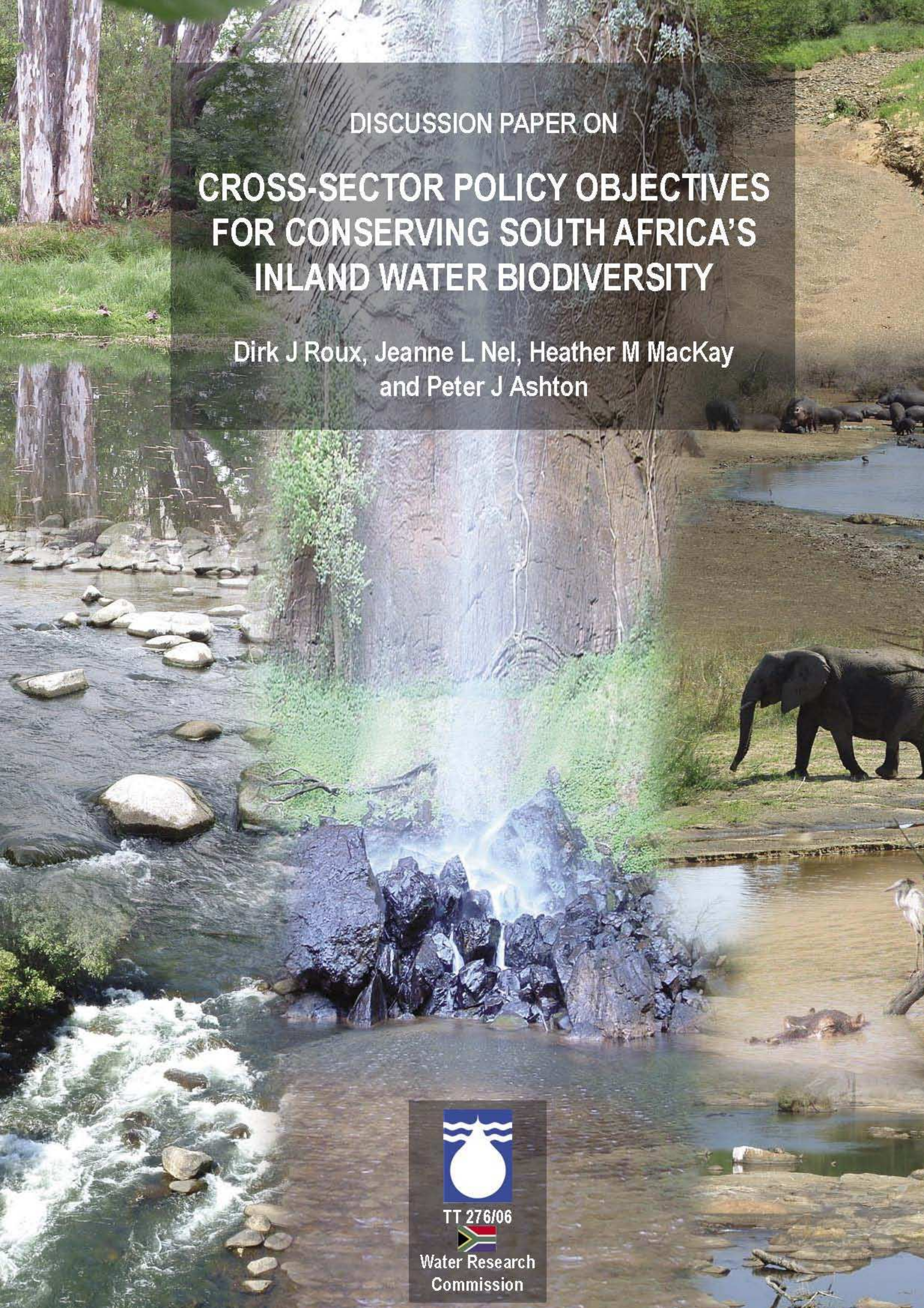
DISCUSSION PAPER ON

CROSS-SECTOR POLICY OBJECTIVES FOR CONSERVING SOUTH AFRICA'S INLAND WATER BIODIVERSITY

Dirk J Roux, Jeanne L Nel, Heather M MacKay and Peter J Ashton



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Water Research Commission

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CROSS-SECTOR POLICY OBJECTIVES FOR CONSERVING SOUTH AFRICA'S INLAND WATER BIODIVERSITY

Report to the
Water Research Commission
by

Dirk J. Roux*, Jeanne L. Nel*,
Heather M. MacKay and Peter J. Ashton***

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Name	Organisation*	Cross-sector meetings	
		8 Sep 2005	22 Feb 2006
Ms Alétia Albertus	DWAF	✓	
Dr Harry Biggs	SANParks		✓
Mr Alex Botha	DLA		✓
Mr Thys Botha	DoA	✓	
Dr Geoff Cowan	DEAT	✓	
Mr John Dini	SANBI		✓
Ms Amanda Driver	SANBI		✓
Mr Koos du Plessis	DoA	✓	
Dr Quentin Espey	DWAF	✓	
Mr Llewellyn Foxcroft	SANParks		✓
Dr Howard Hendricks	SANParks	✓	
Ms Mamogala Kadiaka	DWAF	✓	✓
Mr Ahmed Khan	DWAF		✓
Mr David Kleyn	DoA	✓	
Dr Neels Kleynhans	DWAF		✓
Dr Stanley Liphadzi	WRC	✓	
Ms Wilma Lutsch	DEAT	✓	✓
Mr Freddy Mamuremi	DPLG	✓	
Dr Steve Mitchell	WRC	✓	✓
Mr Edward Netshithothole	DEAT	✓	✓
Mr Harrison Pienaar	DWAF	✓	✓
Mr Bill Rowlston	DWAF	✓	✓
Ms Barbara Schreiner	DWAF	✓	✓
Ms Leseho Sello	DEAT	✓	
Mr Keith Taylor	DoA	✓	✓
Mr Johan van Rooyen	DWAF	✓	✓

*see list of acronyms

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EXECUTIVE SUMMARY

INTRODUCTION

In South Africa, the responsibility for conserving inland water ecosystems is shared between several segments or sectors of society and departments of government, with the result that there is often a considerable overlap of mandates. Departments that are responsible for water resource protection and management, biodiversity conservation, land use management, and integrated development planning are all key role players and their cooperative actions are necessary if inland water ecosystems and their biodiversity are to be managed effectively.

