
Evidence of valuin of aquatic and desert biomes. Aquatic environments has seaweed such as kelp and fish lives in rivers , lakes and oceans. pictorial illustrations in text book (fig 9 and 10) Desert environments are habitats for animals such as Gemsbok which lives in the Kalahari Desert, camelthorn trees which also grows in the Kalahari and Social weavers in the Kalahari. Pictorial illustrations in text book' (fig 11-13).	TB7 pg 6 prg 25 TB7 pg 6 prg 26-27
Valuing evidence in the 'Did you know block": "The seedpods of the camelthorn, *Erioloba acacia* are made into a nutritious porridge and eaten by local people."	TB7 pg 7
Classification distinguish value of each living organisms by its characteristics. Science of classifying living organisms is called kingdoms. Five kingdoms pictorial illustrations in text book.	TB7 pg 11 prg31- 35
Animal diversity; fish, amphibians, reptiles found everywhere in every habitat and environment except the Antarctic, birds found in ecosystems around the world from Arctic to the Antarctic and mammals lives almost in any habitat, e.g. camels in hot deserts, polar bears in frozen ice of Arctic.	TB7 pg 14-16 prg45-51
Invertebrates; phylum arthropod divided into insects, arachnids and crustaceans. More than a million different species of insects have been identified, arachnids consist of over 100 000 different species while crustaceans has about 67 000 species.	TB7 pg 17-18 prg 52-56
Classification skills focus activity on pg 20-21 has pictorial illustration	
Diversity of plants; there are 290 000 species of plants growing all over the world.	TB7 pg 22 prg76
Angiosperms are the most diverse group of plants and largest within plant kingdom.	TB7 pg 23 prg80
Reproduction ensures that life continues.	TB7 pg 29 prg 86
Variation within a species and individuals of the same species can reproduction.	TB7 pg 56 prg 140
THREATS TO BIODIVERSITY	
Dispersal of seeds and fruits; case study on Humans and Aliens - how Port Jackson, Acacia saligna introduced to Western Cape from Australia - resulted in habitat loss.	TB7 pg 37 prg 101
CONSERVING AND SUSTAINABILITY	
For life to be sustained, need energy, gases, water, soil and favourable temperatures.	TB7 pg 1
Reproduction sustains life because it ensures that life continues through sexual reproduction, pollination, fertilisation and dispersal of seeds and fruits.	TB7 pg 29 prg 86
RESTORATIVE ACTIONS	
Humans must not intentionally disperse seeds of plants intentionally across the world as this increases alien plants. Members of the same species can reproduce with one another to make more individuals of the same species.	TB7 pg 37 & pg 59

Appendix J: Analytical Memo Grade 8 Textbook

EXTRACT	SOURCE
ECOSYSTEM SERVICES	
Interaction of organisms in an ecosystem and interdependence amongst them.	TB8 pg 3 prg 3-4
Physical, chemical and living environment are needed by organism in their environment.	TB8 pg 12 prg 27
Ecological classification system is very important in an ecosystem; population, communities, ecosystems and biosphere.	TB8 pg 13 prg 32-34
Decomposers breaking down the remains of dead plants and animals. As a result the useful minerals from the bodies of plant and animals goes back into the soil to be used by plants to make new nutrients and start new process all over again.	TB8 pg 21 prg 66
Plants and algae are producers because they are the only organisms that capture energy from the sun.	TB8 pg 22 prg 69
Analyze a food web : statements about food relationships among organisms in a farm dam in KwaZulu -Natal	TB8 pg 27 prg 81
South African organisms feeding (pictorial fig 2-19)	TB8 pg 26 fig 2.19
Each ecosystem has only certain amount of food, water and places to shelter. They are called resources.	TB8 pg 28 prg 83
People like animals depend on the natural resources of their environment to live. Water, soil and air are our life support system.	TB8 pg 38 prg 116
Many of these natural resources example sunlight don't disappear we call them renewable resources.	TB8 pg 38 prg 116
Others like coal and oil are non –renewable resources.	TB8 pg 38 prg 116
In Southern Africa most important natural resource is water because it has a dry climate. Hence people in South Africa find it difficult to collect water and it is therefore responsibility of the government to provide piped water to everyone.	TB8 pg 39 prg 124
Clean water brings value in health for everyone, fewer children die each year and population would be more stable.	TB8 pg 39 prg 124
Wetlands are important to us because they filter, clean and control water flow. Wetlands keep our water clean and reduce the risk of serious floods that cause serious damage.	TB8 pg 40 prg 126
We need soil to live because we need plants and plants need soil.	TB8 pg 40 prg 127
We need clean healthy air to breathe or we will suffer from diseases that damage lungs.	TB8 pg 40 prg 131
Indigenous plants and animals are usually better suited to our environment than those that have been introduced from other places.	TB8 pg 38 prg 120
Bat eared fox are valued for helping farmers by eating pests such as white ants and mice.	TB8 pg 39 prg 121
Indigenous plants often contains ingredients that can be used as important medicines	TB8 pg 39 prg 121
Natural habitats that are conserved gives people great pleasure and tourist attractions that generate money which can be used for maintenance and development of protected areas.	TB8 pg 39 prg 122
They also protect sensitive areas important for things such as our supply of clean water.	TB8 pg 39 prg 122
We share our planet with many different kinds of plants and animals so it is important not to destroy them.	TB8 pg 39 prg 123
Without microorganisms there is no life.	TB8 pg 48 prg 145
Microorganisms are essential to healthy ecosystems	TB8 pg 62prg 184
They decompose dead material	TB8 pg 62 prg 184
Micro -organisms are used by people for cleaning water and treating sewage was described as their ecological value.	TB8 pg 63 prg 186
Micro -organisms direct use include making food such as yoghurt, bred, beer and wines.	TB8 pg 64 prg 186
People use microorganisms to make medicines such as antibiotics. Example penicillium	TB8 pg 64 prg 187
Discuss careers on environment and microorganisms; Natural Resource Management, ecological surveys, Environmental Impact Assessment and others	TB8 pg 63 prg 188-192

