conservation education

BIODIVERSITY IN LIFE SCIENCES

A handbook for educators to support biodiversity conservation education in the Cape Floristic Region in the Grades 10-12 Life Sciences curriculum.

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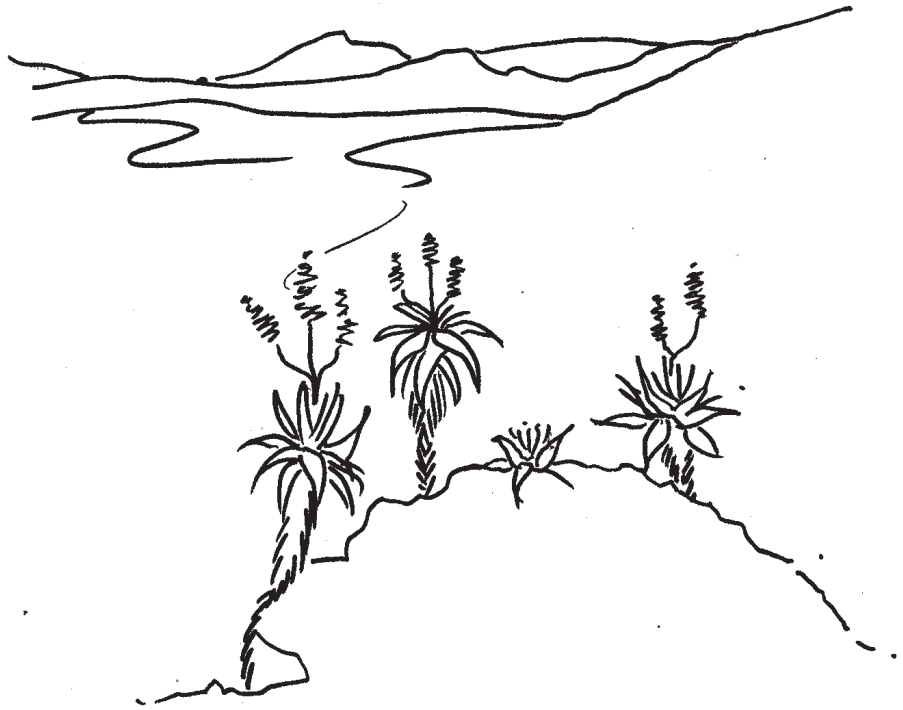
acknowledgements

Prepared by: Dr Glenda Raven on behalf of the
C.A.P.E. Conservation Education Programme
Edited by: Dr Eureta Rosenberg

Proofreading: Mariss Stevens
Artist: Tammy Griffin
Design and layout: Katie Farrington

Contact details: C.A.P.E. Conservation Education Programme Co-ordinator
Rhodes University Environmental Education & Sustainability Unit
PO Box 94, Grahamstown, 6140
Tel: +27-46-622 3432 • Fax: +27-46-636 1495
e-mail: capeccep@ru.ac.za
website: www.capeaction.org.za



contents

1 introduction

In 2000 the Cape Action for People and Environment (C.A.P.E.) was established. The broad aim of C.A.P.E. is to develop and implement a long-term strategy for conserving biodiversity in the terrestrial, marine and freshwater ecosystems of the Cape Floristic Region (CFR). In C.A.P.E., conservation education is seen as the active involvement of all people, from all walks of life, in conserving the region's rich biodiversity, for both present and future communities. In supporting conservation education, the emphasis is on active participation and learning around issues that threaten the biodiversity, and consequent value and benefits, of the CFR.

This booklet, produced by C.A.P.E.'s Conservation Education Programme, aims to support biodiversity conservation education in the CFR. Its focus is Life Sciences in the Grade 10-12 National Curriculum Statement (NCS). The booklet aims to:

- highlight opportunities and possibilities for addressing biodiversity concerns in the Life Science (Grades 10 to 12);
- support planning for, and implementation of, active learning experiences;
- support curriculum planning and implementation in Further Education and Training (FET).

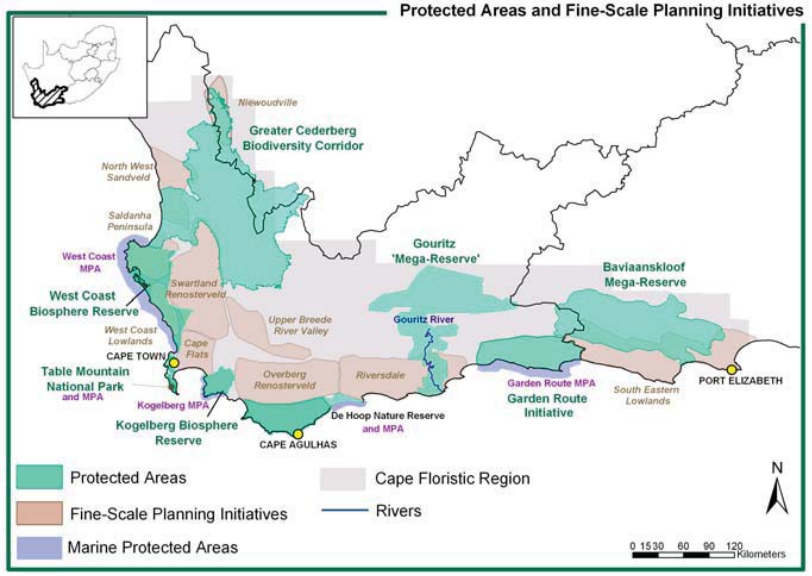


Figure 1: Map of the Cape Floristic Region

The booklet has FET (Grade 10-12) Life Sciences educators in mind. It would also be useful for projects, NGOs and state departments who work with school-based educators to plan and implement the new Life Sciences curriculum.

Please note

This booklet is not a replacement for the National Curriculum Statement. It is a complementary resource to the NCS for Life Sciences. As you work with it, keep the NCS documents at hand.

Section 1, following this introduction, explores the connections between biodiversity, ecosystems and human well-being. Often the sciences are taught as if people do not exist, and conservation has been taught as if people should rather not exist! The NCS, however, gets learners to explore the fundamental relationships between people and the natural world, and between science and society. Section 1 provides educators with contents and concepts which would be particularly useful for teaching in the Environmental Studies context of Life Sciences, towards all the required Learning Outcomes.

Section 2 takes us into the Cape Floristic Region, perhaps the 'hottest hotspot' on earth! Read about biodiversity in the CFR, its value for the people of the region, and the key threats to biodiversity. These topics relate particularly well to the Life Sciences context of Diversity, change and continuity. Section 2 alerts educators to key biodiversity issues in the region and thus to opportunities for exploring local biodiversity concerns relevant to their particular local contexts.

Section 3 is an overview of the key threats to the biodiversity of the CFR. As such it provides valuable content for both diversity, change and continuity and environmental studies in the Life Science curriculum, and explains why the CFR is such an important conservation hotspot.

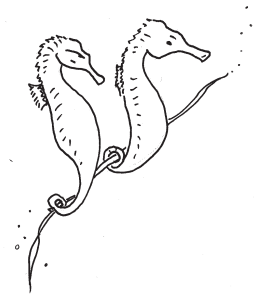
Section 4 reviews what governments have done about biodiversity concerns, in terms of both international and national agreements and policies. It highlights the growing global and local concern about, and responses to threats to biodiversity. These responses include a strong emphasis on education, illustrated by the United Nation's declaration of a Decade of Education for Sustainable Development.

Section 5 zooms in on opportunities and possibilities for biodiversity in the Life Sciences curriculum. These include:

- the principles underpinning the NCS
- the critical outcomes of the NCS
- links between Natural Sciences in Grades 1-12 and Life Sciences in Grades 10-12
- the process skills embedded in the Learning Outcomes and Assessment Standards of Life Sciences
- Life Sciences concepts and contexts
- opportunities for integration between Learning Areas

Section 5 illustrates a number of activities which educators can use to explore issues of biodiversity and ecosystem threats, while teaching towards the Learning Outcomes and Assessment Standards for Life Sciences.

Section 6 is a list of references used in the development of this booklet, which may also be useful in planning for biodiversity conservation education in the Life Sciences curriculum.



2

biodiversity, ecosystems and human well-being

biological diversity, or biodiversity as it is commonly known, refers to the variety of life forms – plants, animals and micro-organisms – that make up ecosystems on Earth. Over the past 50 years in particular, human actions have irreversibly changed the diversity of life on earth. Projections show that the extinction of species and degradation of ecosystems are likely to continue and possibly accelerate, unless something is done to stop the damage caused by modern lifestyles.

Many would argue, from spiritual and ethical points of view, that the diversity of life on Earth has intrinsic value, and that it is worth protecting for its own sake. Biodiversity also has utilitarian value for humankind, in that it makes possible the healthy functioning of the ecosystems which support human beings not only directly, but also by providing the raw materials for economic activity. The following ecosystem services (Millennium Ecosystem Assessment, 2005) are dependent on biodiversity:

- provisioning services such as food, water, timber and fibre;
- regulating services such as the regulation of climate, floods, diseases, wastes and water quality;
- cultural services such as recreation, aesthetic enjoyment and spiritual fulfilment;
- supporting services, such as soil formation, photosynthesis and nutrient cycling.

In recent times, it has become evident that one cannot ignore the interrelationship between people, biodiversity and ecosystems in trying to address threats to biodiversity and degradation of ecosystems. Human beings are an integral part of ecosystems and the diversity of life forms that make up these ecosystems. Given the interrelationship between people, biodiversity and ecosystems, threats to biodiversity and ecosystems could contribute to the decline in human well-being.

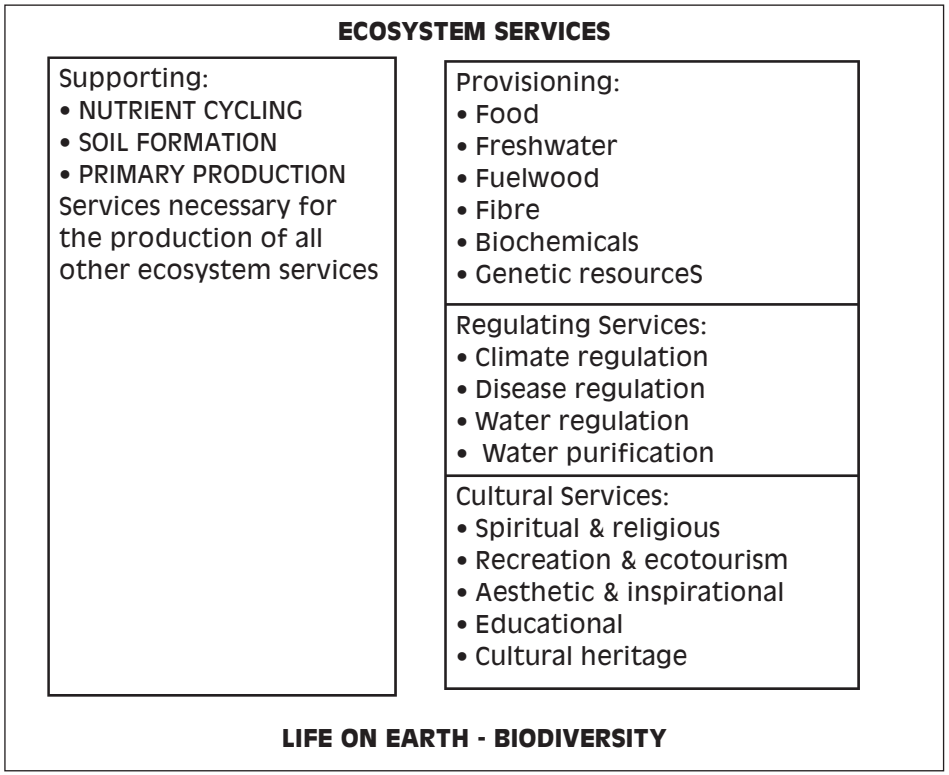


Figure 2: Ecosystem Services (from Millennium Ecosystem Assessment, 2005)

The White Paper on Conservation and Sustainable Use of South Africa's Biological Diversity (1997) recognises biological resources as an important buffer against poverty and as a significant provider of opportunities for self-employment. A large proportion of the South African population derive their livelihood directly from biological resources, such as gathering, harvesting and hunting of animals and plants for food, medicinal purposes, shelter, fuel, building materials and trade. Industries such as fishing, hunting, wildflower collection, horticulture, natural products and wood harvesting, also directly depend on biological resources. As a developing country, biodiversity conservation in South Africa carries central significance, given the levels of dependence on biological resources.