A central feature of this project has been its focus on facilitating cross-sector engagement. To this end, a first cross-sector meeting was held on 8 September 2005. Representatives of various departments of national government and other organs of state (see acknowledgements) deliberated a set of policy objectives contained in a draft discussion paper. The policy objectives were revised to incorporate the comments, discussion and recommendations arising from the meeting of 8 September 2005. The revised discussion paper was circulated to a number of national and international specialists and conservation practitioners for review. The comments and additions received from these reviewers (see acknowledgements for names) were incorporated into a further draft of the discussion paper. This draft was then tabled for consideration by the cross-sector representatives during a second meeting that was held on 22 February 2006. The contents of this final version of the discussion paper have been approved by the representatives (see acknowledgements) that attended the February meeting.

The primary purpose of this discussion paper is to support the development of shared (i.e. inter-departmental) policy objectives and guiding principles that will promote the practical conservation of inland water biodiversity across multiple sectors and spheres of government. The paper contains detailed discussions of both the policy and scientific contexts that underpin the conservation of freshwater biodiversity, in order to inform and support a process of shared learning and decision-making in this field. The paper reflects the outcomes that have been achieved to date from the processes of analysis, consultation and deliberation that have taken place amongst the representatives of the main agencies that have primary responsibility for conserving freshwater biodiversity. Ideally, this should lead to consensus on a common policy statement and a cooperative implementation plan for the conservation of inland water biodiversity in South Africa.

BIODIVERSITY SCIENCE AND MANAGEMENT

Loss of biodiversity inevitably leads to ecosystem degradation and subsequent loss of important ecosystem services. Moreover, this loss tends to harm poor rural communities more directly, since they have limited assets and infrastructure and are more directly dependent on common property resources for their livelihoods. In contrast, the wealthy are buffered against loss of ecosystem services by being able to purchase basic necessities and scarce commodities. Our path towards sustainable development, poverty alleviation and enhanced human well-being for all, is therefore dependent on how effectively we are able to manage and protect natural resources including biodiversity.

The value of and need for biodiversity conservation is summarised by The Paris Declaration on Biodiversity (see Section 3.9) as follows: "*Biodiversity, as the natural heritage and a vital resource for all humankind:*

- *Is a source of aesthetic, spiritual, cultural, and recreational values;*
- *Provides goods that have direct use values, such as food, wood, textiles and pharmaceuticals;*
- *Supports and enhances ecosystem services on which human societies depend often indirectly, such as plant and animal production, crop pollination, maintenance of water quality and soil fertility, carbon sequestration, nutrient cycling, protection against pathogens and diseases, and resistance of ecosystems to disturbances and environmental changes; and*
- *Provides opportunities for human societies to adapt to changing needs and circumstances, and discover new products and technologies*."

Biodiversity is an umbrella term that refers to the variety of all life on Earth, and encompasses genetic, species and ecosystem (including habitat) diversity. Today's biodiversity is the result of millions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. While some two million species have been identified and described to date, scientists estimate that there are between three and 100 million species on Earth.

Because of its broad scope and multi-dimensional nature, biodiversity studies have the potential to serve a unifying role that transcends different disciplines. For example, biodiversity integrates ecology with evolution and biogeography. At the ecological scale, biodiversity integrates structure with function and biotic variables with abiotic variables. It also links spatial and temporal phenomena across hierarchical scales and levels of biological organisation (Ward and Tockner, 2001).

A central tenet of biodiversity conservation is to set aside representative examples of ecosystems to act as "biodiversity banks" as a proactive protection against potential future modifications. Such conserved areas become heritage resources for sharing the current biodiversity heritage with future generations, as well as benchmarks against which human modification of ecosystems can be measured in the long-term. Several international agreements address this issue at global and regional levels, and there is a range of relevant policy and legislation in place in South Africa (see Chapters 4 and 5 of this discussion paper).

International as well as local studies confirm that inland water biodiversity is generally in a poorer state and more endangered than terrestrial biodiversity. Two factors make the conservation of inland water biodiversity particularly challenging in comparison to efforts aimed at conserving terrestrial biodiversity. Firstly, while protected areas can support partial cessation of inland water habitat degradation and associated biodiversity loss, the design of protected areas is generally biased towards terrestrial biodiversity features, with inland water ecosystems being addressed only incidentally as part of their inclusion within terrestrial reserves. Even where inland water systems are included in such planning exercises, this is typically done to serve terrestrial conservation goals.

Secondly, the longitudinal nature of rivers and the relatively large size of most river basins makes it difficult to include whole catchments or the entire length of a river (e.g. greater than third order) within formally protected areas. In addition, rivers are often used as a convenient way to designate the boundaries of parks or protected areas. This partial inclusion in a protected area is no guarantee for protection, since impacts that take place outside park boundaries can still have negative consequences for riverine biodiversity within the park. A good example of this can be seen in the Kruger National Park, South Africa’s flagship national park. Rivers in the region of the Kruger National Park flow in an east-west direction, whilst the park spans the landscape in a north-south direction. This means that all the larger rivers flow through the park, rather than being contained within the park.

Experiences around the world confirm that *ad hoc* conservation efforts have failed to conserve the diversity of our biodiversity heritage. Without the adoption of a new management philosophy and approach, this trend is likely to continue. To address the need for a more proactive and systematic focus on inland water biodiversity, a relatively new discipline of “freshwater conservation planning” has emerged. This requires truly trans-disciplinary approaches, and draws on insights from the fields of systematic conservation planning, ecology and conservation biology, aquatic ecology (including hydrology, biology, geomorphology), water resources planning and management, and spatial information technology.