THREATS TO BIODIVERSITY	
Activity 2.2 learners investigate examples of human interference in the area. The suggest how human changes may have affected the animal and plant populations of the area.(pictorial illustrations of litter figure 2.8	TB8 pg 19 prg 56
If there is no enough grass growing to provide food for the number of grass eating herbivores, the some of the herbivores will go hungry and the grass will be damaged and will not grow again.	TB8 pg 28 prg 83
Balance of ecosystem is easily disrupted.	TB8 pg 28 prg 83
Natural factors that affect the ecosystem; floods, drought very high and low temperatures and unusual events such as volcanoes, tsunamis and meteorites can disrupt ecosystems.	TB8 pg 28 prg 85
Human factors are threats also, the activities of people cause more disruption of the world's ecosystem than any natural factors.	TB8 pg 28 prg 86
People cause harm when they remove the natural animals and plants that were in balance with the ecosystem by hunting, poaching, burning and cultivating soil.	TB8 pg 28 prg 86
People also pollute the air, soil and water with chemical substances that are harmful to living things.	TB8 pg 28 prg 86
An unbalanced ecosystem affects what can live there.	TB8 pg 29 prg 87
Activity 2.6 case study about food web from the Southern ocean shows how a change in a factor can have unexpected results.	TB8 pg 29-30 prg 89-91
Example of case studies: lack of food in a game reserve due to drought example elephant in Tsavo National Park, Kenya, Habitat destruction due to farming . Conversion of Brazilian rain forest into grass for cattle ranching, reduced migration by fencing in game reserves , the need to cull elephants in Kruger National Park, The effect of hunting example extinction of the Quagga in the Karoo, Mining –titanium mining on coastal sand dunes	TB8 pg 31 prg 93
Activity 2.7 evaluate the effect of removing an organism from a food web. Questions; what will happen to the population of rats and mice because they are not being preyed upon by hawks, what could happen to the population of mongoose because of the change in population size of the rats and mice, could the loss of hawks affect the population of hadeda ibis, what other populations might be affected by the loss of the hawks in this food web?	TB8 pg 32 prg 96
Poorly adapted organisms become extinct in their environment.	TB8 pg 36 prg 114
Recently progress in technology and medical science has caused an increase in the human population and so we are using more and more of the world's resources.	TB8 pg 38 prg 117
Already through human mismanagement of the environment some plant and animal species have become extinct.	TB8 pg 36 prg 118
Introduced species are not adapted to our environment indigenous species are well adapted	TB8 pg 36 prg 119
Plants and animals that are not naturally form the ecosystem are called aliens	TB8 pg 36 prg 120
Main cause of soil erosion: overgrazing, over cultivating and removing plants to expose soil	TB8 pg 40 prg 129
Pollution harms the soil by damaging the plants and kill the soil organisms that make humus.	TB8 pg 40 prg 130
Acid rain is a threat also it destroys the life in many rivers and damages plants.	TB8 pg 41 prg 131
In South Africa power stations are main source of acid rain	TB8 pg 41 prg 131
Coal, wood and charcoal fires in houses give out poisonous gases in rural areas where population is over large area they cause less damage whereas in towns smoke from domestic fires and heaters can cause lung diseases.(pictorial illustration figure 2,37)	TB8 pg 41 prg 131
Activity 2. 11 write about the effects of some irresponsible human behaviors on ecosystems.	TB8 pg 42 prg 134
Although fungi are useful decomposers some cause diseases	TB8 pg 50 prg 148

Prostists live in animal bodies and cause disease example Malaria which lives in human body and kills many thousands people in Africa	TB8 pg 48 prg 149
Pathogens are also organisms that causes diseases examples AIDS disease caused by virus, tuberculosis caused by bacterium, malaria caused by protest.	TB8 pg 52 prg 153-163
Almost 500 million people are infected with Malaria from mosquitoes a year	TB8 pg 52 prg 162
Waterborne diseases are very dangerous; Every year more than three and a half million of people die from diseases carried in water, diarrhea is the most common. Cholera is an example of serious disease that causes diarrhea	TB8 pg 53-54 prg 166
CONSERVING AND SUSTAINABILITY	
There is a population of elephants living in the Kruger National Park	TB8 pg 13 prg 32
Natural habitats that are conserved gives people great pleasure and tourist attractions that generate money which can be used for the maintenance and development of protected areas.	TB8 pg 39 prg 122
" The care full use of natural resources is called conservation"	TB8 pg 38 prg 117
Conserving living things	TB8 pg 38 prg 118
Keeping biodiversity intact by conserving all the living organisms it contains is very important.	TB8 pg 38 prg 119
There are many reasons to conserve the living organisms in our ecosystems.	T8 pg 38 prg 119
Environmentalists try to manage ecosystems carefully so that they will still benefit future generations of people.	T8 pg 38 prg 119
Detecting pollution earlier can help us to save wild organisms which are sensitive to pollution hence conserving our environment.	TB8 pg 39 prg 121
It is therefore important that environmentalists conserve indigenous animals and plants in game reserves.	TB8 pg 39 prg 122
Money generated from game reserves can be used for the maintenance and development of protected areas.	TB8 pg 39 prg 122
One such area in South Africa is in the Drakensberg Mountain, it is a small part of the Maloti /Drakensberg Trans frontier Conservation Area. It is established to protect the special ecosystems of the area and our water supply.	TB8 pg 39 prg 122
We therefore also need to conserve and protect our soil from erosion and pollution.	TB8 pg 40 prg 127
Individuals can contribute to conservation	TB8 pg 41 prg 132
Conserving ecosystems help people to lead healthier lives.	TB8 pg 41 prg 132
Each of us can help choose conservation by what we do and how we live because conversation is everyone's responsibility.	TB8 pg 41 prg 132
Activity 2.10 write about the importance of biodiversity and sustainability	TB8 pg 41 prg 133
Learners are to find out how biodiversity can be maintained and the importance of using natural resources sustainably.	TB8 pg 41- 42 prg 133
Maintenance of biodiversity in ecosystems and sustainable use of resources	TB8 pg 41 prg 133
Each person's action to help conserve the environment and to keep it safe and healthy.	TB8 pg 41 prg 132
Safe disposal of human waste such as urine and faeces, carful disposal of other household waste. Applying three R's: Reduce, Recycle, Reuse	TB8 pg 41 prg 132
Activity 2.11 learners write about three ways to keep our local environment healthy	TB8 pg 42 prg 134
Educating people to boil untreated water before use to prevent cholera outbreaks, providing waterborne sewage or carefully designed pit latrines and educating people about the importance of using them correctly. Washing carefully after using the toilet and before handling food.	TB8 pg 55 prg 169
To avoid malaria we should remove stagnant water, use mosquito nets, protect windows with screens and use mosquito repellent and creams.	TB8 pg 55 prg 169
Being careful with fresh water because diseases that are carried in water cause more deaths of children than any other thing.	TB8 pg 55 prg 171

Modern science actions such as use of antiseptics, pasteurization, use of antibiotics, immunizations, poliomyelitis- used to kill polio virus which had killed and maimed millions of children each year.	TB8 pg 55 prg 173-176
RESTORATIVE ACTIONS	
Environmentalists try to conserve places for different kinds of plants and animals in our planets. At the same time conservation areas also help us to conserve the natural resources we need.	TB8 pg 39 prg 123
Environmentalists have the important job of trying to conserve and preserve wetlands.	TB8 pg 40 prg 126

Appendix K: Analytical Memo Grade 9 Textbook

EXTRACT	SOURCE
ECOSYSTEM SERVICES VALUING	
No evidence of Ecosystem services valuing	
THREATS TO BIODIVERSITY	
South Africa is fortunate to have rich mineral deposits. However this significant economic activity has major environmental impacts such as:-- creation of mine dumps, pollution of water, resources damage to places with high tourist or cultural heritage value, loss of farming and wild life environments	TB9 pg 178-179
Too much ultraviolet radiation also is a threat to life on Earth ;human health, photosynthesis, life cycles and sizes of populations of species	TB9 pg 186
The greenhouse effect which is a natural phenomenon .It warms the atmosphere sufficiently to sustain life.	TB9 pg 187
This is how the natural greenhouse effects works. The greenhouse gases trap the ultraviolet radiation which then warms the air closest to the surface of the Earth.	TB9 pg 187
"The most common greenhouse gases are carbon dioxide, water vapor and methane."	TB9 pg 187
An increase in greenhouse gases leads to global warming. Global warming is a potentially life threatening problem on Earth.	TB9 pg 188
"Global warming could lead to:-climate change, rising sea levels, food shortages and mass extinctions".	TB9 pg 188
CONSERVING AND SUSTAINABILITY	
Department of Mineral and Energy regulates mining industry in South Africa. Government to put in drastic actions to cut back the use of fossil fuels.	TB9 pg 188
RESORATIVE ACTIONS	
No evidence of restorative actions	