Human actions directly and indirectly affect biodiversity and ecosystems and consequently the benefits that people derive from ecosystems (ecosystems services). Biodiversity loss and the decline of ecosystem services are primarily caused by the conversion of natural ecosystems to human-dominated ecosystems. Some of the most significant causes of biodiversity loss and ecosystems change, globally, include habitat change (caused by changes in land use, the modification of rivers, water withdrawal from rivers, loss of coral reefs and damage to sea floors as a result of trawling), climate change, invasive alien species, overexploitation and pollution.

People-Environment Relations (Millennium Ecosystem Assessment, 2005)

Substantial portions of natural habitat have been changed due to agriculture, urban development, forestry, mining and dams. For example, in the Greater Cederberg region of the CFR, more than 90% of the land surface has been modified for farming purposes. Coupled to this, habitat loss and degradation, overexploitation of species, introduction of exotic species and pollution of air, soil and water, have had significant effects on terrestrial, marine and freshwater biodiversity.

Significant percentages of species have been listed as threatened in the South African Red Data Books, including 15% of plant species, 14% of bird species, 24% of reptiles, 18% of amphibians, 37% of mammals and 22% of all butterfly species. Trends suggest that ecosystems continue to decline with growing and migrating human populations and unsustainable rates of resource consumption.

As a result of degradation to ecosystems and biodiversity loss, human well-being – broadly defined as income and material needs, health, social relations, security and freedom of choice and action – is significantly affected. Though many people have benefited from the manipulation of ecosystems and the exploiting of biological resources over the past fifty years, at the same time, losses in biodiversity and changes to ecosystems have adversely affected the well-being of many other people.

For example, many countries are now experiencing dramatic changes in weather patterns. These changes have included severe droughts or floods that adversely affected food production, for example, and resulted in food shortages as experienced in many African countries in recent times. Changes to weather patterns are thought to be the consequences of excessive pollutants into the common global atmosphere, through intensive industrial processes. While the beneficiaries of this industrial activity may accumulate sufficient material wealth to 'buy themselves out' of the impact of these issues and so avoid the longer-term impacts, such as food shortages, others, the poor in particular, bear the brunt of environmental issues such as climate change.

This example illustrates how people are centrally linked within ecosystems, and that threats to biodiversity and ecosystems are inextricably linked to human well-being.

South Africa has a history of socially unjust laws, creating unequal access to natural resources amongst the broader population. For example, the majority of people were denied access to fertile land and were disproportionately affected by environmental degradation, for example, soil erosion in the former homelands, or air pollution from coal stoves. Consequences of these unjust laws are still evident after apartheid, and are impacting negatively on the environment and biological resources. For example, the post-apartheid period is characterised by increased migration and urbanisation, increasing the demand for land and ecosystems services in urban areas. In many of these areas there is still a lack of adequate waste management, and raw sewage and other waste can be found in rivers, vleis and estuaries. Local species are affected and people become sick. Polluted wetlands and rivers are more easily filled in or converted to canals – and by then they have lost both their biodiversity, and their capacity to reduce flood damage or breed fish stocks. It is thus clear that biodiversity issues are not just about protecting plants and animals, but are also directly connected to human well-being.

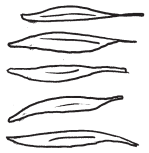
In line with international thinking, this view of people centrally connected within ecosystems and biodiversity is reflected in a range of new policies that seeks to reconcile issues of development and conservation in post-apartheid South Africa. These policies include the new curriculum (see Section 4).

3

the Cape Floristic Region – the hottest hotspot?

Located in the CFR, the Cape Floral Kingdom is the smallest of the world's six floral kingdoms and the only one that is located entirely in one country. It spans an area of 90 000 square kilometres across three provinces, namely the Eastern, Northern and Western Cape (see Map in Introduction). Its uniqueness lies in the astonishing variety of life found here. Despite being the smallest of the floral kingdoms, it boasts more types of indigenous plants than found in any other similar sized surface area on Earth. In addition, about 70% of its plant species are endemic, that is, they are found nowhere else on Earth.

The uniqueness of the CFR lies in the extent of diversity found here, reflected in the following extract:



The Unique Biodiversity of the CFR

Plants

The CFR is home to the greatest non-tropical concentration of higher plant species in the world with 8 200 species found in a relatively small land area (90 000km^2). 5 682 or 69% of these species are endemic, that is, they are found nowhere else in the world. The CFR is also the only region that encompasses an entire floral kingdom, with six of South Africa's ten endemic plant families and 193 endemic genera found within its borders. Amongst the well-known plant species of the region is South Africa's national flower, the King Protea (*Protea cynaroides*), and the Red Disa (*Disa uniflora*). Endemism is also significant on a smaller scale; for example, a single, isolated limestone outcrop of 1,5 squared kilometres is home to four different endemic plant species.

Fish

The total vertebrate diversity of the CFR, of 592 species, includes 68 endemic fish species. The Knysna Seahorse is the most endangered seahorse in the world.

Birds

Diversity in bird species is relatively low, thought to be the result of limited structure in the vegetation and a shortage of available food. Nonetheless, 288 land birds are found in the CFR, of which six are endemic. Four of these endemic species are restricted to fynbos habitats, namely the Cape Sugar bird, the Orange-breasted Sunbird, the Protea Canary and the Cape Siskin.

Mammals

While the Cape region never supported large concentrations of animals, it did once have significant populations of many of the well-known large mammals, including Eland, Buffalo, Lion, Black Rhinoceros, Hippopotamus, Elephant and Zebra. Nearly all of these populations have disappeared or have been reduced to small remnant groups. Species like the Blue Buck, Quagga and Cape Lion have become extinct. One of the remaining large mammals is the Bontebok, which faced extinction in the mid-1800s. The Bontebok currently numbers 2000 due to dedicated conservation efforts.

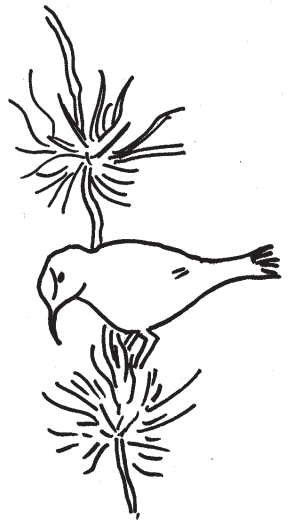
Reptiles

The CFR has 109 reptile species of which 19 are endemic. The region has an impressive diversity of tortoise species. South Africa is recognised as having the highest tortoise diversity in the world and five of these species are found almost exclusively in the CFR. Two of these, the Geometric Tortoise and the Southern Speckled Padloper are amongst the 25 most endangered tortoise species in the world. There are six species of endemic Dwarf Chameleons in the Cape Fold Mountains, one of which is the highly endangered Cape Dwarf Chameleon.

Amphibians

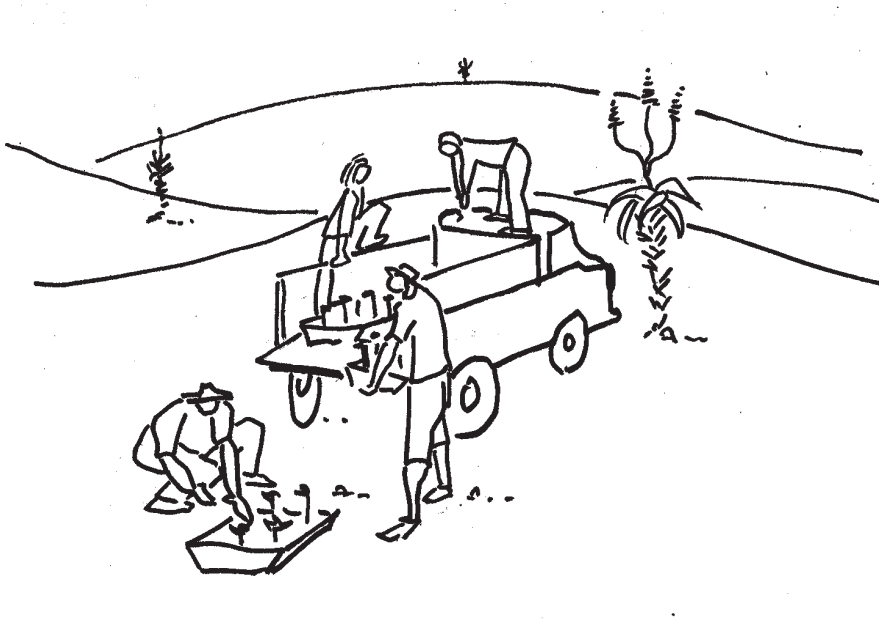
The region has 33 amphibian species of which 19 are endemic. The Micro Frog from the Cape Lowland Fynbos and Rose's Ghost Frog that lives on Table Mountain are two critically endangered species that are close to extinction.

Adapted from a report for C.A.P.E. by J. Turpie, 2000
Extra information from the IUCN Red Data Book website



The rich diversity of biological resources in the CFR has long been a source of economic benefit and of sustaining livelihoods. For example, the well-known fynbos of the region provides a wealth of cut flowers and garden plants. The socio-economic benefits of plants used for herbal teas, perfumes and thatching are increasingly being recognised as they have more recently come to provide significant opportunities for job creation. The biological diversity of the CFR attracts millions of national and international visitors per year, with numbers steadily increasing in one of the fastest-growing sectors of the economy. However, unmanaged exploitation of these benefits can not only contribute to the loss of these rich and diverse biological resources, but also compromise potential benefits derived from them.

The CFR has been identified as one of the world's most important biodiversity conservation 'hotspots', given its richness of species, but also the level of threats to these species. Due to various factors, most associated with unchecked developments, various species in the CFR are under threat. For example, 1 400 of its plant species are either endangered or close to extinction. Various freshwater fish species face extinction, and some marine and shellfish stocks including abalone (perlemoen) are very low. Factors causing these trends are reviewed next.



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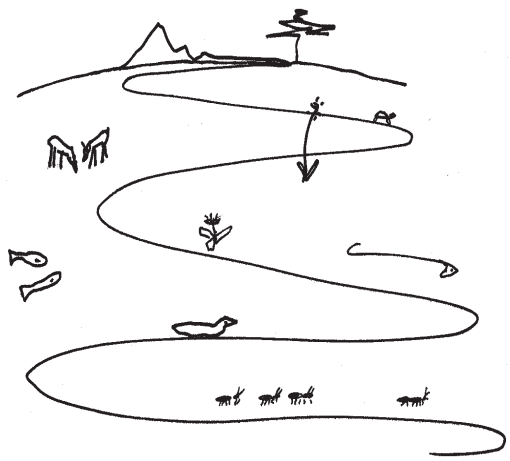
threats to biodiversity in the CFR



Key factors threatening biodiversity in the CFR are:

- *Land transformation and habitat loss*

Land transformation is considered to be one of the biggest threats to biodiversity in South Africa. Land is transformed from its natural state by activities such as cultivation, grazing, urban developments, afforestation, mining and the introduction of invasive alien plants. Considered to be the primary cause of loss in terrestrial (land-based) biodiversity, land transformation is largely due to social and economic pressures coupled to poor land use planning and management. In the CFR critical factors in land transformation and habitat loss are agricultural development, urbanisation, industrial development and tourism.

- *Over-exploitation*

Several species are being harvested at a rate that exceeds their renewal rate. The public nature of biological resources, particularly, for example, wildflowers, fish and other marine resources, leads to over-utilisation. Recently attempts have been made to control the over-exploitation of biological resources, such as the introduction of quotas for fish and marine resources. However, challenges continue to emerge in balancing the sustainable use of resources for commercial, subsistence and recreational use, particularly in the context of disparate and unequal socio-economic groups in South Africa.