Conservation planning began as a discipline that was developed specifically for the purposes of selecting formal protected areas, with a focus on terrestrial biodiversity. Over the years this narrow focus has broadened in two significant ways that have made the field more accessible to conservation planning for inland water ecosystems. First, the process of selecting conservation areas began to consider a full range of conservation management options – as opposed to focusing on formal protected areas only, thereby supporting the concept of maintaining and utilising biodiversity within a multiple use landscape. This paradigm shift is more appropriate in the context of conserving inland water ecosystems, as conserving these ecosystems requires management of whole catchments, and it is seldom feasible to incorporate entire catchments into protected areas. Secondly, it became clear that representing a sample of all biodiversity patterns needed to be supplemented with explicit incorporation of biodiversity processes. This notion is particularly applicable to conserving inland water ecosystems, which rely heavily on the maintenance of processes that depend on longitudinal, lateral, and vertical connectivity.

Conservation planning also requires that biodiversity should be depicted in some operational way, generally requiring the use of biodiversity surrogates that can serve as proxies for biodiversity pattern. The derivation of meaningful surrogates for inland water biodiversity has been one of the main challenges in this newly developing field. There are inherent problems when using species data as biodiversity surrogates, primarily because these data are even less complete than the data available for terrestrial species. Problems with incomplete data, collection bias and incomplete taxonomic understanding can drive conservation planners to select areas that are well sampled, whilst ignoring areas that might be important but have no data. Terrestrial conservation plans have circumvented this by classifying the landscape according to vegetation types or broad habitat types and using this as the primary biodiversity surrogate in selecting areas (although ideally this should be supplemented with species data). However, classifying inland water ecosystems across the landscape has remained elusive, mainly because it is more difficult to depict inland water ecosystems in a spatially explicit manner because of the highly dynamic nature of water resources in both time and space. It is only in recent years that hierarchical procedures for systematically classifying inland water ecosystems have been developed (see Section 8). Deriving such classifications to depict biodiversity has provided further impetus for the application of conservation planning principles and tools to inland water ecosystems.

INTERNATIONAL, REGIONAL AND NATIONAL POLICY CONTEXTS

An extensive body of international, regional and national policies and treaties exists that relate to the conservation of inland water ecosystems. These treaties and policies reflect certain societal norms, values and aspirations; the nations that subscribe to them are legally and morally bound to give effect to their principles and objectives.

Where South Africa is a signatory to an international treaty or convention, all organs of state should embrace the associated responsibilities and implications. In the cascading down of policy from international to national contexts, and especially where an issue of concern may involve more than one sector, it is critically important to pay close attention to policy coherence. Policy coherence has two dimensions, namely vertical coherence and horizontal coherence. Vertical policy coherence entails ensuring that local and provincial authorities pursue policies that are aligned with and support, and do not undermine, national policies; and that individual nations pursue policies that support regional and / or international policies and treaties. Horizontal policy coherence entails achieving a complementary consistency of policies across related sectors at any particular level. As an example, the policy interests of this discussion paper would require coherence in the expression of objectives regarding land use and ecosystem protection across the water, industry, health, biodiversity, environmental management and agricultural sectors.

International biodiversity governance

South Africa has been, and continues to be, involved in international efforts related to biodiversity governance to different degrees and in different ways. The nature of this involvement has influenced the development of national policy and legislation, as described in more detail in Section 4 of this document. The mandates, obligations and responsibilities arising from the following international conferences, governance bodies, treaties and conventions are considered in Section 3 of the discussion paper:

- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (also known as the Ramsar Convention), signed in Ramsar, Iran in 1971;
- The United Nations Conference on the Human Environment (5-9 June 1972, Stockholm, Sweden) and United Nations Environment Programme;
- The Brundtland Report published by the World Commission on Environment and Development in 1987;
- The United Nations Conference on Sustainable Development or “Earth Summit” (3-14 June 1992, Rio de Janeiro, Brazil) and its Agenda 21;
- The Convention on Biological Diversity (1994);
- The Cartagena Protocol on Biosafety (2003);
- The United Nations Millennium Summit (6-8 September 200, New York, USA) and its eight Millennium Development Goals;
- The World Summit on Sustainable Development (26 August to 4 September 2002, Johannesburg, South Africa); and

- The International Conference on Biodiversity Science and Governance (24-28 January 2005, Paris, France) and its Paris Declaration on Biodiversity.

Regional and national policy context

The most relevant regional initiatives for achieving coherence at regional level are the New Partnership for Africa's Development (NePAD) and the Southern African Development Community (SADC). NePAD spells out the vision of African leaders to eradicate poverty and to place their countries, individually and collectively, on a path of sustainable growth and development. It provides the overarching trans-national strategy that will influence future development and management of Africa's natural resource base. It has been recognized that a healthy and productive environment is a prerequisite for the success of NePAD, together with the need to systematically address and sustain ecosystems, biodiversity and wildlife. SADC (with member states Angola, Botswana, Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) aspires to achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of southern Africa, and support socially disadvantaged groups through regional integration. Article 5(g) of the SADC Treaty aims to achieve the sustainable utilization of natural resources and to effectively protect the environment.

At the national level, South African environmental policies and legislation have been influenced by international trends in the environmental field, and by South Africa's obligations as a Contracting Party to several multi-lateral environmental agreements. In addition, domestic priorities have been equally significant in catalysing changes in policies. Since 1994, South African government policy has focused on equitable and sustainable social and economic development for the benefit of all South Africa's people. At the time (1994), many of South Africa's existing laws were not appropriate to achieving these objectives. Therefore, the policy and legal framework in South Africa has been thoroughly reviewed and re-aligned with the new direction set out by government. In the water and environmental sectors, previously fragmented policies have been consolidated and re-formulated in accordance with principles of sustainable development and equitable access, to allow all South Africans to benefit from improved access to and use of these resources.

Section 4 presents an overview of the major post-1994 developments that took place, often concurrently, in the water, environmental, agricultural and land planning sectors. Several of these developments are convergent in the sense that they share a common philosophy, and support the development of cross-sector policy for the conservation of inland water biodiversity. However, the necessary next step is to develop shared operational plans, objectives and approaches that are in accordance with the common philosophy – it is this step that is the focus of this discussion paper.