Appendix L: Category Sheet for Interviews

CATEGORY	
CATEGORY 1:Phases of recontextualisation=Development of CAPS	What happens there?
CATEGORY 2: Recontextualisation process=Implementation phase	
CATEGORY 3:Role players/actors	

Appendix M: Analytical Memo for Interviews

CATEGORY 1:Phases of recontextualisation=Development of CAPS	What happens there?
Ministerial Task Team to review the Implementation of the National Curriculum Statement Grades R – 12. "I was fortunate to be part of the National Curriculum Statement Review committee members, who made recommendations to writers" (PCint//7)	Made recommendations to writers. Their role was also to ensure that each grade is standardized and there is content and conceptual progression in the CAPS from grade 7-9(PCint//12).
Thereafter the DBE called on all provincial coordinators to communicate the development of CAPS. The Task team was appointed by the minister for all subjects including Natural Sciences.	In charge of Natural Sciences Curriculum and Assessment Policy Statements for the National Curriculum Statement Grades R-12
Writing teams were appointed in January 2010 to develop CAPS for all approved subjects in each grade. Natural Sciences provincial coordinators contributed to knowledge or content in the content and concepts of the curriculum. The strand Earth and beyond for [all] three grades (Grade 7, 8 and 9) was my core during formulation of CAPS as I had a good command of Space Science and Environmental physics specialization" (PCint//15).	In some cases the writing teams were intensified to do this (PCint1//44)
First draft completed and submitted t to the minister by the writers	For approval
Public comments process CAPS documents were sent out for public comment around September 2010. The comments were then collated and the documents revised in relation to the recommendations	public to comment on the newly developed Draft National Curriculum and Assessment Policy Statements.
He explained further that the documents were then approved by the Ministerial Project Committee and sent to editors (PCint//45).	
the CAPS was submitted again to the Minister for her approval and gazetting(PCint//48)	
CATEGORY 2: Recontextualisation process=Implementation phase	
In reflecting on how the CAPS curriculum was then cascaded to teachers and other involved stakeholders. He explains that the Minister of Basic Education declared the CAPS Grades R – 12 as national education policy by the end of April 2011 to be implemented during the period 2012-2014(PCint//52).	
2014 was the first year of Grade 7,8 and 9 CAPS implementation at schools	
"The National Core Training Team trained the provinces which were subject education specialists and other partners such as teacher unions and universities" (PCint//55).	

A workshop was held for all Subjects Specialists by the National Team which were Provincial Coordinators of all provinces(SES1int//14) A workshop was held for all Subjects Specialists by the National Team which were Provincial Coordinators of all provinces.(SES1int//22)	
"NS provincial coordinators visited the training session to support them and report on challenges faced by teachers during implementation" (PCint//13).	
"As SESs we had to train teachers in our districts" (SES1int//24)	
"I had to train my teachers in the district after were trained and all the logistics in terms of materials for training, CAPS policy documents were from both National and Provincial level" (SES2int//17). As SESs we were to collate information regarding content gaps identified during the training process in different districts (SES1int//23).	
Textbooks publisher	
"We just follow the CAPS document and it's a lead to how we write and organise content in textbooks (TBint//8). "We structure it the way CAPS curriculum has been structured. You cannot deviate from CAPS. If the topic or sub topic addresses or focuses on recalling of knowledge you do so also and besides those topics are closely packed you just have to focus on what is required add few pictures and few expanded information because CAPS is just bullet points information, which are just abstract for teacher(TBint//12-14) .	
CATEGORY 3:Role players	What do they do?
Provincial coordinators-NS	part of the National Curriculum Statement Review committee members ,train SESs and support CAPS implementation
Ministerial Task team	Review of the Implementation of the National Curriculum Statement, October 2009 made several recommendations to improve the Curriculum.
National Core Training Team (NCTT)	Training of senior education specialists and other stakeholders
-Wits University-Setlhare Trust Teacher Development	Part of development of CAPS and responsible for teacher training
- Umalusi	Ensure quality of developed CAPS documents
- public	To comment on the newly developed Draft National Curriculum and Assessment Policy Statements.
- Minister of Basic Education	approval and gazetting of CAPS

	Declaration of CAPS as national education policy
- Senior education specialists	Responsible for training teachers and support teachers to implement CAPS
- Ministerial Project Committee	was appointed to oversee the development of Curriculum and Assessment Policy Statements for the National Curriculum Statement Grades R-12
- NGO's- SASOL	Part of development of CAPS
- Politicians	Oversee development and implementation of CAPS
-Teacher unions	To check on the do-ability of the curriculum (PCint//46).
CATEGORY 4: Biodiversity concepts/knowledge	
Commenting on how did the CAPS come up with the content and topics especially biodiversity knowledge. He explains that partly they were taken from the previous NCS documents and other related material (PCint//39)	
The provincial coordinator highlighted the value of biodiversity saying it is important and relevant in schooling as it is one of environmental the topics that you can easily put the content and concepts learnt in context(PCint//17	
concept that support the broader aims of the curriculum by including concepts such as conservation and management of natural resources(PCint//19)	
to teach learners to sort or analyze the animals but they will be able to do that when they have been taught in context. They will know how to classify them; what they eat, sexual reproduction and adaptations. It develops observation skills of everyday life like being able to identify features of different animals (SES1int//15)	
Learners also learn caring principles such as if you destroy things like seeds you destroy and decrease species (SES1int//21).	
they understand concepts such as variation; why human beings or other species are different" (SESint1//20).	
"I value our cultural values because I feel its prior knowledge for learners so I emphasise that teachers do the cultural value of biodiversity thoroughly before they can dwell much on its components like how plants and animals depend on each other, micro-organisms and others(SES2//37)	
cultural values are sometimes lost by learners by explaining that " our learners loose rich culture information because they are not exposed to those old plants like " lengana" for flu that we used traditionally in the olden days(SES2//38)	

Appendix N: Letter requesting permission for an interview with NS PC

Mrs Makwena Mmekwa
8368 Morula View
Mabopane, Pretoria
0196
11 March 2016

[redacted]

NATURAL SCIENCES PROVINCIAL COORDINATOR

Sir

Re: Request to participate in the study.

I am a ***2nd*** year student engaged in a research project titled, **Investigating how biodiversity knowledge is recontextualised in the Grade 7 Natural Sciences CAPS Curriculum** under the supervision of **Dr Ingrid Schudel** of Rhodes University.

My research would be greatly enhanced if I could add your perspective and insights on the above mentioned topic.