- *Social pressures*

Various social factors impact on biodiversity in the CFR. Poverty creates a heavy reliance on biological resources for sustaining livelihoods. Other causes include population increase, and the associated increase in the demand for goods and services like water and sanitation. In the changing political context since 1994, migration and urbanisation have increased, creating an ever-growing demand for land in urban centres. Examples are the urban periphery of Cape Town in the Western Cape and Port Elizabeth and Uitenhage in the Eastern Cape. The post-apartheid era also continues to show the effects of unequal access to resources – with under-development in some areas and over-consumption in others.

- *Economic pressure*

The constant increase in the demand for consumer goods and the drive towards greater industrial development and economic growth is one of the primary causes of land transformation and habitat loss. The economic benefits associated with the growth in tourism and the construction of upmarket housing estates, often tip the scale against biodiversity conservation and the sustainable use of biological resources. Ironically, if these development patterns continue, they may destroy one of the biggest drawcards for tourism and upmarket housing developments, namely the natural environment.

- *Pollution*

Also associated with unregulated industrial development and over-consumption is the problem of pollution, the emission of waste products into the atmosphere, discharges and dumping in rivers, wetlands and the oceans. This places great pressures on these ecosystems, with an associated loss in biodiversity and decline in ecosystem services.

- *Invasive alien species*

A key threat to biodiversity in the CFR is the introduction and spread of invasive alien species that affect the natural functioning of ecosystems. Many hectares of land have been invaded by alien tree species like Port Jacksons and black wattles, which out-compete local species and use up scarce water. Alien marine and fresh water animal species also pose a threat to local biodiversity.

- *Inadequate management and enforcement*

To address the threats outlined above will require a range of responses, from changes in individual lifestyles to reduce consumption and waste, to better management practices by resource users, and the development and enforcement of laws and policies to better control over-exploitation and destructive developments. Though the policy framework for addressing biodiversity concerns has received much attention in recent years (see Section 4), government's capacity to enforce legal and regulative measures is currently falling short of addressing the increasing scale of threat to biodiversity.

Want to know more?

For more information on threats to biodiversity in the CFR, visit the C.A.P.E. website at www.capeaction.org.za. Threats are also discussed in the State of the Environment Report for South Africa, and in provincial State of the Environment Reports, available on the website of the Department of Environmental Affairs and Tourism, at www.deat.gov.za. You could also access the National Spatial Biodiversity Assessment Report that highlights some of the key threats to biodiversity in different biomes, through links from this website to SANBI. These could be useful resources for educators' use in the planning of lessons, and also as a reference for learners working on projects or other learning activities.

Some specific local issues for consideration in contextual lesson planning

Some of the information in this section might be used to introduce learners to the concept of biodiversity and some of the locally occurring threats. Learners could use this introduction in subsequent activities as they begin to explore the nature of biodiversity issues in their areas and explore potential responses to these issues:

- In the Eastern Cape, much controversy continues around the Coega Development, its projected benefits in terms of economic development and job creation and its potential environmental impacts.

- A recent newspaper carried an article of yet another Golf Estate development in the Southern Cape that has had a significant impact on the environment, even though the legal requirements were adhered to.

- In Cape Town, authorities approved plans for a film studio and associated housing development, which will destroy 20 hectares of seasonal wetlands in Khayalitsha, which are a buffer against flood damage to the surrounding low-income housing, and a biodiversity corridor allowing local species to migrate and survive.

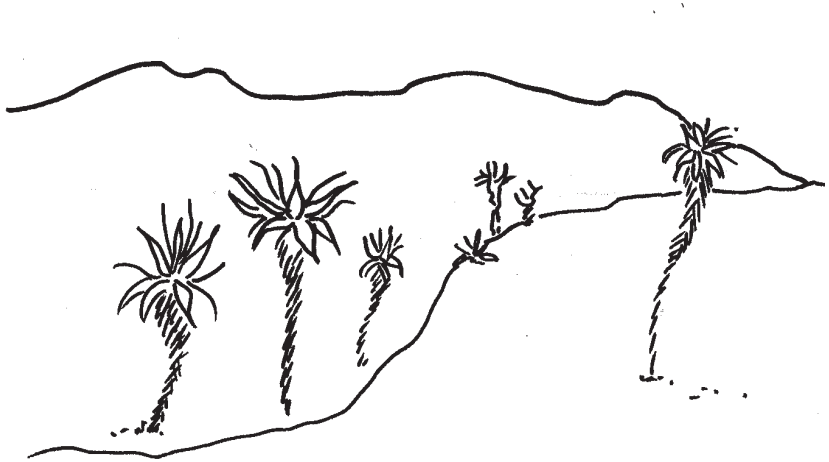
- Several West Coast communities are feeling the impact of the decline in the fishing industry in this region.

- In the Sandveld region, potato farming has contributed to the loss of indigenous renosterveld, and a staggering drop in the water table near Lamberts Bay, which puts future farming prospects in danger.

1. What are some of the issues associated with biodiversity loss and/or ecosystem threats in your local area?
2. Could you use any of these issues in your teaching, and as a basis for a lesson plan?
3. What resources could give more information on these contextual, local issues?
4. Which Learning Outcomes and Assessment Standards could you address through these focus areas?
5. Can you think of learning activities through which learners could explore the issue and use critical thinking and problem-solving skills to come up with solutions?

The level of diversity in the CFR and the extent of the threats to biodiversity outlined above, place a great responsibility on all the people of the region to work towards the wise use of biological resources, so that all can benefit in a fair, equitable and sustainable manner.

In the next section we look at what government has done in terms of national and international agreements and policies. In Section 6, we will focus on what educators can do to address biodiversity conservation concerns.



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what government is doing about biodiversity concerns

This section provides an overview of responses to biodiversity conservation and development issues, through a range of national and international policies, agreements and events. The overview would be useful background for educators planning to address biodiversity in Life Sciences teaching. It might also be useful for guiding learners on a search for information relating to biodiversity issues in a global context.

A possible activity for Grade 12: learners might explore critically the evolving thinking around 'Sustainable Development', 'Ecosystems', 'Conserving Biodiversity', amongst others, through a selection of international and national policies, conventions and debates. Learners could be encouraged to do this through an information search, using some of the ideas in Section 1 as a starting point and exploring how international trends are reflected in national policy, and the possible implications of these policy statements. An activity of this nature could form part of a lesson plan addressing Learning Outcome 2 in Life Sciences, where learners are encouraged to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant in Life Sciences: Interpreting and making meaning of knowledge in Life Sciences: Interpret, organise, analyse, compare and evaluate concepts, principles, laws, theories and models and their application in a variety of contexts (NCS Life Sciences, p.25).

The *Constitution of South Africa* states that:

> *Everyone has the right*
>
> *(a) to an environment that is not harmful to their health or well-being; and*
>
> *(b) to have an environment protected for the benefits of present and future generations through reasonable legislative and other measures that:*
>
> *(i) prevent pollution and ecological degradation;*
>
> *(ii) promote conservation;*
>
> *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.*

A range of policy initiatives reflect a commitment to address these constitutional rights.

- **The National Environmental Management Act, 1998 (NEMA)**

In 1998 Government expressed its commitment to environmental management and sustainable development by adopting the National Environmental Management Act (NEMA). NEMA is a legislative framework which emphasises the need for development that is socially, environmentally and economically sustainable. As part of NEMA, a number of other Acts were put in place, for example the National Water Act and the Biodiversity Conservation Act.

- **The National Biodiversity Conservation Act, 2004**

The National Environmental Management: Biodiversity Conservation Act (2004) has been developed for the management and conservation of South Africa's biological resources, the protection of species and ecosystems under threat, the sustainable use of indigenous biological resources and the fair and equitable sharing of benefits arising from bio-prospecting indigenous biological resources.

The Biodiversity Conservation Act provides the legal framework for the establishment of the South African National Biodiversity Institute (SANBI). Amongst SANBI's first tasks was the development of a National Biodiversity Strategy and Action Plan in 2004 that seeks to translate policy goals into workable strategies and action plans towards the conservation and sustainable use of resources and fair and equitable sharing of benefits arising out of biological resources.

The Department of Environmental Affairs and Tourism's website at www.deat.gov.za provides more detail on the policy framework supporting biodiversity conservation education in South Africa. It also has the detailed National Biodiversity Strategy and Action Plan, that can also be accessed on the South African National Biodiversity Institute website at www.sanbi.ac.za

Our policy and legislative framework not only highlights biodiversity as a key concern in the development of South Africa. It also highlights the importance of conservation education and provides a framework for addressing key environmental and biodiversity concerns through education. Our policies – including our educational policies – reflect the evolving international approach to biodiversity conservation towards a better understanding of the close links between biodiversity, ecosystems, and the well-being of people.

- **The 1995 White Paper on Education and Training**

This early document, which informed subsequent policy developments, states that environmental education, as an interdisciplinary, integrated and active approach, should be an integral element of all education and training programmes at all levels to ensure that:

> ... all South Africans, both present and future, enjoy a decent quality of life through the sustainable use of resources.

• The National Curriculum Statements

The key role of education to support the sustainable use of biological resources for the benefit of all South Africans is reflected in the *National Curriculum Statements for General Education and Training* and *Further Education and Training*. This is reflected in the curriculum framework through the integration of environmental and social concerns into one of the key principles underpinning the curriculum, namely the principle of promoting human rights, inclusivity, environmental and social justice. All subject statements are infused with this principle, which has informed the development of both Critical Outcomes and Learning Outcomes, across all Learning Areas and Subjects. (See Section 5)

The Department of Education has also shown its commitment to addressing environmental issues by agreeing to take the lead in the implementation of the Decade of Education for Sustainable Development, a United Nations initiative discussed next.

• UN Decade of Education for Sustainable Development (2005 – 2014)

The World Summit on Sustainable Development (WSSD, see below) confirmed the significance of education in promoting the objectives of sustainable development, and addressing global concerns such as poverty, rural development, water and sanitation, biodiversity and values. Following the WSSD, the period between 2005 and 2014 was marked by the United Nations as the Decade of Education for Sustainable Development.

The vision for a UN Decade of Education for Sustainable Development is a world where all people have equal opportunity to benefit from quality education and learn the values, behaviour and lifestyles required for a sustainable future and positive transformation of society. Education for Sustainability is seen as being fundamentally about values and respect – respect for present as well as future generations, for difference and diversity, for the environment and the resources of the planet that we inhabit. Some of the key processes envisaged for the Decade include:

- *learning for sustainable development embedded in the whole curriculum* – which has been achieved at a policy level in the NCS (see discussion below) and needs to be further realised through the integration of biodiversity and sustainability issues in classroom practice (which this booklet seeks to support);
- *critical thinking and problem-solving approaches intended to lead to confidence in addressing dilemmas and challenges of sustainable development* – that provide some ideas for developing active learning activities that include critical thinking around, and problem-solving of issues of biodiversity loss, ecosystem degradation and sustainable use of resources.

• The World Summit on Sustainable Development (2002)

The focus of the World Summit on Sustainable Development held in Johannesburg in 2002 was people, planet and prosperity. Much emphasis was placed at the Summit on the alleviation of poverty through sustainable development. Achieving the three objectives of the Convention of Biological

Diversity (see below) was seen as a prerequisite to sustainable development and alleviating poverty. This is further indication of the links being made in the international context between human well-being, biodiversity, ecosystems and sustainable development.

This vision of nature, as inextricably linked to and vitally important to people and their well-being, has developed prominence since the 1992 Earth Summit held in Rio de Janeiro. Here, the language and thinking in the conservation world began to change from an almost exclusive focus on conserving the natural environment, to linking the protection of the environment to issues of development and human well-being. This new approach is reflected not only in national policies, but in a series of international declarations and conventions. Prominent among them is the *Convention on Biological Diversity* (see below).