In order to achieve horizontal alignment and agreement on the conservation of inland water biodiversity in South Africa, it is essential to build common understanding of terminology, key concepts and strategic intent across the water resource management, environmental and biodiversity management, land use, agriculture and integrated development planning sectors. For this purpose, a concerted effort was made to highlight those issues that are embedded in relevant national policy and legislation and that are fundamental to the conservation of inland water biodiversity.

NATIONAL CONSERVATION GOAL

From a purely practical perspective, it is simply not possible to allocate a high level of protection to all resources throughout the country without prejudicing social and economic development. Equally, it is not desirable for all resources to be classified at a uniformly low level of protection that would permit them to be used and exploited to the maximum extent possible. For water resources, this aspect has been addressed through the water resource classification system, which provides for the development of a framework for assessing and managing water resources in terms of their selected class, level of protection, or "ecological state". Each ecological state has implications for the way and extent to which that water resource is utilised (see Section 4.3.1).

This discussion paper is concerned with the identification of those water resources that should receive a high level of protection in order to serve the objective of effectively conserving inland water biodiversity. The water resource classification system provides the primary rationale and implementation tool in this respect, and in applying the system it is necessary to address questions such as:

- How many inland water ecosystems should be maintained in the "natural class", or in other words, should be awarded a high protection status?
- Which inland water ecosystems are best suited to being designated as a natural class?
- How should inland water ecosystems with a high protection status be integrated or linked into an overall (national) conservation design to provide optimal efficiency and benefit?
- Should rehabilitation targets be set for inland water ecosystems that may be heavily used / impacted or that are unacceptably degraded, but are critical for achieving overall inland water conservation targets?

The above questions can only be answered if we know what we would like to achieve; i.e. we need a shared vision or goal statement. In line with the aspiration of modern society to sustain the diversity of life on earth, the goal that was adopted by the cross-sector representatives for inland water conservation is:

to conserve a sample of the full variety or diversity of inland water ecosystems that occur in South Africa, including all species as well as the habitats, landscapes, rivers and other water bodies in which they occur, together with the ecosystem processes responsible for generating and maintaining this diversity, for both present and future generations.

CROSS-SECTOR POLICY OBJECTIVES

While it may be relatively easy to share a common philosophy and goal, little will be achieved in reality unless the common goal is cascaded down into a comprehensive set of common operational objectives, where all agree on what must be done, and who will take responsibility and accountability for certain tasks. These operational objectives must be clearly understood by all, collaboratively developed, and cooperatively implemented.

A set of five core objectives and associated implementation principles are presented in Sections 7 to 11 of this document as imperatives to achieving the inland water biodiversity conservation goal stated above. Objectives one to three deal with planning and design issues, while objectives four and five deal with implementation issues. Each objective is covered in a separate section. First, a statement and brief description of the objective is provided; this is then supported by a summary of the associated implementation principles. Secondly, since the implementation principles are necessarily quite technical in nature, in each case a considerable amount of information is provided on the scientific basis and rationale for the implementation principles. Thirdly, a set of cross-sector policy recommendations is presented. These recommendations were discussed and agreed at the meetings of cross-sector representatives on 8 September 2005 and 22 February 2006.

The five objectives and their supporting recommendations are repeated here for convenience.

Objective 1: Set and entrench quantitative conservation targets for inland water biodiversity

This objective addresses the setting of minimum requirements for inland water biodiversity conservation in order to: allow an evaluation of whether existing conservation efforts represent the biodiversity of a region adequately; provide guidance for planners who are balancing a number of competing demands for natural resources in a region; and provide water resource management and biodiversity conservation agencies with common quantitative measures for which to aim.

There are three implementation principles associated with this objective. The first implementation principle is to ***set and endorse national targets for conservation of inland water biodiversity***. To support this principle, the following policy recommendations were agreed to:

- The quantitative target for inland water biodiversity conservation in South Africa should be to maintain (and restore where necessary) at least *20 % of each inland water ecosystem type* (determined at the appropriate scale – see Section 8.2) in a Natural Class, where Natural Class refers to the highest level of protection afforded by DWAF's Water Resource Classification System.
- The national government departments responsible for water resources, biodiversity, land management and integrated planning should officially endorse the national conservation target for inland waters and integrate this target into their respective policy and strategic processes.
- National government is, and should remain, accountable for achieving the 20 % conservation target. However, all spheres of government (national, provincial and local) should have a role in prioritising inland water ecosystems for conservation, and share a responsibility for achieving effective conservation of identified systems. National government should be responsible for driving the process of harmonising conservation prioritisation and implementation between national, provincial and local spheres of government.
- The conservation of inland water ecosystems that are shared with neighbouring countries should be addressed through the development of bi-national or multi-national agreements.

The second implementation principle is to ***cascade the national targets differentially to sub-national implementation levels***. To support this principle, the following policy recommendations were agreed to:

- The national inland water conservation target should be cascaded down as sub-national targets to correlate with the 19 WMAs set out by the NWRS.
- Where specific inland water ecosystems are shared between two or more WMAs, the national target need not necessarily be met uniformly across these areas of administrative responsibility. Rather, the constitution of the national target through sub-national component targets may reflect variation in the richness of inland water biodiversity as well as achievability due to present levels of ecological transformation across the landscape. Overall, a fair and equitable distribution of responsibility regarding biodiversity conservation should be achieved; and responsibilities should be matched with appropriate resources (in terms of skilled staff, equipment, information and funding).
- Sub-national targets should be set in collaboration with the relevant sub-national government agencies; ideally, these should be juxtaposed with biodiversity assessment and conservation planning exercises. It should be the overall responsibility of national government, and specifically DEAT (primarily through SANBI), to facilitate and oversee the spatially nested processes of biodiversity assessment, conservation planning and target setting.
- It should be the responsibility of DWAF, primarily through its CMAs and the practice of integrated water resource management (IWRM), to implement the conservation targets at sub-national level. CMAs should be responsible for fostering horizontal and vertical coherence and coordination of conservation actions. For example, planning for the conservation of inland water biodiversity should engage with the National Biodiversity Framework and its responsible parties, the relevant Catchment Management Strategy(s) and its responsible parties, and local development planning and decision-making structures including municipalities within the jurisdiction of the relevant Catchment Management Agency (or DWAF Regional Office where a CMA has not been established).