I'd be grateful if you could find time to see me or do a Skype meeting, where we could explore your contribution in the curriculum in the form of an oral interview**.** Additional comments relative to the research that might occur to you would be most welcome. Perhaps we could agree to meet or Skype for an hour initially, and if further discussion seems useful we can arrange another meeting.

Furthermore, I would like to assure you that this study has been reviewed and received ethics clearance through Rhodes University Faculty of Education Higher Degrees Committee. However, the final decision about participation is yours. In the event that you have any comments or concerns resulting from your participation in my study, please contact Prof .Mellony Graven Chairperson of Education Higher Degrees Committee at Tel: 046 603 7268; m.graven@ru.ac.za or Prof Di Wilmot at d.wilmot@ru.ac.za ; dean.education@ru.ac.za ; Tel: 046 622 8385

I trust you will agree with me that your work is of high quality in the implementation of the CAPS Curriculum. Your participation in my project will enrich my research base and your insights will enlighten my interpretation of the biodiversity knowledge in Natural Sciences and the CAPS curriculum.

If you decide to participate, you can choose not to answer questions, if you wish, and are free to withdraw from the research project at any time. All research project information, such as audiotapes and notes, will be stored indefinitely in a secure location, accessed only by the researcher. I have attached an abstract of the study and the research proposal and ethics approval letter from Education Higher Degrees Committee.
In case you would like to reach me, my cell number is 083 9731 063 and my e-mail address is mmekwamp@gmail.com.

Looking forward to meeting with you.
Sincerely,
Mmekwa MP

Appendix O: Letter requesting permission for an interview with SES 1

Mrs Makwena Mmekwa

8368 Morula View

Mabopane, Pretoria

0196

07 July 2016

[redacted]

[redacted]

Dear Sir/ Madam

Re: Request to participate in the study.

I am a ***2nd*** year student engaged in a research project titled, **Investigating how biodiversity knowledge is recontextualised in the Senior Phase Natural Sciences CAPS Curriculum** under the supervision of **Dr Ingrid Schudel** of Rhodes University.

My research would be greatly enhanced if I could add your perspective and insights on how you as a textbook publisher take part in the curriculum. I refer to your Grade 7,8, and 9 Learner's Natural Sciences textbooks.

I'd be grateful if you could find time to see me or do a Skype meeting, where we could explore your contribution in the curriculum in the form of an oral interview**.** Additional comments relative to the research that might occur to you would be most welcome. Perhaps we could agree to meet or Skype for an hour initially, and if further discussion seems useful we can arrange another meeting. I'd appreciate as well the names of other persons who were involved in the textbook writing whom I might contact as possible resources for this study.

Furthermore, I would like to assure you that this study has been reviewed and received ethics clearance through Rhodes University Faculty of Education Higher Degrees Committee. However, the final decision about participation is yours. In the event that you have any comments or concerns resulting from your participation in my study, please contact Prof .Mellony Graven Chairperson of Education Higher Degrees Committee at Tel: 046 603 7268; m.graven@ru.ac.za or Prof Di Wilmot at d.wilmot@ru.ac.za ; dean.education@ru.ac.za ; Tel: 046 622 8385

I trust you will agree with me that your textbook is of high quality and easy to use by both learners and teachers. In the implementation of the CAPS Curriculum you made a signal contribution with such a material for teaching and learning. Your participation in my project will enrich my research base and your insights will enlighten my interpretation of the biodiversity knowledge in the Natural Sciences textbook and the CAPS curriculum. This study aims at improving and strengthening

environmental learning in education. The findings of the study will add value to those who are interested in teacher development, curriculum transformation and so forth.

If you decide to participate, you can choose not to answer certain questions, if you wish, and you are free to withdraw from the research project at any time. All research project information, such as audiotapes and notes, will be stored indefinitely in a secure location, accessed only by the researcher. I have attached an abstract of the study and the research proposal and ethics approval letter from Education Higher Degrees Committee.

In case you would like to reach me, my cell number is 083 9731 063 and my e-mail address is mmekwamp@gmail.com .I greatly look forward to meeting with you.

Sincerely,

Mmekwa MP

Appendix P: Letter requesting permission for an interview with SES 2

Mrs Makwena Mmekwa
8368 Morula View
Mabopane, Pretoria
0196
07 July 2016

[redacted]

[redacted]

Dear Sir/ Madam

Re: Request to participate in the study.

I am a ***2nd*** year student engaged in a research project titled, **Investigating how biodiversity knowledge is recontextualised in the Senior Phase Natural Sciences CAPS Curriculum** under the supervision of **Dr Ingrid Schudel** of Rhodes University.

My research would be greatly enhanced if I could add your perspective and insights on how you as a textbook publisher take part in the curriculum. I refer to your Grade 7,8, and 9 Learner's Natural Sciences textbooks.

I'd be grateful if you could find time to see me or do a Skype meeting, where we could explore your contribution in the curriculum in the form of an oral interview**.** Additional comments relative to the research that might occur to you would be most welcome. Perhaps we could agree to meet or Skype for an hour initially, and if further discussion seems useful we can arrange another meeting. I'd appreciate as well the names of other persons who were involved in the textbook writing whom I might contact as possible resources for this study.

Furthermore, I would like to assure you that this study has been reviewed and received ethics clearance through Rhodes University Faculty of Education Higher Degrees Committee. However, the final decision about participation is yours. In the event that you have any comments or concerns resulting from your participation in my study, please contact Prof .Mellony Graven Chairperson of Education Higher Degrees Committee at Tel: 046 603 7268; m.graven@ru.ac.za or Prof Di Wilmot at d.wilmot@ru.ac.za ; dean.education@ru.ac.za ; Tel: 046 622 8385

I trust you will agree with me that your textbook is of high quality and easy to use by both learners and teachers. In the implementation of the CAPS Curriculum you made a signal contribution with such a material for teaching and learning. Your participation in my project will enrich my research base and your insights will enlighten my interpretation of the biodiversity knowledge in the Natural Sciences textbook and the CAPS curriculum. This study aims at improving and strengthening environmental

learning in education. The findings of the study will add value to those who are interested in teacher development, curriculum transformation and so forth.

If you decide to participate, you can choose not to answer certain questions, if you wish, and you are free to withdraw from the research project at any time. All research project information, such as audiotapes and notes, will be stored indefinitely in a secure location, accessed only by the researcher. I have attached an abstract of the study and the research proposal and ethics approval letter from Education Higher Degrees Committee.

In case you would like to reach me, my cell number is 083 9731 063 and my e-mail address is mmekwamp@gmail.com .I greatly look forward to meeting with you.

Sincerely,

Mmekwa MP

Appendix Q: Letter requesting permission for an interview with TB

Mrs Makwena Mmekwa
8368 Morula View
Mabopane, Pretoria
0196
07 July 2016

[redacted]

Dear Sir/ Madam

Re: Request to participate in the study.

I am a ***2nd*** year student engaged in a research project titled, **Investigating how biodiversity knowledge is recontextualised in the Senior Phase Natural Sciences CAPS Curriculum** under the supervision of **Dr Ingrid Schudel** of Rhodes University.