• The Convention on Biological Diversity (1992)

The *Convention on Biological Diversity* was signed in 1992 during the Rio Earth Summit. It provides the countries of the world with an institutional framework for the development of legislation, policy and scientific initiatives that support the conservation and sustainable use of biological resources.

South Africa became a signatory to the *Convention on Biological Diversity* in 1997. Thus Government committed us to striving towards the conservation and sustainable use of biological resources to the equal benefit of all people.

The *Convention on Biological Diversity* is a landmark treaty in that it tries to overcome the common practice of playing off conservation goals and development goals against each other. In recognising the common concern for conserving biodiversity for both present and future generations, the Convention notes that while key priorities for developing countries are economic and social development and poverty eradication, the conservation and sustainable use of biodiversity is critical for meeting the food, health and other needs of these countries' growing populations.

The objectives of the Convention are:

(a) the conservation of biodiversity;
(b) the sustainable use of biological resources;
(c) the fair and equitable sharing of benefits arising from the use of genetic resources.

Towards these objectives, Article 13 of the Convention states that *Contracting parties shall:*

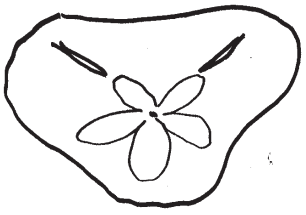
(b) promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes;
(c) cooperate ... in developing educational and public awareness programmes with respect to conservation and sustainable use of biological resources.

This highlights the importance of including biodiversity concerns in educational programmes, to promote the conservation and sustainable use of biological resources.

To support the development of strategies and action plans to implement the obligations of the Convention, the 'ecosystems approach' was recommended to signatories. The ecosystems approach is a strategy for the integrated management, conservation and sustainable use of biological resources in an equitable way. It recognises humans, with their cultural diversity, as an integral part of all ecosystems. Through 12 key principles the ecosystems approach provides practical strategies that support and promote the conservation and sustainable use of biological resources.

If you, your learners or colleagues have an interest in the practical strategies proposed through the ecosystems approach towards managing, conserving and promoting the sustainable use of biological resources, you could explore the details at www.biodiv.org.

This might be useful if you, for example, encourage your learners to explore a practical strategy for managing, conserving and sustainably using biodiversity in their particular region (see Section 5).



More details on the links between biodiversity and the WSSD is available on www.biodiv.org as well as the UNESCO website at www.unesco.org. These are useful sources for:

- accessing information;
- interpreting and making meaning with respect to information of knowledge in life sciences; and
- understanding the application of life sciences knowledge in everyday life;

… and thus the Assessment Standards for Life Sciences Learning Outcome #2,

… in the context of Environmental Studies and Diversity, Change and Continuity

… for Grades 10, 11 and 12. (See Section 5.)

The website www.biodiv.org has more information on this convention. It might be useful for research in lesson planning or for pointing learners towards more information on biodiversity conservation and international trends and developments (see example of activity above).

• The Millennium Ecosystems Assessment (MEA, 2005)

The Millennium Ecosystems Assessment (MEA) was completed in 2005 after a four-year process of assessing the impact of ecosystems change on human well-being. The aim of this assessment was to establish a scientific basis for action to enhance the conservation and sustainable use of ecosystems and their contribution to meeting human needs.

The MEA describes biodiversity as "the diversity of life on Earth … essential for the functioning of ecosystems that underpin the provisioning of ecosystems services that ultimately affect human well-being". It focuses quite centrally on the link between ecosystems and human well-being, and in particular, ecosystem services, underpinned by biodiversity. (See Figure 2 in Section 2)

The Synthesis Report of the Millennium Ecosystem Assessment gives an overview of the key findings of the assessment, including:

- How ecosystems have changed over the past 50 years;
- The gains and losses arising out of ecosystems change;
- Projections of the state of ecosystems for the next 50 years given current trends in development;
- Recommendations for reversing ecosystem degradation.

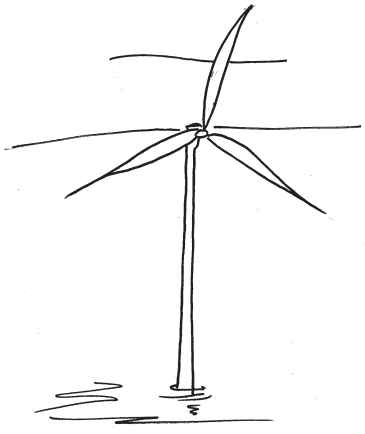
The Synthesis Report also explores key questions about biodiversity conservation and human well-being, for example:

- How have ecosystem changes affected human well-being and poverty alleviation?
- What are the most critical factors causing ecosystem changes?
- What options exist to manage ecosystems sustainably?

The synthesis report is available on the UNESCO website, www.maweb.org, or access it through links from www.biodiv.org.

This report might be useful for exploring biodiversity issues with learners. It can also be a source for learners themselves as they explore critical threats to biodiversity, possible future scenarios and options for slowing down or minimising biodiversity loss.

In exploring how ecosystem degradation could be reversed, the MEA Synthesis Report also notes the significance of public awareness, communication and *education.* It sees these as critical areas in which to promote the objectives of the various environmental conventions and the sustainable management of natural resources.



6

what schools can do: biodiversity in life sciences

This section focuses more closely on the opportunities and possibilities for biodiversity conservation education in the Grade 10-12 Life Sciences curriculum. It includes various activities for teaching and learning in Life Sciences.

• Key Principles of the National Curriculum Statement (NCS)

As noted before, conservationists and governments have started to recognise the strong links between biodiversity, ecosystems and human well-being, which is particularly significant in a developing country context like South Africa. The connection between biodiversity, ecosystems, environmental degradation, sustainable development and human well-being is addressed through various elements of the NCS for Grades 10-12. Like a number of others policies developed to address injustices of the past, the NCS links issues of environmental concern to human rights and social responsibilities. For example, the NCS is based on 12 principles, one of which is *human rights, inclusivity, environmental and social justice* (NCS for Life Sciences, p.1).

Through this curriculum principle, educators and learners are being called to engage with environmental concerns *in relation to* human rights, social justice and inclusivity. This is in keeping with the national and international approach we reviewed in Section 4. The following example shows that it is not difficult to keep human rights, inclusivity and social justice in mind when addressing biodiversity issues in the classroom.

Consider the following example of links between social justice, human rights and environmental concerns:

Many South Africans still live in conditions of under-development as a result of the unjust socio-economic laws of the past (social injustice). Many people live in informal settlements often situated on vulnerable land, close to a wetland or on sand dunes, resulting in habitat disturbance, threat or loss (environmental concerns). Services in these informal settlements, like water, sanitation and waste removal, are inadequate (human rights). This could result in dumping of waste in biologically vulnerable areas, causing habitat loss, pollution, and disease (environmental and human rights concerns).

Many women in informal settlements still collect wood for heat and cooking. Over time this might result in chopping down of growing trees, which could harm soil fertility, biodiversity and a healthy environment. Supplying electricity to marginalised people is a way of addressing human rights, social and environmental justice. However, generating electricity also impacts negatively on biodiversity. Coal power stations use large amounts of water and emit pollution into the atmosphere contributing to greenhouse gases which affects both human health and climate change. Climate change will lead to biodiversity loss (environmental concern) and will most affect those people who have few alternatives, such as subsistence farmers and small-scale fishers (social justice).

If these issues were raised amongst learners who, for example, live in an informal settlement near a wetland, who might feel discriminated against, then the principle of inclusivity in education is violated.

Adapted from: *A Workbook for Developing Lesson Plans with an Environmental Focus in Natural Sciences*, Department of Education, 2004.

• Critical Outcomes

In addition to its underlying principles, the NCS aims to achieve seven Critical Outcomes that are inspired by the Constitution, and which should inform all teaching. Two of the Critical Outcomes provide opportunities for addressing biodiversity and human well-being in the classroom. They are:

- CO #6: Use science and technology effectively and critically by showing responsibility towards the environment and the health of others;

- CO #7: Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

These Critical Outcomes encourage learners to understand basic life processes and the interrelationship and interdependence of components of the biological and social world. It encourages them to explore problem-solving approaches in environmentally and socially responsible ways. This would include inquiry into the complex nature of biodiversity issues and human well-being, and ways of addressing them.

In each subject, Learning Outcomes and Assessment Standards show in greater detail how the curriculum principles and Critical Outcomes can be addressed. Before we consider the relevant Grade 10-12 Learning Outcomes and Assessment Standards for the Life Sciences, we look at what learners are likely to have learnt with regards to biodiversity, in the earlier grades.

• From GET to FET

Biology, as it used to be known, features in the FET band (Grades 10-12) in the subject Life Sciences. In the General Education and Training band (GET, Grades R-9) it features in a Learning Area called Natural Sciences.

Grade 10 learners are likely to have had some previous exposure to biodiversity in the curriculum through the Natural Sciences, which is compulsory. Below is an outline of the opportunities for biodiversity conservation education in Grades 7-9. It alerts educators to the prior knowledge with which learners might enter Grade 10. This potential prior knowledge should be considered in planning for biodiversity conservation education, to ensure progression in what is being taught and learnt. It should also be reviewed in order to establish what learners already know, as a basis for their further learning. The Learning Outcomes which Grade 7-9 learners should achieve are similar to those in the Life Sciences (discussed later). The Natural Sciences Learning Outcomes for Grades 7-9 are:

Natural Sciences Learning Outcome #1: Scientific Investigations

The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts, evident when learners:

- Plan investigations,
- Conduct investigations and collect data,
- Evaluate data and communicate findings.

Natural Sciences Learning Outcome #2: Constructing Scientific Knowledge

The leaner will know and be able to interpret and apply scientific, technological and environmental knowledge, evident when a learner:

- Recalls meaningful information when needed,
- Categorises information to reduce complexity and look for patterns,
- Interprets information.

Natural Sciences Learning Outcome #3: Science, Society and the Environment

The learner is able to demonstrate an understanding of the interrelationship between science and technology, society and the environment, evident when the learner:

- Understands science as a human endeavour in cultural contexts,

Understands sustainable use of the Earth's resources.

The above does not include the varying depth of the Assessment Standards at each grade level. Please consult the National Curriculum Statement for the Natural Sciences for this detail.

The Natural Sciences curriculum specifies the development of process skills (reflected in the Learning Outcomes above) but also some core concepts and knowledge, which have been clustered in four categories. The outline below highlights only those core concepts and knowledge within these categories that link particularly strongly to ecosystems and biodiversity.

Life and living	Interactions in the environment	• Organisms and adaptations • Ecosystems – food webs, biodiversity • Pollution interferes with natural processes • Decomposition and recycling in nature
	Biodiversity, change and continuity	• Loss of biodiversity seriously affects the capacity of ecosystems to sustain life on Earth • Human activities result in the loss of biodiversity

Table continued overleaf...

Energy and change	Energy transfers and systems	• There are an unlimited number of systems which can be made to store or transfer energy, including biomass and ecosystems • Energy in ecosystems
	Energy and development in SA	• Renewable and non-renewable sources of energy • The impact of energy production and mining • Development and poverty relief in relation to energy supply • Trees as a source of energy, associated impacts and precautions
Earth and beyond	Atmosphere and weather	• Biosphere • The atmosphere and its role in protecting the Earth from harmful radiation • Changes in the atmosphere due to natural events and human activities
	The changing earth	• Landforms are the result of constructive and destructive forces • Fossil fuels are non-renewable • Mining and the control of environmental effects of mining
Matter and materials	Properties and uses	• Raw materials must be mined, grown or imported – these processes have environmental impacts

It is evident that learners are most likely to have been exposed to process skills in relation to many concepts and topics associated with biodiversity. When planning lessons for FET learners keep this in mind. You need to ensure that you address these topics at the appropriate level for FET learners. You should also consider an introductory activity that recaps prior learning. The following example might be one way of doing this.