The third implementation principle is to ***improve and refine national and sub-national targets over time***. To support this principle, the following policy recommendations were agreed to:

- The national conservation targets for inland water ecosystems should be subject to review every five years. Review should be coordinated by SANBI, with inputs from all of the relevant national custodians and stakeholders of these targets, for example DWAF, DEAT, NDA, DPLG, and SANParks.
- The national custodians of the inland water conservation targets should identify and support the research needed to enable informed revision of the national targets over time.

Objective 2: Plan for representation of inland water biodiversity

The objective of representing inland water biodiversity is to ensure adequate representation of the full spectrum of inland water biodiversity, based on the systematic description and depiction of the inland water biodiversity within the region of concern. A key objective of conserving representative examples of inland water biodiversity is the promotion of a systematic approach to the identification, prioritisation and conservation of inland water ecosystems, as opposed to a focus on well-studied, relatively unmodified, or biologically more diverse systems. Three implementation principles inform the achievement of this objective. The first implementation principle is to ***use surrogate measures as indictors to describe and classify inland water biodiversity***. To support this principle, the following policy recommendations were agreed to:

- As a pragmatic consideration, landscape or ecoregion-level measures of heterogeneity in inland water ecosystems may be used as surrogates for achieving representation of inland water biodiversity features in conservation planning;
- Surrogates should be tested and validated through proper hypothesis testing to ensure their scientific rigour; and
- Ecoregional surrogates (as coarse filters of biodiversity) should be supplemented wherever possible with fine filter surrogates (such as species or community level data).

The second implementation principle is to ***define the appropriate scale***. To support this principle, the following policy recommendations were agreed to:

- Conservation planning should follow a spatially nested approach with coordination and alignment between at least three scales:
    - National planning: The CBD calls for the development of ***countrywide*** conservation plans and conservation of representative samples of all ***major ecosystem types***. As such, the delineation, analysis and representation of inland water biodiversity at a national scale should be viewed as a priority.
    - Sub-national planning: Since planning and allocation of water resources takes place at a sub-national and catchment level, catchment-based biodiversity representation and planning should be closely aligned with and complement national-level plans.
    - Regional planning: The regional significance (e.g. uniqueness) of inland water ecosystems should also be considered. In this regard the region of the Southern African Development Community (SADC) becomes a relevant planning unit. At present, there are serious data discrepancies between South Africa and its neighbouring countries. This should be addressed through the development of minimum data and monitoring requirements for the region, and by spelling out shared responsibilities and time frames for generating basic and uniform data layers for the region.

The third implementation principle is to ***incorporate local ecological knowledge***. To support this principle, the following policy recommendation was agreed to:

- People with local ecological knowledge – whether experts that have worked in the area or local inhabitants such as farmers or community members – should be involved wherever possible to point out areas of special interest and to review planning outputs; this is especially important for fine-scale inland water conservation plans. To facilitate its use in conservation planning, this knowledge must be recorded in a spatially explicit manner with clear explanations as to why each mapped feature is important, and options for how they could be managed in a conservation-friendly manner.

Objective 3: Plan for persistence of inland water biodiversity

The objective of planning for biodiversity persistence addresses the need to conserve the ecological and evolutionary processes that generate and maintain inland water biodiversity. Conserving species and habitats, as considered under biodiversity representation, provides a snapshot of the biodiversity that currently exists. If we wish this biodiversity to persist and naturally evolve over time, we also need to make sure that: populations, communities or ecosystems that are both viable and of high ecological integrity are selected; natural ecological processes (functional elements) and disturbance regimes such as floods, droughts and fires continue to operate within their natural ranges of variability; and the size of a conservation design is sufficient to allow a system to recover from natural disturbances.

There are four implementation principles associated with achieving this objective, the first of which is to ***select inland water ecosystems of high integrity***. To support this principle, the following policy recommendations were agreed to:

- Only ecosystems that reflect a present ecological state of A or B will contribute to achieving inland water conservation targets; and
- Where necessary, and subject to feasibility, ecological restoration or rehabilitation should be undertaken to achieve the set conservation target.

The second implementation principle is to ***ensure connectivity***. To support this principle, the following policy recommendations were agreed to:

- In many instances it is virtually impossible to find an un-dammed, or un-regulated river system. Given that virtually all of South Africa's main rivers have been dammed or regulated in some way, longitudinal connectivity for selected rivers should be enhanced as far as possible, for example through construction of appropriate fish ladders and adoption of water release regimes that adhere to environmental flow requirements.
- In order to optimise the protection of the functional elements of inland water ecosystems, adjacent river reaches rather than isolated reaches should, wherever possible, be selected for contributing towards conservation targets. Where this is not attainable, river ecosystems that are designated for conservation (in an A or B ecological state) should, where relevant, be connected through river ecosystems that are in an ecological state that will support ecological connectivity. This functionality commonly concurs with ecological assessment category C. However, this relationship should not be seen as a given and each potential connecting river should be assessed carefully, based on process attributes such as its ability to allow the migration of a key species.
- Where ecosystems are in an ecological state that is lower than A or B but are deemed important for providing connectivity, such ecosystems should be considered part of an overall design for inland water conservation. The maintenance of their ecological state will be necessary for achievement of the overall conservation target. However, they should not contribute towards satisfying the quantitative conservation target.
- The management and conservation of inland water ecosystems must address maintenance or re-establishment of environmental gradients along longitudinal, lateral and vertical dimensions.
- The need for lateral connectivity emphasises the importance of aligning land and water biodiversity priorities and management strategies. Similarly, the need for vertical connectivity emphasises the importance of aligning surface and groundwater management strategies.

The third implementation principle is to ***include large-scale ecosystem processes*.** To support this principle, the following policy recommendations were agreed to:

- Where appropriate (in catchments that are designated for conserving inland water biodiversity), natural disturbance regimes, such as floods, droughts and fires, should be allowed to operate within their natural ranges of variability; and

- There are few places in the world where completely unaltered environmental regimes and natural disturbances currently exist. Therefore the potential to restore regimes and disturbances through active management (e.g., releases from dams according to in-stream flow requirements, including floods) should be evaluated when selecting conservation areas.