My research would be greatly enhanced if I could add your perspective and insights on how you as a textbook publisher take part in the curriculum. I refer to your Grade 7,8, and 9 Learner's Natural Sciences textbooks.

I'd be grateful if you could find time to see me or do a Skype meeting, where we could explore your contribution in the curriculum in the form of an oral interview**.** Additional comments relative to the research that might occur to you would be most welcome. Perhaps we could agree to meet or Skype for an hour initially, and if further discussion seems useful we can arrange another meeting. I'd appreciate as well the names of other persons who were involved in the textbook writing whom I might contact as possible resources for this study.

Furthermore, I would like to assure you that this study has been reviewed and received ethics clearance through Rhodes University Faculty of Education Higher Degrees Committee. However, the final decision about participation is yours. In the event that you have any comments or concerns resulting from your participation in my study, please contact Prof .Mellony Graven Chairperson of Education Higher Degrees Committee at Tel: 046 603 7268; m.graven@ru.ac.za or Prof Di Wilmot at d.wilmot@ru.ac.za ; dean.education@ru.ac.za ; Tel: 046 622 8385

I trust you will agree with me that your textbook is of high quality and easy to use by both learners and teachers. In the implementation of the CAPS Curriculum you made a signal contribution with such a material for teaching and learning. Your participation in my project will enrich my research base and your insights will enlighten my interpretation of the biodiversity knowledge in the Natural Sciences textbook and the CAPS curriculum. This study aims at improving and strengthening

environmental learning in education. The findings of the study will add value to those who are interested in teacher development, curriculum transformation and so forth.

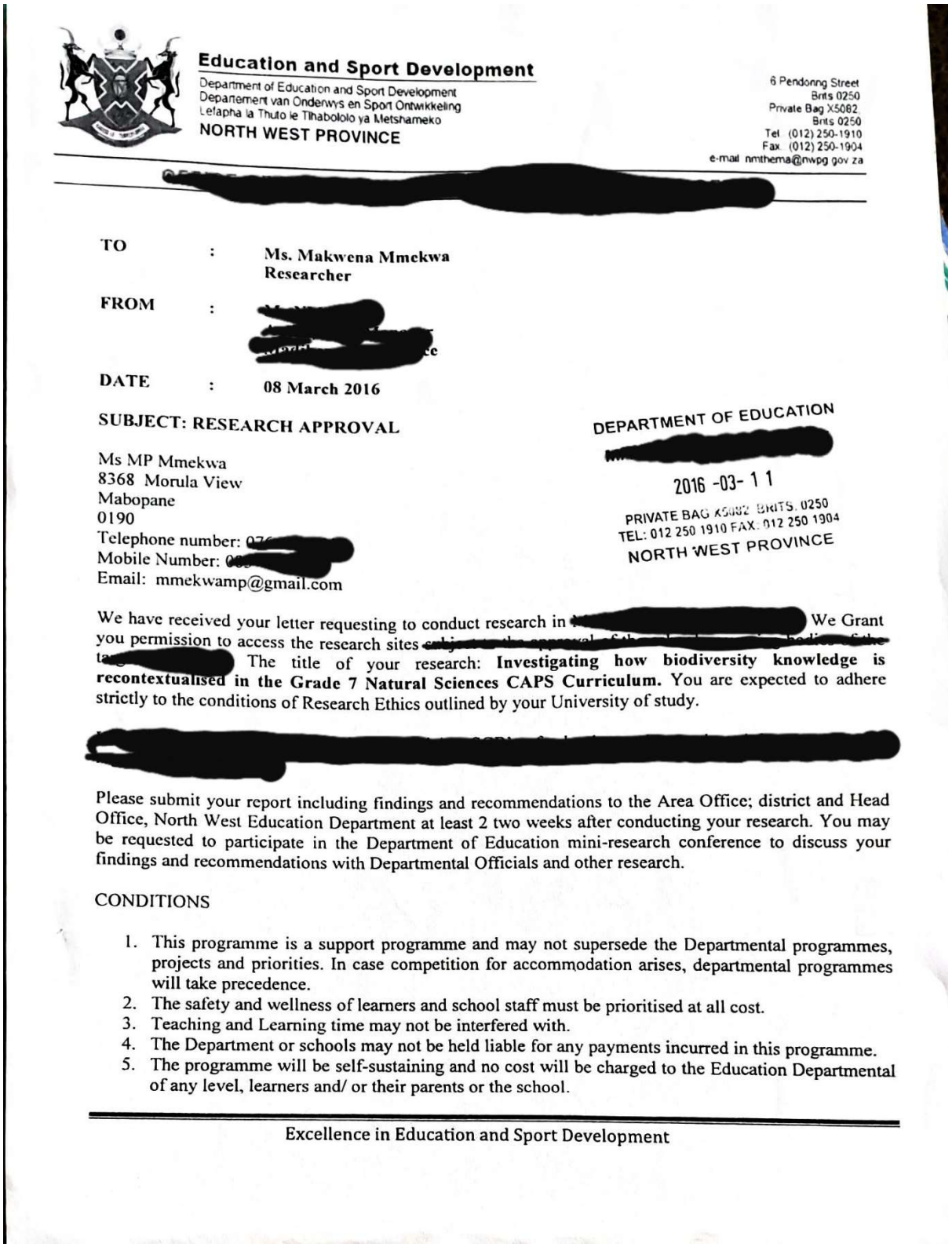
If you decide to participate, you can choose not to answer certain questions, if you wish, and you are free to withdraw from the research project at any time. All research project information, such as audiotapes and notes, will be stored indefinitely in a secure location, accessed only by the researcher. I have attached an abstract of the study and the research proposal and ethics approval letter from Education Higher Degrees Committee.

In case you would like to reach me, my cell number is 083 9731 063 and my e-mail address is mmekwamp@gmail.com .I greatly look forward to meeting with you.

Sincerely,

Mmekwa MP

Appendix R: Research approval from the Department



Education and Sport Development
Department of Education and Sport Development
Departement van Onderwys en Sport Ontwikkeling
Lefapha la Thuto le Tlhabololo ya Metshameko
NORTH WEST PROVINCE

6 Pendoring Street
Brits 0250
Private Bag X5082
Brits 0250
Tel (012) 250-1910
Fax (012) 250-1904
e-mail nmthema@nwpg.gov.za

[redacted]

TO : **Ms. Makwena Mmekwa**
Researcher

FROM : [redacted]

DATE : **08 March 2016**

SUBJECT: RESEARCH APPROVAL

DEPARTMENT OF EDUCATION
[redacted]
2016 -03- 11
PRIVATE BAG X5082 BRITS 0250
TEL: 012 250 1910 FAX: 012 250 1904
NORTH WEST PROVINCE

Ms MP Mmekwa
8368 Morula View
Mabopane
0190
Telephone number: [redacted]
Mobile Number: [redacted]
Email: mmekwamp@gmail.com

We have received your letter requesting to conduct research in [redacted] We Grant you permission to access the research sites [redacted] The title of your research: **Investigating how biodiversity knowledge is recontextualised in the Grade 7 Natural Sciences CAPS Curriculum.** You are expected to adhere strictly to the conditions of Research Ethics outlined by your University of study.