Activity 5.1 – A Biodiversity Quiz

A biodiversity quiz could be a useful activity through which to recap on learners' prior knowledge and to encourage the recall of understandings of biodiversity concepts and knowledge explored in earlier grades. Such a quiz could incorporate some of the following questions (you could also add others):

1. How is biodiversity best described?
2. Name an animal and plant species found in our school grounds or on a nearby nature reserve.
3. Describe one web of interaction between some of the plant and animal species found in our school grounds or on a nearby nature reserve.
4. What are some of the key threats to biodiversity in our area?
5. Name one of the plant or animal species that are under threat in our area.
6. What is the primary cause of this threat?

Some things to consider:

- You could take learners into the field (school grounds or suitable nature area) prior to the quiz.
- You could ask learners in groups to develop a set of questions to ask another group in the class – it might be an idea for learners to formulate these questions during observations in the field.
- Following the quiz to establish prior knowledge, you could ask learners to do an information search around biodiversity issues.
- Consider a process of peer assessment, where one group of learners assesses and evaluates the answers given by another group.
- Instead of a quiz you could develop a worksheet or questionnaire, where you offer learners some options for answering the questions. This would help you establish individual learners' prior knowledge.
- If you find that learners have a limited knowledge of local biodiversity, you could consider a useful 'tuning in' activity, a biodiversity survey (see Activity 5.2). Such a survey could help considerably to deepen learners' knowledge and address a number of process skills and concepts relevant to the FET grades.

Activity 5.2 - A Biodiversity Survey

- This activity could be undertaken as a group project, and over a period of a few weeks. The extended time frame would allow learners to plan their exploration, collect the necessary data, analyse and synthesise the data and communicate their findings. This addresses Assessment Standards for Life Sciences Learning Outcome #1: Scientific Inquiry and Problem-solving Skills.

Divide the class into groups of five or six.

1. Each group chooses a particular geographical area or biome as a focus within which to conduct their biodiversity survey - here learners could be encouraged, through classroom discussions, to motivate for their choice of the particular biome as a focus for their study (identifying phenomena – identifying and motivating for their concern for biodiversity in a particular biome).
2. Each group plans an investigation of the chosen biome and so begins to develop questions around biodiversity in the chosen biome.

Note here that: Grade 10 learners would require more detailed instructions on conducting the investigation, whereas Grade 11 and 12 learners would require less guidance.

Grade 11 and 12 learners would also require more critical interaction

and discussions around the planned investigation in terms of identifying advantages and limitations of the planned investigation (Grade 11) and evaluating the investigative process (Grade 12). See details of assessment in the NCS.

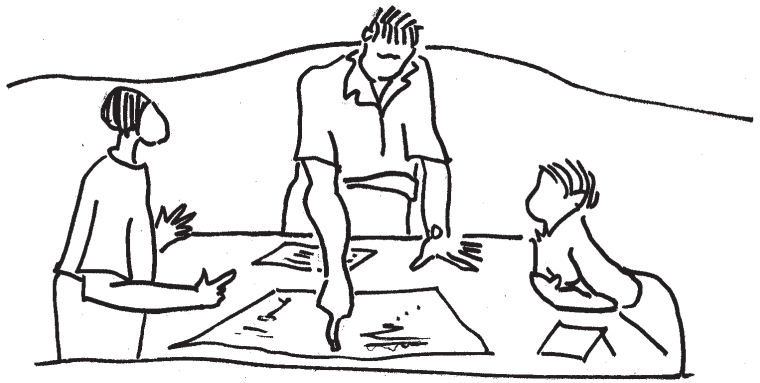
Grade 11 and 12 learners could be encouraged to focus more on variances or factors which impact on biodiversity in the biome, for example, human interactions in ecosystems (e.g. farming, water pollution) or invasive alien plants. Comparing the biodiversity in two areas, one invaded by alien plants like Port Jackson trees, and another free of alien plants, can work well as an introduction to the role of this factor in biodiversity loss.

Explain to learners the ecosystems approach that sees human beings as integral within ecosystems. They could extend their observations of biodiversity in the field with interviews with people in the biome, to find out how people value biodiversity and how they interact within the ecosystem.

4. Learners conduct their investigation (survey) in the field, by measuring out their area and counting and recording the number of species they observe in the area. Learners must be clear whether they are counting numbers of plants and animals observed, or numbers of plant and animal species observed. Note that for comparative purposes, the size of the areas surveyed must be exactly the same.

5. Learners then engage in the analysis, synthesis and evaluation of data. This part of the activity would also have to be carefully guided by the educator. For example, learners would require critical discussion around recognising possible inconsistencies in data (Grade 11), and identifying and using emerging patterns in data (Grade 12).

6. Learners then communicate their findings. Learners in Grade 10 could be encouraged to develop, for example, a fact sheet around 'Biodiversity in the chosen biome (replace with name of biome explored). Grade 11 and 12 learners might be encouraged to develop both a fact sheet and a research report that explains the investigative process they followed. See the details of Assessment Standard #3, Learning Outcome #1 for Grade 11 and Grade 12, which requires learners to do a critical analysis of their investigation. The educators could use the fact sheets and research reports for assessment purposes and include them in the learners' portfolios. If of sufficient quality, they could also be entered for science expos or competitions.



• Life Sciences Learning Outcomes

The NCS defines Life Sciences as …

> … *the systematic study of life in the changing natural and human made environment, involving critical inquiry, reflection, understanding concepts and processes and their application in society.*

With its emphasis on process skills, the Life Sciences require learners to not only grasp knowledge and concepts about biodiversity, ecosystems and the sustainable use of natural resources, it also requires learners to develop process skills such as scientific investigation or inquiry, critical thinking and problem-solving. These skills could be developed in the context of investigating biodiversity, thinking critically about threats to biodiversity, and solving problems in relation to the promotion of biodiversity conservation and human well-being. Learners would then also have an opportunity to articulate the value of taking responsible actions to address biodiversity concerns. Thus the teaching and learning process would involve skills, knowledge and values.

The skills and values referred to are evident in the three Learning Outcomes which learners should achieve in the Life Sciences:

Life Sciences Learning Outcome #1:
Scientific Inquiry and Problem-solving Skills

The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem-solving, critical thinking and other skills.

Assessment Standards

Achievement of Learning Outcome #1 is evident when a learner:

- Identifies and questions phenomena and plans an investigation;
- Conducts an investigation by collecting and manipulating data;
- Analyses, synthesises and evaluates data and communicates findings.

Note: The process skills referred to in the above Assessment Standards for LO1 are very relevant to biodiversity conservation. Issues associated with biodiversity are often complex in nature. For example, we know that unplanned human settlement on vulnerable land is a threat to biodiversity. We also know, however, that there is a great demand for land, that urbanisation is on the increase and that there is a critical shortage of housing in many areas. How do we address the issues?

We also know that various species are threatened. How can further exploitation be prevented, when some people depend on these species for their livelihoods, others rely on them as a means to generating employment and income, and still others engage in large-scale exploitation for economic gain? Responses to these issues are often more appropriate if they are based on reliable information and not mere suspicion, and scientific inquiry skills are clearly critical in providing some of the answers.

Life Sciences supports learners to develop skills to identify a problem, plan an investigation, collect the necessary data (through observation, talking with people, consulting written sources, etc.), make sense of the data (analysis, synthesis) and evaluate the findings. All of these support them in developing concrete and appropriate responses to biodiversity issues and risks.

The levels of attaining the above Assessment Standards progresses from less complex inquiry and problem-solving skills in Grade 10, to more complex skills in Grade 12. Refer to the NCS for details.

Life Sciences Learning Outcome #2: Construction and Application of Life Sciences Knowledge

The learner is able to access, interpret, construct and use Life Sciences concepts to explain phenomena relevant to Life Sciences.

Assessment Standards

Achievement of Learning Outcome #2 is evident when a learner:

- Accesses knowledge;
- Interprets and makes meaning of knowledge in Life Sciences;
- Shows an understanding of the application of Life Sciences knowledge in everyday life.

Perspectives on issues, threats and options to minimise biodiversity loss often differ from one group of people to another. For example, conservationists would react differently to the over-exploitation of abalone, since they may have access to scientific data about the species and the extent of loss. Small-scale fishers, concerned about making enough money to feed their families, might have a different perspective on the threat to abalone than do conservationists. The big business owner or syndicate leader deriving economic benefit from exporting abalone to the Far East, may also have a different argument about abalone and the threat of extinction. How does one decide what to do? In order to participate actively in decision-making and problem-solving around issues of biodiversity loss, ecosystems degradation and sustainable use of resources, and take responsible actions, learners need a sound understanding of biodiversity, ecosystems and sustainability, the threats and options. It also requires laerners to share knowledge and participate in critical conversations about these issues.

Through Learning Outcome #2, Life Sciences helps learners to develop the competence to access information (for example, from printed texts, the internet, their own observations, parents and elders in communities), interpret and make meaning of the information (through reviewing data

from different sources and drawing conclusions) and to understand the application of scientific knowledge in everyday life.

The above Assessment Standards progress from less complex levels of accessing, interpretation and application of knowledge in Grade 10, to more complex levels in Grade 12. Refer to the NCS for details.

Learning Outcome #3: Life Sciences, Technology, Environment and Society

The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society.

In understanding complex issues associated with biodiversity to participate actively in decision-making and problem-solving approaches, learners need to understand how ideas have evolved over time, how environments have changed and why and how different beliefs, attitudes and values shape understandings and actions.

Assessment Standards

The attainment of Learning Outcome #3 is evident when a learner:

- Explores and evaluates scientific ideas of the past and present cultures;
- Compares and evaluates the uses and development of resources and products and their impact on the environment and society; and
- Compares the influence of different beliefs, attitudes and values on scientific knowledge

Learning Outcome #3 encourages learners to explore and compare scientific knowledge of the present and the past, for example, traditional knowledge about medicinal plants, which are today used in scientifically proven medicines and other products. It also allows opportunities for learners to explore in more depth the uses and development of resources and products and their impact on the environment and society. An example might be the sustainable use of medicinal plants now being patented for mass production. The learner is also able to explore how perspectives around biodiversity issues are shaped by beliefs, values and attitudes.

Each of the required Assessment Standards differs in complexity from Grade 10 to Grade 12. Refer to the NCS for details on the degree of complexity appropriate for each grade.

• Content and Context for Biodiversity in Life Sciences

The achievement of the Learning Outcomes outlined above is enabled through working with various concepts and knowledge that are core to the subject. The NCS for Life Sciences outlines four core knowledge areas. They are:

- Tissues, cells and molecular studies;
- Structures and control of processes in basic life systems;
- Environmental studies;
- Diversity, change and continuity.

Opportunities for biodiversity conservation education exist in all these knowledge areas. This booklet will only focus only on the latter two.

Note!

The suggested content and contexts are defined to serve the Learning Outcomes and Assessment Standards and support learning towards these. These concepts and knowledge areas are not ends in themselves, but rather the means to the end of achieving the Learning Outcomes.

The knowledge areas have been developed taking into account the principles underpinning the NCS, and progression from Natural Sciences in GET to Life Sciences in FET, to enable progressive deepening and broadening of integrated thinking patterns through the grades. The four broad knowledge areas apply to each of the three Learning Outcomes and each of the three FET grades. Within the four broad categories, knowledge and concepts have been defined for each of the grades. The next table indicates the ample opportunities for biodiversity education within these knowledge areas.