The fourth implementation principle is to ***select areas of sufficient size***. To support this principle, the following policy recommendations were agreed to:

- Inland water conservation actions should cover multiple spatial scales, from local (e.g. small-patch ecosystems) to large landscapes. At least some larger scale efforts should interface with terrestrial and marine conservation plans.
- Since administrative boundaries are often smaller than, or poorly aligned with, the span of ecological processes, a national conservation planning framework should provide clear guidance regarding the conservation of ecological and evolutionary processes at sub-national levels. Such a planning framework for conserving inland water processes should form part of South Africa's National Biodiversity Framework (discussed in Section 4.3.2-e).

Objective 4: Establishing a portfolio of inland water conservation areas (IWCAs)

The objective of establishing inland water conservation areas addresses the incorporation of the first three objectives into spatial configurations that will constitute the portfolio of inland water conservation areas (IWCA) of South Africa**.** There are five implementation principles associated with achieving this objective. The first implementation principle is to ***legislate IWCAs through complementary legal mechanisms*****.** To support this principle, the following policy recommendations were agreed to:

- Departments responsible for biodiversity conservation, water resource management, land use (agriculture) and integrated development planning should promote coherence between their respective policies and strategies. Coherence can be enhanced by actively incorporating the policy objectives and principles of this document into their future policy and strategy processes.
- Inland water conservation priorities should be linked to appropriate legal mechanisms for implementation.

The second implementation principle is to ***strive for optimal land-use efficiency***. To support this principle, the following policy recommendations were agreed to:

- Integrated planning and management of natural resources (both aquatic and terrestrial) should be regarded as a priority for achieving efficient conservation of inland water ecosystems. Appropriate mechanisms for achieving this, for example the appointment of natural resource management coordinators at district levels, should be carefully investigated.
- Since the conservation of inland water ecosystems is dependent on an ability to achieve appropriate land management practices within associated drainage areas, the least conflicting cross-sector options should be sought wherever possible; i.e. to steer away from allocating inland water conservation priorities in catchment areas designated for types of development that conflict with conservation objectives.
- Ideally, inland water conservation plans should be carried out in parallel to terrestrial, and marine conservation plans and all plans should be well-integrated.

- Inland water conservation planners should design, in collaboration with terrestrial and marine conservation planners, one or two large conservation areas that would focus on integrating conservation objectives for terrestrial, inland water, estuarine and marine ecosystems.
- Prioritisation systems that consider biodiversity together with social and economic realities should be developed and tested.

The third implementation principle is to ***prioritise and initiate conservation actions timeously***. To support this principle, the following policy recommendations were agreed to:

- The allocation of resources for conserving inland water biodiversity should be guided by (a) an assessment of the vulnerability of each inland water ecosystem to threats or resource use pressures; and (b) an assessment of the options available for conserving each inland water ecosystem.
- Investigative research should be initiated to improve our understanding of the vulnerability of inland water ecosystems.

The fourth implementation principle is to ***conserve first where appropriate, rather than restore later***. To support this principle, the following policy recommendations were agreed to:

- Inland water ecosystems that are ecologically intact should receive priority in the selection for achieving representation (this relates to the implementation principle of "selecting ecosystems of high integrity").
- In instances where the sub-national conservation target cannot be met owing to past or current over-utilisation of certain inland water ecosystems, the restoration of these ecosystems should be considered on the basis of ecological feasibility and affordability.

The fifth implementation principle is to ***provide explicit selection options and management guidelines***. To support this principle, the following policy recommendations were agreed to:

- When prioritising inland water ecosystems for conservation, explicit information should be provided about the biodiversity features contained by these ecosystems as well as the regional significance of these features, e.g. are they endemic to the Water Management Area or to the country.
- For each potential selection, some information should be provided on the main pressures on biodiversity and how best to mitigate these.
- Catchment zoning, in which the most deleterious activities for the resource are relegated to the furthest part of the catchment, should be investigated as a management option in instances where whole catchments cannot be conserved.
- All selected catchments should have management plans for the removal and management of alien species.

Objective 5: Enable effective implementation

Acknowledging that the value of a conservation design is only realised through its effective application, the objective of effective implementation addresses the creation of an institutional environment that can ensure sustained conservation actions for all designated inland water conservation areas.

There are five implementation principles underpinning this objective. The first implementation principle is to ***facilitate stakeholder adoption of inland water conservation targets and priority areas.*** To support this principle, the following policy recommendations were agreed to:

- Stakeholders (key decision makers and water user groups) should be engaged at the outset of the planning process, and at various stages through the planning process rather than only at the end of the process.
- Conservation plans for inland water ecosystems need to be aligned with the frameworks and terminology used by the targeted resource managers, e.g. Bioregional Plans and Catchment Management Strategies.

The second implementation principle is to ***reflect the conservation of inland water ecosystems as an explicit function in institutional design***. To support this principle, the following policy recommendations were agreed to:

- Every sub-national implementation agency responsible for conserving inland water biodiversity should plan for and acquire internal capacity for effectively executing their responsibilities in this regard. Capacity implies both the skills to facilitate networking and collaboration among relevant agencies, as well as sufficient depth of knowledge in aquatic ecology and conservation science to harness external knowledge in this regard and to effectively apply such knowledge.
- CMAs, provincial conservation departments / agencies, and district and local municipalities should plan and budget for the financial and human resource implications associated with effective implementation of their agreed component of the inland water conservation objectives and targets in their geographic areas of responsibility.

The third implementation principle is to ***enable cooperative governance in the conservation and management of inland water biodiversity***. To support this principle, the following policy recommendations were agreed to:

- Performance management in a cooperative governance setting should be promoted through the development, testing and demonstration of suitable quantitative and qualitative indicators.
- The establishing of regular interaction with counterparts in cooperative agencies should be encouraged. Regular and quality interactions are necessary for building personal and professional relationships; especially where stakeholders are geographically dispersed.

The fourth implementation principle is to ***facilitate a science-management continuum***. To support this principle, the following policy recommendation was agreed to:

- National custodian departments should institute and support suitable mechanisms and processes that will promote an adaptive management framework for conservation of inland water biodiversity.