[redacted]

Please submit your report including findings and recommendations to the Area Office; district and Head Office, North West Education Department at least 2 two weeks after conducting your research. You may be requested to participate in the Department of Education mini-research conference to discuss your findings and recommendations with Departmental Officials and other research.

CONDITIONS

1. This programme is a support programme and may not supersede the Departmental programmes, projects and priorities. In case competition for accommodation arises, departmental programmes will take precedence.
2. The safety and wellness of learners and school staff must be prioritised at all cost.
3. Teaching and Learning time may not be interfered with.
4. The Department or schools may not be held liable for any payments incurred in this programme.
5. The programme will be self-sustaining and no cost will be charged to the Education Departmental of any level, learners and/ or their parents or the school.

Excellence in Education and Sport Development

Appendix S: Acknowledgement of Willing Participant in the Study

Fwd: Re: Request to participate in the research study

[redacted]

[redacted]

[redacted]

[redacted]

.

Good Day Ms Mmekwa

This communique serves to acknowledge the receipt of your request for me [redacted] to participate in the research in question. As Provincial Curriculum Advisor for Natural Sciences in [redacted], I'm more than willing to assist and participate in the research and envisage that the output of your research will benefit and add value to Natural Sciences curriculum in general.

The above details my official reply to your request and hope that you will feel free to begin your research conversation as per request letter.

Kind Regards

[redacted]

Appendix T: Grade 7 Pictorial Illustration

The camelthorn tree grows in the Kalahari Desert. It has long roots that reach water deep underground and small leaves to reduce water loss. Its long thorns protect the leaves from being eaten by herbivores, but the seedpods are often eaten by giraffes and elephants. The seeds have a thick coat so that they are not digested in the stomach of animals but the seed coats are softened. The seeds are passed with the animal's droppings and are spread away from the parent plant.

Social weavers live in the Kalahari. They seldom need to drink water. Each flock of social weavers builds a large communal nest that keeps them cool in the day and warm at night. The nest protects the birds from high daytime temperatures.

Did you know?
The seedpods of the camelthorn, *Erioloba acacia*, are made into a nutritious porridge and eaten by local people.

Figure 11 Gemsbok are adapted to survive in deserts.

Figure 12 Leaves and thorns of the camelthorn

Figure 13 Communal nest of social weaver birds

Activity 5 Describe adaptations

1. Explain what an adaptation is.
2. Read the information about the adaptation of organisms to desert environments.
   a) Describe the physical conditions of the desert.
   b) Describe how gemsbok and camel thorn trees are adapted to survive in the Kalahari desert environment.

Key concepts

- Living things need energy, gases, water, soil and correct temperatures to survive.
- Organisms are adapted to the conditions of the environment in which they live.

Appendix U: Grade 8 Pictorial Illustration

Part E: Investigate examples of human interference in the area
Work in small groups.

Step 1 During your visits to investigate the abiotic and biotic factors, you may have noticed places where people have changed the ecosystem in some way. This could be by making paths through the area, by dropping litter, cutting firewood or many other things. Make a list of what you remember noticing.

Step 2 Revisit your ecosystem with your list and record, in paragraphs or by diagrams, some examples of human interference.

Step 3 For each example, suggest how the human changes may have affected the animal and plant populations of the area.

Step 4 Make a presentation of your observations to other groups. Collect examples from the whole class that can be kept for others to use.

Figure 2.8 Litter is one way that humans interfere with ecosystems

Part F: Investigate animal and plant remains in some soil
Work in small groups.

Step 1 Find an area with untouched soil.

Step 2 Collect a small sample of the soil, no more than the amount that would fill a standard (400g) food tin.

Step 3 Take the sample back to the classroom, spread it out on clean, white paper and examine it carefully with the hand lens.

Step 4 Collect any small pieces of leaf, bark, wood, seeds and animal parts (such as pieces of wing, insect leg or other body part) from your sample.

Step 5 Identify each piece as accurately as you can and make a drawing of it.

Step 6 From your investigation, could you conclude that soil contains pieces of animal and plant material?

Step 7 Discuss your results with another group.

Feeding relationships

You have learnt that in any ecosystem the different factors of the ecosystem interact with each other. One of the most important interactions is the way the living organisms depend on each other for food. Ecologists often classify living organisms in an ecosystem by the job they do when feeding. Let us find out about the main groups of living organisms that are classified by the way they feed.

Appendix V: Grade 9 Pictorial Illustration

Unit 5

Greenhouse effect

Key words

- **greenhouse** – a structure made of glass in which plants are grown
- **greenhouse effect** – a warming effect caused by the trapping of energy in the atmosphere
- **greenhouse gases** – gases that absorb Earth's outgoing energy, trapping it in the atmosphere
- **global warming** – an increase in the average temperature of the atmosphere
- **fossil fuel** – are coal, oil and gas made from the remains of plants and animals that lived long ago
- **mass extinctions** – the extinction of one or more species in a short period of time
- **climate change** – long term changes in Earth's temperature and precipitation patterns
- **extinct** – when any species dies out completely it is said to be extinct

A **greenhouse** is a structure made of glass in which plants are grown. You can see a picture of a greenhouse in Figure 21.

Figure 21 A greenhouse is made of glass that traps energy inside it

The glass allows the Sun's energy to pass through it, but does not allow energy out again. The energy is trapped inside the glass house. As result, air inside the greenhouse is warmer than air outside it. The greenhouse has a warming effect on the air.

On Earth, there is a natural **greenhouse effect**. This warms the atmosphere sufficiently to sustain life. Without the greenhouse effect, the atmosphere would be so cold that nothing could survive.

Certain gases in Earth's atmosphere, together with clouds, are responsible for the greenhouse effect. The gases are known as **greenhouse gases**. The most commo greenhouse gases are carbon dioxide, water vapour and methane.

The greenhouse effect on Earth happens as follows. Look at Figure 22 as you read the points below.

- Energy from the Sun passes through the atmosphere, and warms the surfac of Earth.
- The warmed Earth radiates energy back to space.
- The greenhouse gases absorb most of this energy, warming the atmosphe closest to Earth's surface. Without the greenhouse gases, most of the energ would pass out to space and the atmosphere would be much colder. The gases of the atmosphere are similar to the glass of the greenhouse – they energy, making the air warmer than it would otherwise be.