Environmental Studies			
Learning Outcome	**Concept and Knowledge areas**		
	Grade 10	**Grade 11**	**Grade 12**
LO#1 Scientific enquiry and problem-solving skills	• Investigation of human influence on the environment (e.g. patterns of urbanisation, the introduction of exotic species, over-exploitation of resources; • Management and maintenance of natural resources (e.g. water resources, soil, fishing stocks and other marine resources); • Investigating a local issue, problem-solving and decision-making (e.g. a local threatened species, the impact of a new development on biodiversity).		
LO#2 Construction and application of Life Sciences knowledge	• Biospheres, biomes and ecosystems; • Living and non-living resources, nutrient cycles and energy flow in the environment.	• Human influence on the environment (air, land, water issues); • Sustaining our environment; • Air, land and water borne diseases.	• Local environmental issues; • Effects of pollutants on human physiology and health (e.g. allergies, water-borne diseases like cholera).
LO#3 Life Sciences, technology, environment and society	• Historical developments: indigenous knowledge systems, biotechnology, environment, legislation, social behaviour and ethics; • Exploitation vs. sustainability: exploring issues; • Industrialisation and the impact of industry; • Management, use and abuse of resources; • Eco-tourism; • Air (e.g. ozone, greenhouse effect, global warming, acid rain & consequences); • Waste management; • Rehabilitation of the environment • Land issues (e.g. ownership and use of land, nature and game reserves, agriculture, desertification, forestation and deforestation, urban decay; • Exploring the land issue: politically, legally, economically, ethically, environmentally and other influences.		

Diversity, change and continuity			
Learning outcome	Concept and knowledge areas		
	Grade 10	**Grade 11**	**Grade 12**
LO#1: Scientific inquiry and problem-solving skills	• Planning, conducting and investigating plants and animals - a comparison; • Population studies (see NCS p.39 for details).		

LO#2 Construction and application of Life Sciences knowledge	• Biodiversity of plants and animals and their conservation; • Significance and value of biodiversity to ecosystem function and human survival; • Threats to biodiversity; • Parasitism, diseases.	• Population studies: characteristics of populations; growth; fluctuation; limiting factors. • Social behaviour: predation; competition. • Managing populations.	• Origin of species; evaluation and theories of mass extinction (see NCS p.40 for details).
LO#3 Life Sciences, Technology, Environment and Society	• Historical developments: indigenous knowledge systems, biotechnology, environment, legislation, social behaviour and ethics; • Adaptation and survival; • Sustainable development; • History and the nature of science; • Extinction of species, red data listing and endangered species; • Fossil records, museums, zoos; • Population changes over time; • Beliefs about creation and evolution; contested nature and diverse perspectives.		

Like the Learning Outcomes, the knowledge areas for the Life Sciences clearly provide various opportunities for the exploration of biodiversity and the loss thereof, ecosystem threats (for example, human influence, urbanisation, introducing exotic species), the functioning and management of ecosystems and the wise use of natural resources by exploring, for example, population dynamics, exploitation vs. sustainable use, and the rehabilitation of degraded ecosystems.

Note Again ...

Core knowledge and concepts are not in themselves learning outcomes to be achieved. Instead these are the vehicles to attaining the required Learning Outcomes. As you plan lessons for Life Sciences in the NCS:

- *First, decide on the Learning Outcomes and Assessment Standards you need to address;*
- *Secondly, decide on and select the knowledge areas through which the Learning Outcomes and Assessment Standards could be attained.*

Coupled with the Learning Outcomes of the Life Sciences, this suggested content and context provides opportunities for learners to develop an in-depth understanding of the nature and value of biodiversity, biodiversity loss, ecosystems degradation and the sustainable use of biological resources, and to engage actively in decision-making and problem-solving processes in order to address these issues.

- **Active learning**

As noted before, issues associated with biodiversity and human well-being are often complex. If learners are to really make sense of such issues, and participate actively in decision-making and problem-solving approaches that address them, educators should use an inquiry-based, situated and active approach to teaching and learning. Active learning could start by asking any of the following questions about biodiversity and ecosystems:

- What is there (biodiversity, ecosystems) and how does it work?
- What is changing in our local landscape? What is happening to biodiversity?
- Why is it important? How are people using biodiversity and ecosystem services? What do people value?
- Is there a problem? What are the issues and risks affecting biodiversity and human well-being?
- What is being done? What are communities, government, scientists, industries doing to address the issues and risks?
- What should be done? What more could be done, and what can we do ourselves?

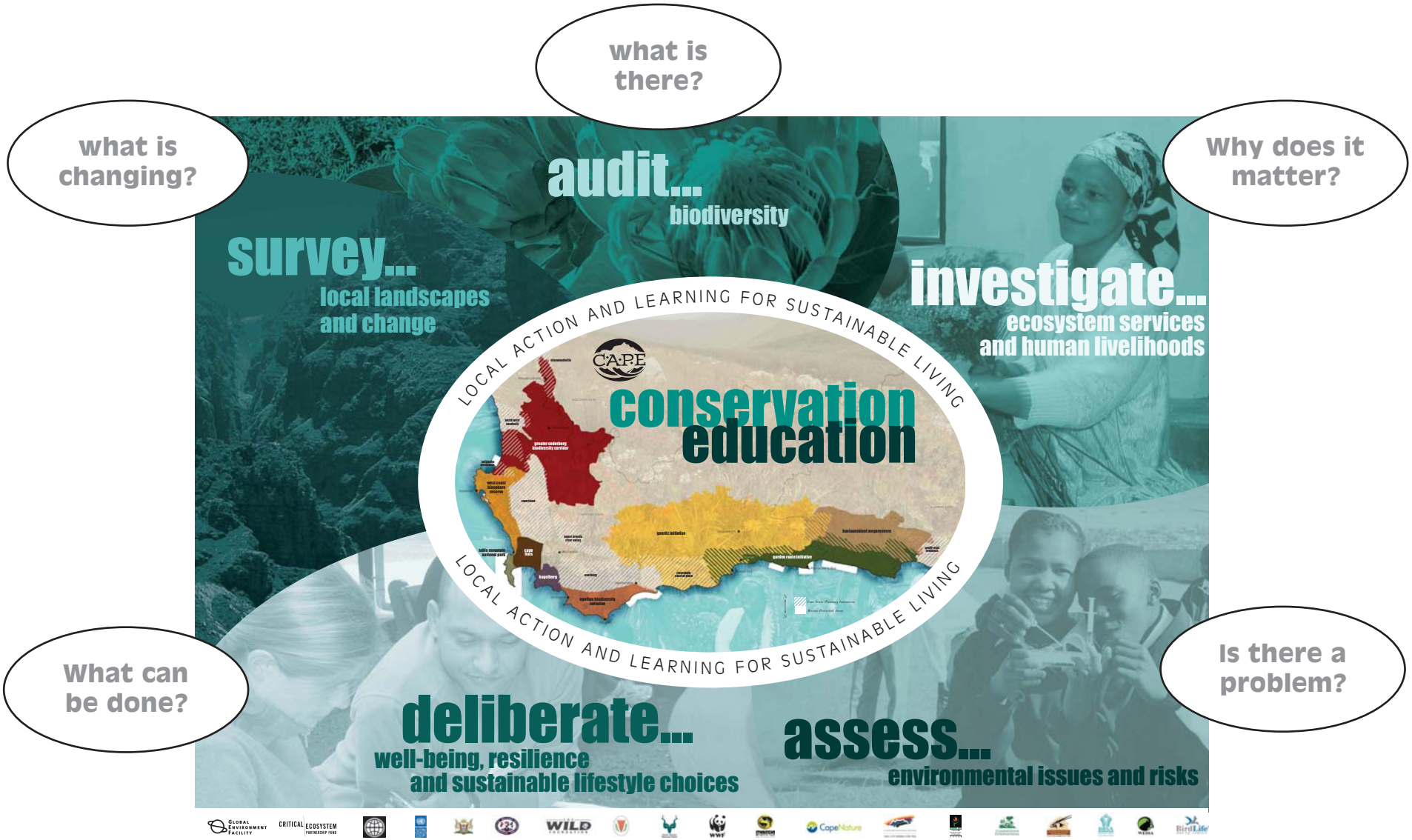
In trying to answer any of these questions, learners would also have to consider:

- What do we already know? And what are the gaps in our knowledge? This could be done by looking at existing research findings and own explorations. Research processes are often strengthened, complemented and duplication averted if learners are able to access and use existing knowledge. In this way learners would (a) work towards LO#2 and (b) focus their investigations on the gaps in knowledge, and what they *do not know* about the issue.

The Life Sciences present many opportunities for exploring these key questions. With biodiversity, ecosystems and human well-being as the focus for learning, within the required Life Sciences knowledge areas (see above), the Learning Outcomes and Assessment Standards provide and indeed require opportunities for contextually situated, active and inquiry-based approaches to teaching and learning, as the following examples will show.

Note

Core concepts and knowledge should be taught in 80% of instruction time in the Life Sciences. A further 20% instruction time is suggested for contextualising Life Sciences concepts and knowledge to local contexts and to integrate local knowledge into the curriculum.



C.A.P.E. Cape Action for People and Environment

(a) What is there?

Learners could survey a local landscape (e.g. a river or open land near the school, a nature reserve, an area invaded by alien plants) after identifying a research question (What biodiversity is there in this area?). Working towards Life Sciences Learning Outcome #1, they would plan the investigation (biodiversity or ecosystems survey), conduct the survey, then make meaning of the data gathered, and communicate their findings. The Biodiversity Survey introduced in Activity 5.2 is an example.

(b) How does it work?

To understand the role of biodiversity, and how ecosystems work, learners could plan and conduct many different kinds of inquiries. And while ecosystems are complex, these inquiries can be kept quite simple if necessary. For example, to understand how wetlands help to clean water, learners could build a 'wetland in a bottle' using a two-litre plastic drink bottle, and filter dirty water through it. To understand how plants work to prevent soil erosion and flood damage, they could build models of slopes with and without plants, and run water down them, comparing the relative speed and loss of soil. Learners could also do field-based investigations, for example, observing plants and animals at the beach or in a forest, using a field guide, then mapping out a food web based on their observations and reading.

(c) What is changing?

Here the focus would be on changes in the landscape and its associated biodiversity and ecosystems. Activity 5.3 below gives an idea of the kinds of learning processes which could flow from this question.

Activity 5.3
Survey Local Landscape Change

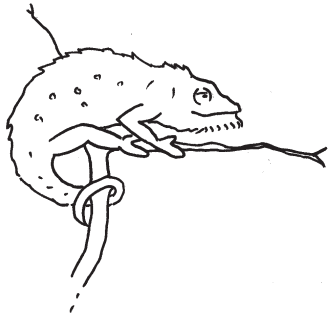
The educator could start this activity by asking learners what changes they have observed or are aware of in their local environment, including the natural landscape. The educator can then choose among their responses a suitable landscape for further investigation – that is, one in which Life Sciences concepts, knowledge and Learning Outcomes could be meaningfully addressed through the learners' own enquiry.

For example, the hills surrounding Grahamstown have changed to grasslands in recent years, as Working for Water teams cleared alien trees (black wattle). Learners could explore these and other associated changes by interviewing local residents who have observed the changes. One group of learners could go further back in time and find library photographs of what the area looked like years ago – was it a grassland ecosystem? Another group of learners could call a representative from Working for Water to find out why the trees have been cleared, and whether it has resulted in more water for Grahamstown. This person may even provide them with GIS maps showing the extent of the clearing. Another group could speak to local residents who have used the black wattle trees for firewood, and who now have to travel further for wood. Other members of the class could investigate whether this has led to an increase in the use of indigenous trees for firewood among local community members.

When compiling all their data and making meaning of their findings, learners could also consider whether removing the black wattle from the hills was a worthwhile response to biodiversity issues, and what more can be done (See question f below).

Other landscape changes learners could investigate include:

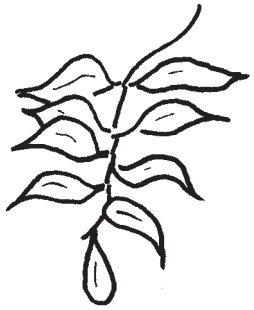
- Changes in rivers and estuaries (e.g. after the introduction of an irrigation scheme)
- Changes in the landscape after veld fires
- The shifting, mining and alien infestation of sand dunes
- Spreading informal housing and upmarket estates in a flood plain
- The building of a new road and associated impacts on biodiversity
- The regeneration of an area after it has been proclaimed a nature reserve
- The introduction of food and indigenous gardens at schools and residents' homes



(d) Why is it important?