The fifth implementation principle is to ***promote discovery, inventory and improved understanding of inland water biodiversity***. To support this principle, the following policy recommendations were agreed to:

- Clear responsibilities should be established regarding biodiversity collections and inventories, as well as the means to coordinate actions and responsibilities at national level.
- Priority monitoring gaps and limitations should be identified, responsible parties should be identified, and appropriate interventions should be developed.
- A protocol for the systematic collection and curation of species data should be drawn up to guide museums and other collectors.

CONCLUSIONS

The discussions and decisions reported in this paper provided the basis for several important conclusions. These were presented in Section 12 and are repeated here for completeness.

Water is a cross-sector issue that affects every level and activity of society and life on Earth. Therefore, water policy must also be cross-sectoral in character if it is to correctly reflect the complex nature of water management. As a result, the successful achievement of water policy goals requires close and sustained cooperation and coordinated effort amongst all of the agencies that are responsible for policies and activities that affect, or are influenced by, water (MacKay and Ashton (2004). In a similar way, biodiversity issues span several different sectors and biodiversity policy therefore also qualifies as cross-sectoral policy. Importantly, where the area of management focus is inland water biodiversity, the overlapping sectoral roles and responsibilities of both water and biodiversity must apply. In this situation, it is extremely important to ensure that the respective sets of policies and management instruments are both coherent and properly aligned with each other, in order to avoid the confusion that could arise as a result of conflicting objectives and contradictory management approaches.

Acknowledging the above complexity, the development of this discussion paper was based on a process of searching for and negotiating a shared understanding of key concepts related to the conservation of inland water biodiversity. An important part of this process was to make explicit all those issues or characteristics that are fundamental to future visions that exist within the respective sectors that share responsibility for the conservation of inland water biodiversity. A broad cross-section of representatives from the different sectors, organizations and government departments that have line responsibilities for water resource management, environmental and biodiversity management, agriculture and land use planning, were brought together to engage in a wide-ranging set of debates regarding cross-sector policy objectives for inland water biodiversity conservation.

The convergence in thinking that emerged from these debates was quite remarkable – particularly in the way that a shared vision was achieved for the conservation and management of inland water biodiversity. Most importantly, special attention was paid to ensuring that the recommended policy instruments were coherent and practical, and could be implemented effectively by the different organizations and agencies responsible for specific issues. This focus on the effective ***implementation*** of policy instruments will help to avoid the type of situation where consensus-seeking approaches ignore important management realities and create policy instruments that are either difficult or impossible to implement. In such situations, the respective end-users or operational managers become frustrated by their inability to implement the respective instruments and are likely to revert to older, “tried and trusted” operational methods.

In this study, an effort was made to address the philosophical aspects of policy whilst also ensuring that practical recommendations could be made for the effective implementation of this policy. For this reason, a carefully structured, hierarchical approach was followed. First, a high-level national goal was formulated, followed by clear and unambiguous statements of the five necessary conditions or broad policy objectives that underpin the achievement of this goal. These key objectives were then linked to 20 implementation principles that characterize effective policy implementation. Finally, approximately 50 policy-related recommendations were made to support the practical implementation of the principles.

Several bold decisions were made by the participating government departments, for example to set a quantitative target of conserving 20 % of each major inland water ecosystem type. The uncertainty and lack of scientific validation around this and some other decisions were noted, as well as the need for directed research and the establishment of appropriate feedbacks between research and conservation practice.

Several of the policy recommendations that are made in this paper have institutional and capacity implications. For example, Catchment Management Agencies were identified as primary agencies responsible for achieving conservation targets at the level of a Water Management Area. This will require significant coordination of activities and resources within provincial and local spheres of government; which in turn can only happen if these agencies have an appropriate level of internal knowledge and capacity in the fields of conservation science and aquatic ecology. There is also the intricate issue of coordinating biodiversity assessment, conservation planning and target setting between a national and various sub-national scales; where river catchment and water management area boundaries are not aligned with provincial and district municipality boundaries. The overall responsibility for ensuring this kind of spatial alignment has been allocated to DEAT, primarily through SANBI.

In South Africa, DWAF is the government department with line function responsibility for dealing with water management, while DEAT has the overall line function responsibility to deal with biodiversity management. However, it is clear that neither of these departments can effectively manage inland water biodiversity on its own. The conservation of inland water biodiversity can only be achieved through a comprehensive analysis and understanding of the areas of overlap and the effective sharing of expertise and resources. In fact, while these two departments may be the primary role players representing national government, there are a number of secondary role players that also need to be engaged, including: DoA, DME, DPLG, and DLA. In addition, provincial and local government authorities, conservation agencies such as SANParks, and research facilities such as SAIAB, also need to form an integral part of growing a national capability for the effective management of our biodiversity resources associated with inland waters.

A most important finding, and critical for taking the recommendations in this paper forward, is the need for cooperation across sectors (horizontal) and spheres (vertical) of governance. Conservation planning and the governance of inland water biodiversity takes place in a complex environment where decision-making is typically associated with low levels of certainty and potentially high levels of disagreement among stakeholders. In this environment, active and respectful negotiations are required to ensure that organisations, departments and agencies with different professional identities and mandates can successfully agree to and achieve shared objectives related to the conservation of inland water ecosystems.

Ironically, with the current focus of government on service delivery and tangible outcomes, effective cooperation requires intangible inputs; for example, people need to spend time together developing relationships and learning to communicate with, respect, and trust one another. An overall recommendation of this paper is, as a matter of urgency, to develop a clear understanding of cooperation as a strategy: when is it appropriate; what does it cost; what conditions are necessary for it to exist; what benefits can it realistically generate.