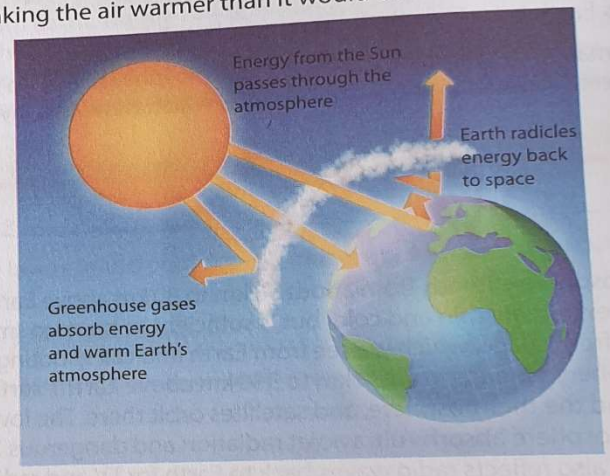


Figure 22 The greenhouse effect

Appendix X: Table consolidating the Biodiversity Key Features in Scientific and Curriculum Documents

BIODIVERSITY KEY FEATURES	ECOSYSTEM SERVICES AND BIODIVERSITY VALUING	BIODIVERSITY THREATS	SUSTAINABILITY AND CONSERVATION	ACTIONS AND RESTORATION
MEA	**ECOSYSTEM SERVICES**: **Provisioning services** (food, water, medicine ,raw materials) **Regulating services**-(maintaining quality of air and soil, control of flood and disease) **Cultural services**-spiritual, tourism, appreciation recreational **Supporting services**- nutrient cycling, soil formation primary production. **BIODIVERSITY VALUING**: **Intrinsic value**- ecological communities, nature working as it is, as in representative portions of natural ecosystems preserved in protected areas **Anthropocentric values**- products that nature can provide: wood, food, fibres. **Aesthetic value**- humans seeking contact with nature, since natural and wild landscapes **Scientific value**- supports economic, social benefits, such as wood, pharmaceuticals, cosmetics and ecosystems services.	**BIODIVERSITY THREATS**: Loss of habitats and degradation Introduction of exotic species Pollution Climate change Over exploitation of resources	**SUSTAINABILITY AND CONSERVATION** Biological systems remaining diverse and productive such a long lived healthy wetlands, forests, rivers etc. remaining diverse and productive. **Conservation:** prevention of waste or loss, preserving and official supervision of rivers, forests and other natural resources and protecting them.	**ACTIONS** **Positive practical activities** Integration of ecosystem management system goals-International, National Environmental agreements-including policies and Acts **Restoring:** Recovering and rehabilitating

SANBI	**ECOSYSTEM SERVICES**: **Provisioning services** (food, water, medicine ,raw materials) **Regulating services**-(maintaining quality of air and soil, control of flood and disease) **Cultural services**-spiritual, tourism, appreciation recreational **Supporting services**- nutrient cycling, soil formation primary production. **BIODIVERSITY VALUING**: **Intrinsic value**- ecological communities, nature working as it is, as in representative portions of natural ecosystems preserved in protected areas **Anthropocentric values**- products that nature can provide: wood, food, fibres. **Aesthetic value**- humans seeking contact with nature, since natural and wild landscapes **Scientific value**- supports economic, social benefits, such as wood, pharmaceuticals, cosmetics and ecosystems services	**BIODIVERSITY THREATS** Loss of habitats and degradation Introduction of exotic species Pollution Climate change Over exploitation of resources	SUSTAINABILITY AND CONSERVATION **Sustainability**: Biological systems remaining diverse and productive such a long lived healthy wetlands, forests, rivers etc. remaining diverse and productive. **Conservation**: prevention of waste or loss, preserving and official supervision of rivers, forests and other natural resources and protecting them	

CAPS – GRADE 7	Foundational knowledge on understanding what makes biodiversity: **plants, animals and microorganisms, and their habitats make up the total biodiversity of the Earth.** Foundational knowledge to species diversity, one of the components of biodiversity -**Classification of living things and diversity of plants and animals** Foundational knowledge to understanding regulatory services- **Procedural knowledge on pollination and importance of pollination** and human environment relation highlighted through **;pollinators play an important role in the production of food crops (such as maize) for humans** Foundational knowledge to understand ecosystem productivity: **variations exists within a species explains that differences between living things of the same species is called variation and that individuals of the same species can reproduce to make more individuals of the same species**	Foundational knowledge to biodiversity loss**. Five main groups (called Kingdoms) of living organisms include Bacteria, Protista, Fungi, Plants and Animals.** **Kingdoms are further subdivided into Phyla/Divisions, then Classes, then Families, then Orders, then Genera, and the smallest group is Species.** **Diversity of animals include Fish, Amphibians, Reptiles, Birds Mammals) and plants diversity (Angiosperms and Gymnosperms monocotyledons and dicotyledons**	Foundational knowledge to understanding healthy biological systems **Requirements for sustaining life- living things need energy, gases, water, soil and favourable temperatures , living things are suited (adapted) to the environment in which they live, such as fish have fins to move easily through water and individuals of the same species can reproduce to make more individuals of the same species.**	Individuals can contribute to conservation in various ways, such as appropriate waste disposal (including recycling, reusing) - environmentalists and others work towards managing ecosystems, such as control of alien vegetation and preservation of wetlands

CAPS – GRADE 8	Foundational knowledge on understanding linkage among human and environment **:Interactions and interdependence within the environment** Conceptual knowledge to understanding relationship between ecology and ecosystem – **ecology is the study of interactions of organisms with one another and with the physical and chemical environment.** - **Study of ecological interactions into four levels; populations, communities, ecosystem and the biosphere.** Conceptual knowledge on ecosystem and procedural knowledge how it works**: all ecosystems combined make up the biosphere** **• an ecosystem consists of an ecological community that includes all living organisms (biotic) such as plants and animals, together with the non-living (abiotic) environment such as temperature, wind, water, interacting as a system** **• the size of an ecosystem is not specifically defined and it usually encompasses a specific, limited area (although it can encompass the entire planet)**	Conceptual knowledge on biodiversity threats**; Identify any human interference in the area (such as litter and pathways.** **- This balance can be disrupted by natural and human factors.** **- Human factors include removing organisms from the ecosystem (such as poaching), human induced pollution.** **- Irresponsible human practices (such as inappropriate waste disposal) and their impact on ecosystems.** **-Suggest possible solutions.** **organisms that are unable to adapt to changes within the environment die out (become extinct.** **- Evaluate disruptions to an ecosystem; giving causes, effects and solutions** Foundational knowledge on understanding conceptual and procedural knowledge on biodiversity loss and threats: **an ecosystem can only accommodate as many organisms as its resources (food, water and shelter) can carry, and it will fail if it does not remain in balance** **• this balance can be disrupted by natural and human factors** **-- natural factors include extreme changes in patterns of weather**	Foundational knowledge on understanding human –nature relations through conceptual knowledge on **-interactions and interdependence in an ecosystem are driven by the need for energy to sustain life** Foundational knowledge to understanding conservation: **individuals can contribute to conservation in various ways, such as appropriate waste disposal (including recycling, reusing)**	