Encourage learners to find out how people use ecosystem services, to better understand the connections between people and biological resources, the risks of over-exploitation and possible responses. They could, for example, while working towards Learning Outcome #2, study existing information about ecosystem services to human well-being. The learning focus could be (among others):

- the role of wetlands in the water cycle, or in minimising flood risks
- the role of fynbos in fresh water supplies
- the role of estuaries in the fishing industry (providing a safe breeding ground for fish)
- the role of local ecosystems in industries such as fruit farming, honey production or cattle grazing.



You could also approach the question by asking how people are using biodiversity and ecosystems. Learners could investigate (through internet searches, reading reports and articles or actually interviewing users themselves), how people use natural resources such as:

- buchu
- dekriet
- cut flowers
- crayfish, abalone, line fish or other marine species
- fire wood
- farm land
- fresh water
- forests
- a rocky beach
- a local wetland, river or estuary

  and many others.

At the FET level, multiple data sources should be used, which suits this kind of inquiry. For example, to find out how people are using fresh water, while interviewing or observing their school friends about water use, might be appropriate in the earlier grades. FET learners would not simply interview or observe household (or agricultural or commercial) users, but would also get facts and figures from the municipality and/or Department of Water Affairs. It could then be interesting to compare how use differs in urban and rural areas, in upmarket or low-income areas, or in periods with or without water restrictions. See Activity 5.4 for more ideas for investigating people using natural resources.

Activity 5.4
Humans Using Ecosystem Resources

This group activity gets learners to explore the use of one or more biological resource. It addresses Assessment Standards from Learning Outcome #1, as it requires learners to undertake research and draw on data to understand the use of biological resources, and perhaps to start considering the risks of over-exploitation of the resource. If one included a question on how the resource has been used traditionally and how it is used today, it would also address Learning Outcome #3: Demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, technology, indigenous knowledge, the environment and society.

1. In groups, learners identify biological resources of interest and concern to them and found relatively near to their school. The whole class could investigate one resource (with different groups doing different components of the investigation) or different groups could investigate different resources. Learners in the Overstrand might consider a threatened marine species like abalone (for example) or proteas being harvested for the market. Learners in the Southern Cape might want to investigate forests and forestry, or the use of medicinal plants. Learners in and around Cape Town and Port Elizabeth might consider land use issues in relation to remaining biodiversity in the urban areas. A useful resource to help learners with the often difficult task of identifying an issue is the State of the Environment Report for South Africa and provincial State of Environment Reports. Find these through the Department of Environmental Affairs and Tourism website at www.deat.gov.za.

2. Support learners to develop a research plan through which they investigate how this resource is being used (by whom and for what purposes) and to what extent/at what rate (LO#1 - Plan and conduct an investigation). As noted, the inquiry might also include finding out how the resource was used in the past and how use has changed over time (e.g. interviews with long-standing members of a fishing community, or with the Department of Environmental Affairs' Marine and Coastal Division).

3. Bear in mind the curriculum requirement of using various methods and sources to access relevant information from a variety of contexts. A case study of how one person, household or business uses the resource can be valuable. But if you want FET learners to develop an understanding of the risks of over-exploitation and to engage in problem-solving that seeks to minimise the risk, for example, they would usually have to do more than interview or observe individual users. They would have to investigate the total use of a resource

in a particular area (or nationally and globally). For this they would obviously have to read existing research and overview reports, available for example from environmental watchdog organisations or consultants, conservation agencies and other government departments. This component may introduce them to mathematical modelling and could link well with the population studies component of their curriculum.

4. Upon completion of their investigation, learners could produce an article for the school or community newspaper, a scientific poster or research report in which they (for example) illustrate the past and present uses of the resource, the role of the resource in individual people's lives, and/or the risks posed by present rates of consumption and development.

This activity could be undertaken in all grades, in the knowledge area Environmental Studies: exploitation versus sustainability; management of resources and use and abuse of resources. It could also be undertaken in the knowledge area Diversity, Change and Continuity: sustainable development.

(e) Is there a problem?

Is there some issue or risk associated with the biodiversity and ecosystem services which learners have focused on? Are some natural resources being over-exploited? Are we really running out of water? Should we really be bothered about global warming? Would it matter if we built a housing development in that smelly old wetland?

Depending on the scope of Activity 5.4, it (or similar learner enquiries in the field) could introduce this question. Other ways of finding out whether there is a problem, is to read:

- newspaper articles (good papers increasingly carry stories of environmental issues which not only sensationalise, but give useful information and contact details; FET learners would have to supplement this information with further investigation for a sound understanding of the issues and risks);
- research reports – look out for reader-friendly versions in informal publications by conservation agencies and other environmental groups (e.g. the Wildlife Society's magazine *African Wildlife*, or the Botanical Society's *Veld and Flora*);
- information sheets and reports from high-quality internet sites, e.g. the various United Nations or national and some local government sites.

Another field-based enquiry to answer the question 'Is there a problem?', (and address LO#1 and LO#3) could involve learners in monitoring ecosystem

health.

Activity 5.5
Monitor Ecosystems Health

This activity may involve taking learners on a field trip for their investigative work, for example, testing water quality at a nearby stream, assessing air quality in an industrial area or assessing impact of human activities on vulnerable land, such as a wetland, dune system or heavily used estuary. You could encourage learners to reflect on the local geographical area and to choose a particular environmental issue (e.g. sand mining, bait collection or invasive alien trees) as a focus for their investigation. Or you might want to provide them with some of the details on localised environmental issues, from which they could choose. The latter might be particularly appropriate for a Grade 10 class, and their particular Assessment Standards, which require them to follow instructions in planning and undertaking an investigation.

This activity would address the Assessment Standards for Learning Outcome #1, through which learners must (1) identify an issue as the focus for their investigation, (2) plan and (3) conduct an investigation, (4) analyse, present and (5) communicate data. Draw on some of the pointers in Activity 5.2, in terms of supporting learners' investigative work, and the varying levels of complexity required by the curriculum for Grades 10, 11 and 12.

You may have to support learners in accessing and using the different materials and equipment for undertaking their investigations, for example, water quality testing kits. Before you go out into the field, let learners practise with the equipment in the classroom. Also discuss in class the use and analysis of data generated.

To inform their investigation of water quality, learners might, for example, need to:

1. Access information on water quality testing methods, assessments that have already been done, findings from prior assessments, or information on different perspectives on water quality. Note that Grade 10 learners are required to use a prescribed method of accessing information, Grade 11 learners are encouraged to use various methods to access information and Grade 12 learners are expected to use various methods and sources to access relevant information from a variety of contexts. The detail of Assessment Standards reflects the progression from Grade 10, through Grade 11 to

Grade 12 and highlights the increasing complexity in the development of process skills – consider these carefully in the design of your learning activities.

2. Identify, interpret and evaluate principles, laws, theories and models that inform water quality testing processes to be drawn on in their investigations. Note here too the progression for each grade.

This activity is situated in the knowledge area of Environmental Studies: investigating human influence on the environment and/or investigating a local environmental issue for all grades and is linked to Learning Outcome #1. It could be extended to also address Learning Outcome #2, which requires learners to learn to access, interpret, construct and use Life Sciences concepts to understand and explain the issue they investigated. An added dimension would involve learners in exploring ways to address the issue and thus in problem-solving and decision-making.

(f) What is being done? What can be done?

While working towards Learning Outcomes #3, learners could be encouraged to review critically what is being done in relation to biodiversity issues.

Examples might be:

- alien clearing programmes like volunteer community hacks or Working for Water
- quota systems for threatened marine species
- the establishment and management of protected areas (nature reserves or national parks) to protect biodiversity
- campaigns to reduce wild fires
- catchment management forums
- rehabilitating wetlands
- clean-up campaigns
- banning of plastic bags
- recycling programmes
- building sanitation facilities (toilets, sewage plants)
- water restrictions
- laws against dumping or air pollution
- environmental impact assessments before approving a proposed new development
- application of scientific research.

By choosing and studying one such initiative, learners could assess the appropriateness and effectiveness of these initiatives, and problem-solve around what else could be done to better respond to the issues. They can also consider what is not being done. As noted before, the process skills outlined in Life Sciences encourage learners to do more than simply accumulate knowledge about biodiversity. They actually encourage learners to participate actively in decision-making processes and develop problem-solving approaches to address issues.

Activity 5.6
What Can We Do?

Activities through which learners draw critically on information gathered, engage in responsible decision-making and develop problem-solving approaches (see Learning Outcome #1) to the issues explored could form a concluding activity for activities 5.2 to 5.4. Concluding activities of this nature support learners in drawing on Life Sciences knowledge gained and to apply this knowledge in real life contexts (see Assessment Standards for Learning Outcomes #2 and #3).

Some ideas for activities include, for example:

1. **Grade 10** learners could draw on knowledge gained through their own investigations, to develop a biodiversity policy for their school, community or local authority, through which they highlight some strategies for minimising or averting threat to biodiversity and further degradation of ecosystems. This could address Learning Outcome #1 through which learners draw conclusions from data collected and communicate their findings through developing a problem-solving approach.

2. **Grade 11** learners could be encouraged to undertake a pilot restoration experiment either in their school grounds, at a nearby river or vulnerable land area. As learners decide on, plan and set up a restoration experiment, monitor the process and report on their findings, they would be working towards the achievement of Learning Outcome #1.

3. **Grade 12** learners could undertake a review of international and national biodiversity conservation strategies. They could also be encouraged to review national biodiversity and conservation legislation and to draw on these sources in developing a Biodiversity Conservation Strategy for the CFR, a provincial Biodiversity Conservation Strategy for either the Western or Eastern Cape Province, or a local Biodiversity Conservation Strategy for their own district. This activity could address Learning Outcome #2 in which learners must be able to access, interpret and evaluate data and apply it in the context of everyday life.

4. Across all grades, learners could similarly be encouraged to undertake a critical appraisal of existing biodiversity conservation projects or initiatives (see above for examples). They could undertake this critical appraisal as part of a research project which could be assessed against the Assessment Standards of Learning Outcome #1 which requires the learner to identify a focus, plan the process of critical appraisal, collect necessary data, draw conclusions from this data and make recommendations (for the continuation or discontinuation of the project or initiative, its reorientation or improvement, or additional responses).

Possibilities in other Learning Areas

This booklet focuses on the Life Sciences. However, it is important to note that an understanding of biodiversity and related issues would benefit from the contributions of other subjects in the FET curriculum. The next section shows how educators working in the Life Sciences can integrate with learning from other subject areas. It also provides an idea of the kinds of learning related to biodiversity concerns, which other subjects can address.

Several of the previous activity examples in the booklet reflect integration across Learning Outcomes within the subject of Life Sciences. But educators can also integrate learning between subjects. For example, one could integrate between a Life Sciences Learning Outcome and a Learning Outcome for Tourism, using science process skills to explore possibilities for an eco-tourism project. Or Life Sciences Learning Outcomes could be integrated with a Learning Outcome from Business Studies, through which learners consider the potential impact of business or production operations on biodiversity and ecosystems health.

The following suggestions are by no means an exhaustive list and you might have other ideas for integration across subjects, relevant to your particular subject framework and the context of your school and learners.

• Tourism

One of the key focus areas defining the scope of the Tourism subject in the NCS is the *promotion of responsible and sustainable tourism*. Through this

key focus, learners are introduced to the concept of resource management and its relationship to sustainable and responsible tourism.

Responsible and sustainable tourism is further clarified in the Tourism Learning Outcome #2, through which:

> … *learners are able to demonstrate an understanding of the importance and benefit of responsible and sustainable tourism on social, economic and environmental growth*

Educators will know that learners have achieved this Learning Outcome when the learners are to:

Grade 10	Grade 11	Grade 12
• Show an understanding of 'environment', 'eco-tourism' and 'sustainable and responsible tourism'. • Examine the role of the community in protecting the environment.	• Evaluate the environmental components in the local community that are indicative of tourism potential; • Draft an implementation plan to upgrade and maintain the local environment.	• Evaluate environmental, social and economic factors impacting on sustainable and responsible tourism development. • Investigate and report on strategies that are in place globally to protect the environment.