	• ecosystems are defined by the network of interactions among organisms, and between organisms and their environment Foundational knowledge to understanding ecosystem resilience**: survival of individual organisms and populations depends on the its ability to cope with changes (adapt) in its habitat (the place where an organism lives) or in the ecosystem** Foundational knowledge on role of feeding relationships in ecosystem through conceptual knowledge of various organisms: Feeding relationships **between producers, consumers, herbivores ,carnivores, scavengers ,insectivores and decomposers.** Foundational knowledge on regulatory service, soil ecosystems and importance of different component species-**decomposers: breakdown (decompose) the remains of dead plants and animals. They recycle important nutrients in the environment (for example bacteria, fungi, earthworms** Foundational knowledge on how ecosystems maintain themselves by cycling energy-**energy flow food chains and food webs.** Adaptations provides foundational knowledge on ecosystem resilience-**adaptation is the change in the structural, functional and**	**and climate, such as floods, drought, extreme and sudden changes in temperatures** **-- human factors include removing organisms from the ecosystem (such as poaching), human induced pollution** **• these factors can contribute to an imbalance in an ecosystem, seriously impacting on its components and altering its nature** **- organisms that are unable to adapt to changes within the environment die out (become extinct** **-some micro-organisms cause diseases, such as TB (caused by bacteria), AIDS (caused by HI virus), malaria (caused by a protest) and how waterborne diseases (such as cholera and diarrhoea) account for many child deaths**		

	behavioural characteristics of an organism **• adaptation allows the organism to survive as it adapts to changing conditions within the environment** Foundational knowledge on the role of microorganisms in biodiversity: --**some micro-organisms play an essential role in ecosystems, such as decomposing dead plant and animal matter, thereby recycling nutrients in the soil** **• some micro-organisms are used by people for making certain foods (such as yoghurt) and medicines (such as penicillin)**			
CAPS – GRADE 9	Not presented	**Conceptual knowledge on threats caused by mining in SA :** **There is large scale mining activity in South Africa** **• this activity has significant environmental impacts such as** **-- creation of mine dumps** **-- pollution of water resources** **-- damage to places with high tourist or cultural heritage value.** **-- loss of farming and wild life environments** **Procedural knowledge on understanding the effects of pollution: too much ultraviolet radiation interferes with life on**	Not presented	Not presented

		Earth(human health, photosynthesis, life cycles and sizes of populations of species Conceptual knowledge on greenhouse effect, procedural knowledge on how it is a threat to biodiversity and how it leads to global warming: the atmosphere sufficiently to sustain life **• greenhouse gases trap the ultraviolet radiation which then warms the air closest to the surface of the Earth (like inside a greenhouse)** **• the most common greenhouse gases are carbon dioxide, water vapour and methane** **• an increase in greenhouse gases leads to global warming** **• global warming is an increase in the average temperature of the atmosphere** **• global warming is a potentially life threatening problem on Earth. It can lead to:** **-- climate change** **-- rising sea levels** **-- food shortages** **-- mass extinctions**		
TEXTBOOK-GRADE 7	Foundational knowledge to understand ecosystem services: **Survival of living organisms depend on ecosystems: access to water, air, food, space, favorable**	**Sometimes exotic plants can become problematic and are called alien invaders**	Sustainability foundational knowledge to understanding healthy biological systems: **For life to be sustained it**	

	temperatures and protection from enemies. Foundational knowledge to understand biomes and its valuing: **valuing of aquatic and desert biomes.** **Aquatic environments has seaweed such as kelp and fish lives in rivers, lakes and oceans. pictorial illustrations in text book.** **Desert environments are habitats for animals such as Gemsbok which lives in the Kalahari Desert, camelthorn trees which also grows in the Kalahari and Social weavers in the Kalahari.** **The seedpods of the camel thorn, Erioloba acacia are made into a nutritious porridge and eaten by local people.**		**needs; energy, gases, water, soil and favourable temperatures.** **Reproduction sustains life because it ensures that life continues through sexual reproduction, pollination, fertilization and dispersal of seeds and fruits.**	
TEXTBOOK-GRADE 8	Foundational knowledge on understanding linkage among human and environment **:Interactions and interdependence within the environment** Conceptual knowledge to understanding relationship between ecology and ecosystem – **ecology is the study of interactions of**	Progress in Technology and medical science as a threat to world's resource use. Industry and agriculture destroy natural habitats Foundational knowledge on threats to biodiversity: **Harmful micro-organisms**	Foundational knowledge on conservation; **natural resources-living orgainsms, water, soil and air.Renewable(sunlight) and non renewable resources(oil and coal)** Conceptual knowledge on sustainable: sustainable is if it is used in a way that	

	organisms with one another and with the physical and chemical environment. Conceptual knowledge on biodiversity**: The range of living organisms is called biodiversity** - **Study of ecological interactions into four levels; populations, communities, ecosystem and the biosphere.** Conceptual knowledge on indigenous knowledge**: they are better suited for our environment. Indigenous animals controls pests such a bat eared fox eating pests such as rats, white ants. Indigenous plants often contains ingredients that can be used for medicines.** Knowledge on aesthetic value **Reserves give people great pleasure and are tourist attaraction** Conceptual knowledge on ecosystem and procedural knowledge how it works**: all ecosystems combined make up the biosphere** **• an ecosystem consists of an ecological community that includes all living organisms (biotic) such as plants and animals, together with the non-living (abiotic) environment such as temperature, wind, water, interacting as a system**	**• some micro-organisms cause diseases, such as TB (caused by bacteria), AIDS (caused by HI virus), malaria (caused by a protest)** **• disease causing organisms are found almost everywhere, such as at ATMs, handrails of staircases and toilets** **• waterborne diseases (such as cholera and diarrhoea) account for many child deaths** **• effective methods of preventing the spread of diseases caused by micro-organisms include washing hands and sterilising** **• modern scientists such as Louis Pasteur play an important role in identifying and developing cures for some diseases**	does not destroy it so that future generation can also use it. All the living organisms in biodiversity must be conserved to keep it intact. Indigenous animals should be conserved not hunted Indigenous plants and animals should be conserved in game reserves. Reserves give people great pleasure and are tourist attraction. Drakensberg Mountains in SA has small paet of th Maloti/Drakensberg Transfronteir Cpnservation Area of SA which is established to save special ecosystems of the area and water supply. Conceptual and procedura; knowledge on conserving water,soil and air. Individuals can contribute to conservation by safely disposing waste,RRR.	

	• **the size of an ecosystem is not specifically defined and it usually encompasses a specific, limited area (although it can encompass the entire planet)** • **ecosystems are defined by the network of interactions among organisms, and between organisms and their environment** Foundational knowledge to understanding ecosystem resilience**: survival of individual organisms and populations depends on the its ability to cope with changes (adapt) in its habitat (the place where an organism lives) or in the ecosystem** Foundational knowledge on role of feeding relationships in ecosystem through conceptual knowledge of various organisms: Feeding relationships **between producers, consumers, herbivores , carnivores, scavengers ,insectivores and decomposers.** Foundational knowledge on regulatory service, soil ecosystems and importance of different component species-**decomposers: breakdown (decompose) the remains of dead plants and animals. They recycle important nutrients in the environment (for example bacteria, fungi, earthworms** Foundational knowledge on how ecosystems maintain themselves by			

	cycling energy-**energy flow food chains and food webs.** Adaptations provides foundational knowledge on ecosystem resilience-**adaptation is the change in the structural, functional and behavioural characteristics of an organism** **• adaptation allows the organism to survive as it adapts to changing conditions within the environment** Foundational knowledge on the role of microorganisms in biodiversity**:** --s**ome micro-organisms play an essential role in ecosystems, such as decomposing dead plant and animal matter, thereby recycling nutrients in the soil** Biodiversity value and explaining wetlands; Wetlands filter, clean the water and control its flow. They keep our water fresh and clean and reduce the risk of serious floods. **• some micro-organisms are used by people for making certain foods (such as yoghurt) and medicines (such as penicillin)**			
TEXTBOOK-GRADE 9				