These Tourism Assessment Standards highlight the potential for addressing biodiversity ecosystems and sustainable development in the subject, and begin to suggest the opportunities for integration with the Life Sciences (bearing in mind that both Tourism and Life Sciences are optional subjects, so not all learners in a class may take the same subjects). The NCS for Tourism also outlines suggested content and context through which to promote the attainment of these Outcomes and Standards, including the following:

Grade 10	Grade 11	Grade 12
• Understand eco-tourism, environment and sustainable and responsible tourism; • Identify elements that contribute to an eco-friendly tourist destination; • Understand the importance and value of conserving heritage for future generations.	• Make decisions on how scarce and sensitive resources could be protected, upgraded and maintained in the context of promoting tourism.	• Identify resources integral to sustainable and responsible tourism; • Show an awareness of approaches and debates on responsible and sustainable tourism.

Examples of integration with the Life Sciences subject include:

For Grade 10 learners		
Tourism Assessment Standards	**Tourism Suggested Content and Context**	**Suggestions For Possible Integration with Life Sciences**
• Show an understanding of 'environment', 'eco-tourism' and 'sustainable and responsible tourism'. • Examine the role of the community in protecting the environment.	• Understand eco-tourism, environment and sustainable and responsible tourism; • Identify elements that contribute to an eco-friendly tourist destination; • Understand the importance and value of conserving heritage for future generations.	Activity 5.2 – A Biodiversity Survey could help learners understand the importance and value of conserving heritage for future generations. Activity 5.3 – Ecosystem Survey would help learners to better understand inter-relationships such as nutrient cycles and food webs, and why it would be important to protect them. Activity 5.4 – Human Use of Ecosystems: Enquiries into how people use biological resources could inform learners' understanding of the role that the community could play in protecting the environment.

For Grade 11 learners		
Tourism Assessment Standards	**Tourism Suggested Content and Context**	**Suggestions For Possible Integration with Life Sciences**
• Evaluate the environmental components in the local community that are indicative of tourism potential; • Draft an implementation plan to upgrade and maintain the local environment.	• Make decisions on how scarce and sensitive resources could be protected, upgraded and maintained in the context of promoting tourism.	Activity 5.2 – A Biodiversity Survey (with an adaptation to the tourism context) could help learners to identify what is there, that may be a valuable resource for sustainable tourism (e.g. exceptional biodiversity, clean water in estuary). Activities 5.4 and 5.5 could help learners identify scarce resources and sensitive areas. Activity 5.6 – What can we do? - could be a precursor to learners developing a rehabilitation plan to be implemented in a local environment.

For Grade 12 learners		
Tourism Assessment Standards	**Tourism Suggested Content and Context**	**Suggestions For Possible Integration with Life Sciences**
• Evaluate environmental, social and economic factors impacting on sustainable and responsible tourism development. • Investigate and report on strategies that are in place globally to protect the environment.	• Identify resources integral to sustainable and responsible tourism; • Show an awareness of approaches and debates on responsible and sustainable tourism.	Activity 5.2 – A Biodiversity Survey and Activities 5.4 and 5.5 could help learners identify ecological, social, economic and political factors which impact on sustainable tourism. Activity 5.7 allows Grade 12 learners to explore international and national strategies for environmental protection.

• Geography

The NCS describes the purpose of the subject Geography as encouraging critical and creative thinking in the context of *sustainable living*, to recognise that the *environment* is affected by values and attitudes, and to apply a range of geographical skills and techniques to *issues* and *challenges*.

Geography focuses on the development of competence to investigate human – environment interactions and so to develop a deeper understanding of these interactions. The Subject further encourages learners to apply their competence and knowledge to contemporary issues and challenges and to seek appropriate means to address these at a national, continental and global level. This clearly provides opportunities for exploring issues of biodiversity, ecosystems, human well-being and sustainability. The Geography Learning Outcomes and Assessment Standards define the competence levels for different grades through which the exploration of human – environment interactions in the context of biodiversity, ecosystems and sustainable living could be undertaken.

Geography Learning Outcome #1

… requires learners to use a range of geographical skills and techniques, evident when learners identify issues and formulate questions for investigation, plan an enquiry process, analyse, classify and organise data into meaningful presentations and communicate findings – see the NCS for Geography for specific details of the Assessment Standards for the various grades.

Possible opportunities for integration with Life Sciences are for example:

- Activity 5.2 – Biodiversity survey – complementing and strengthening the investigative process.
- Activity 5.3 – What is changing? – reviewing existing data, for example, GIS maps.
- Activities 5.4 and 5.5 – Human use of ecosystem resources and monitoring ecosystems health - identifying issues and challenges
- Activity 5.6 - Exploring ways of addressing these issues and challenges and the idea of sustainability.

Geography Learning Outcome #2

… requires learners to know and understand processes and spatial patterns related to interactions between humans, and interactions between humans and the environment in space and time, evident when learners (among others):

In Grade 10:

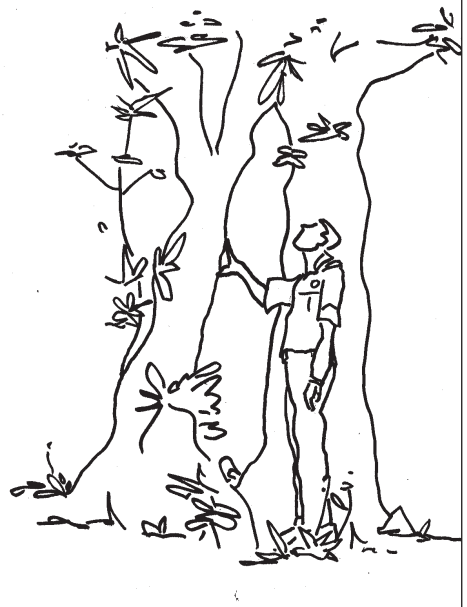
- Describe links between environmental problems and social injustices in a local and global context: See Activity 5.4 for possibilities for integration as learners begin to explore the disparate uses of resources, benefits to some and threats to the well-being of others.
- Describe the interdependence between humans and the Environment: See Activity 5.3.

In Grade 11:

- Examine issues and challenges arising from human and environment interactions in a local and continental context: See Activities 5.3, 5.4 and 5.5 for possibilities for integration.
- Explain different measures of conserving the environment while addressing human needs in a variety of contexts: See Activity 5.6 where learners explore various approaches to biodiversity conservation.

In Grade 12:

- Explore possible responses to issues and challenges arising from human and environment interactions in a local and national context: See Activity 5.6.
- Examine different approaches used to sustain the environment and take into account different knowledge systems in a variety of contexts: See Activity 5.6.



• Agricultural Sciences

The subject Agricultural Sciences aims among other Learning Outcomes to promote an understanding of sustainable agricultural practices, and it emphasises the sustainable use of natural resources and management of the environment. This focus on sustainability provides opportunities for biodiversity conservation education and for integration with the Life Sciences.

Consider for example the following Learning Outcomes:

Geography Learning Outcome #3

… requires learners to apply geographical skills and knowledge to environmental issues and challenges, recognise values and attitudes, and demonstrate the ability to recommend solutions, evident when learners, across the three grades but with differing degrees of complexity:

- Apply skills and knowledge to a range of phenomena, issues and challenges at local and global scales.
- Explore values and attitudes held by individuals and groups associated with processes, spatial patterns and human – environment interactions at local and global scales.

Activities 5.4 to 5.6 provide opportunities for integration with this Learning Outcome.

Agricultural Studies Learning Outcome #2: Sustainable Agricultural Practices

The learner is able to demonstrate an understanding of the dynamic nature of agricultural knowledge and of the appropriate technology, to interpret and apply this knowledge to agricultural management practices and systems to ensure a sustainable agricultural environment.

If learners, for example, explored land use change or the use of biological resources in agricultural practices as key threats to biodiversity (say in Activities 5.3, 5.4 or 5.5), this could help them recognise sustainable and unsustainable agricultural practices. Activity 5.5 could also support them in accessing existing knowledge about agricultural practices, while Activity 5.6 could be oriented to an exploration of more sustainable agricultural practices.

- **Mathematical Literacy**

All learners who do not take Mathematics at the FET level, must take Mathematical Literacy. This subject involves the application of mathematics to real life contexts. It supports learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and solve problems. As such it is a valuable ally to the Life Sciences, in the context of exploring biodiversity concerns.

There are opportunities for integration between Mathematical Literacy (or Mathematics) and Life Sciences whenever learners are required to interpret quantitative or numerical data – both existing and collected – and to present such data.

Two Mathematical Literacy Learning Outcomes that might be involved are:

Mathematical Literacy Learning Outcome #2: Functional Relationships

… requires learners to recognise, interpret, describe and represent various functional relationships and solve problems in real … contexts, evident when they:

- Work with numerical data and formulae in a variety of real life situations in order to establish relationships between variables. For example, interpreting data in Activity 5.3 and drawing conclusions about projected impacts of natural resources being used by people, or studying interrelationships as part of the ecosystem survey in Activity 5.3, or numerically presenting findings in all activities.

- Draw graphs to support their presentation of findings.
- Critically interpret tables and graphs, in accessing and interpreting existing data in all activities.

Mathematical Literacy Learning Outcome #4 – Data Handling

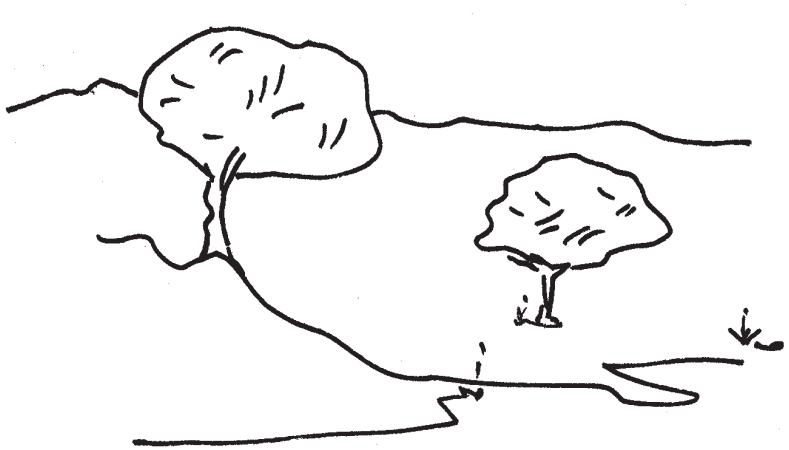
… requires learners to collect, summarise, display and analyse data and to apply knowledge of statistics and probability to communicate, justify, predict and critically interrogate findings and draw conclusions,

evident when they:

- Investigate situations through formulating questions and collecting or finding data by appropriate methods. This could be linked to all investigative processes in the Life Sciences including those related to biodiversity concerns.
- Select, justify and use a variety of methods to summarise and display data in statistical charts and graphs (as above).
- Critically interpret data and representations thereof in order to draw conclusions on questions investigated and to make predictions. Examples include Activities 5.3 and 5.5.
- Effectively communicate conclusions and predictions that can be made from the analysis and presentation of data. For example in Activity 5.4.

Please note that the above suggestions relate to the Assessment Standards generally across the three grades. For more detail on the Assessment Standards and the progression from one grade to the next, please refer to the NCS for Mathematical Literacy.

This section draws on some possibilities in other FET subjects for biodiversity conservation education and, possibly, integration with Life Sciences. There might also be opportunities in other subjects not reviewed here.



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There are many existing resources that you could draw on as you plan for and implement biodiversity conservation education.

These include posters, fact sheets, information cards, booklets and games. For a list of resources that support biodiversity conservation education in the CFR, visit the C.A.P.E. website at www.cape.org.za.

LOCAL ACTION AND LEARNING FOR SUSTAINABLE LIVING

C.A.P.E. Conservation Education Programme Co-ordinator

Rhodes University Environmental Education & Sustainability Unit

PO Box 94, Grahamstown, 6140

Tel: +27-46-622 3432 • Fax: +27-46-636 1495

e-mail: capeccep@ru.ac.za

website: www.capeaction.org.za