GLOSSARY

Biodiversity – is an abbreviation of the term "biological diversity", and is used to describe the variability among living organisms from all sources including, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity, http://www.biodiv.org)

Biodiversity feature – an element of biodiversity for which it is possible to set a quantitative conservation target, for example a river type, a species, or the spatial component of an ecological process (Driver *et al*., 2003)

Biological diversity – see *biodiversity*

Connectivity – the transfer of energy and matter (including biota) across ecotone boundaries (Ward and Tockner, 2001)

Conservation action – the establishment and expansion of conservation areas, both through formal protection and off-reserve land management. Conservation action should normally include engaging with all major landowners and land users across a range of socio-economic sectors, to increase awareness of priority areas for meeting conservation targets, and to ensure that land management and land-use decisions in these priority areas support biodiversity conservation objectives (Driver *et al*., 2003)

Conservation assessment (also called biodiversity assessment) – the development of spatial data layers and the spatial analysis undertaken to identify options for meeting conservation targets for a range of biodiversity features. Conservation assessment should include the interpretation of the results of this analysis for a wide range of stakeholders (Driver *at al*., 2003).

Conservation planning (also called biodiversity planning) – a combination of spatial *conservation assessment* and an *implementation strategy and action plan* that, together, provide the basis for implementing *conservation action* (Driver *et al*., 2003).

Conservation targets (also called biodiversity targets) – quantitative targets that guide how much of each biodiversity feature needs to be conserved in order to conserve a representative sample of biodiversity structure and composition (pattern) and key ecological and evolutionary processes. Targets can be expressed as, for example, the number of occurrences of a particular wetland type.

Ecological and evolutionary processes – the interactive processes between organisms and between organisms and their surroundings, which operate over varying timescales (from seconds to millennia) to generate and maintain biodiversity. Ecological processes usually operate over relatively short time scales, while evolutionary processes operate over much longer time scales. Conservation assessments often include mapping and setting targets for the spatial components of these processes, namely the areas of land or water required to ensure their continued functioning.

Ecoregions – is a derived term that is used to describe distinct areas within larger landscapes, each of which has relatively homogenous characteristics; at the scale of an ecoregion, the mosaic or pattern of ecosystem components (biotic and abiotic) that comprise the ecoregion is different to that of adjacent regions, accounting for their distinction (Omernik and Bailey, 1997).

Ecosystem – a spatial unit of nature in which living organisms and the non-living environment interact adaptively (Wessel, 1993); dynamic assemblages or complexes of plant and/or animal species (including vascular and nonvascular plants, vertebrates, invertebrates, fungi, and microorganisms) that occur together on the landscape; that are linked to similar ecological processes (e.g., fire, hydrology), underlying environmental features (e.g., soils, geology), or environmental gradients (e.g. elevation); and that form a cohesive and distinguishable unit (Poiani *et al*., 2000); people are seen as part of the biotic component of ecosystems, where social and ecological systems are co-evolving at both local and global levels – human behaviour shapes nature and nature influences the development and behaviour of human society (Folke, 2003).

Ecosystem services – the benefits that humans derive from ecosystems. For aquatic ecosystems these include water, food, waste assimilation and purification, runoff retention, nutrient cycling, navigation, recreation, cultural and religious services

Ecotone – the transition area between two adjacent ecological communities

Implementation strategy and action plan – these are coherent, integrated documents that define activities, targets and timelines, lines of reporting and decision-making, specific responsibilities and accountabilities, resources (people, equipment, funds) to be used, measures of success and failure, emergency actions that may be needed, communications procedures and forms. They also usually address issues such as raising awareness, facilitating buy-in and building capacity to facilitate implementation of the outcomes of a *conservation assessment* (Driver *et al*., 2003). An *implementation strategy* should identify the key interventions that are needed to secure biodiversity priority areas that have been identified in a conservation assessment. Ideally, these are the ones that will give the biggest return on the scarce resources available for implementation. To be effective, an implementation strategy and action plan must be developed with the institutions and individuals responsible for implementation, and requires at least one champion based in each implementing institution to take it forward.

Inland water conservation area – an area that has been designated for the conservation of an inland water ecosystem, both in terms of conserving the structural and compositional components of the associated biodiversity and the ecological processes that influence these components of biodiversity.

Inland water ecosystems – Inland water ecosystems can be fresh or saline within continental and island boundaries. They include lakes, rivers, ponds, streams, groundwater, springs, cave waters, and floodplains, as well as bogs, marshes and swamps, which are traditionally grouped as inland wetlands (Convention on Biological Diversity, https://www.biodiv.org/).

Protected areas – areas of land or water that have been "*especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means*" (IUCN, 1994).

Rehabilitation – shifting a degraded ecosystem towards a greater level of integrity or higher use than it may be serving currently, but not necessarily to its original (unimpacted) state.

Restoration – actively trying to return a degraded ecosystem to its original ecological state.

Water resource – surface water found in watercourses (rivers and streams), impoundments (dams), wetlands and estuaries, and groundwater found in underground aquifers (DWAF's NWRS).

ABBREVIATIONS

BMPs	Best Management Practices
CARA	Conservation of Agricultural Resources Act
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMA	Catchment Management Agency
COP	CBD's Conference of the Parties
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Tourism
DLA	Department of Land Affairs
DoA	Department of Agriculture
DLA	Department of Land Affairs
DME	Department of Mineral and Energy Affairs
DPLG	Department of provincial and Local Government
DWAF	Department of Water Affairs and Forestry
ESD	Ecologically Sustainable Development
ESU	Evolutionary Significant Unit
IDP	Integrated Development Plan
IISD	International Institute for Sustainable Development
IUCN	The World Conservation Union
IWCA	Inland Water Conservation Area
MA	Millennium Ecosystem Assessment
MDGs	Millennium Development Goals
MEC	Member of the Executive Council [of a province]
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NePAD	New Partnership for Africa's Development
NSBA	National Spatial Biodiversity Assessment
NSDP	National Spatial Development Perspective
NWA	National Water Act (Act No. 36 of 1998)
NWRS	National Water Resource Strategy (2004)
RCC	River Continuum Concept
SADC	Southern African Development Community
SADCC	Southern African Development Co-ordination Conference
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
UNCED	United Nations Conference on Environment and Development
UNCHE	United Nations Conference on the Human Environment
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
WMA	Water Management Area
WRC	Water Research Commission
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

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1. INTRODUCTION

1.1 Background

An extensive body of international, regional and national policies and treaties have been drawn up or enacted to direct and support the conservation of inland water ecosystems. The wording and content of these laws, treaties and policies reflects specific sets of societal norms, values, and aspirations; nations that subscribe to them are legally and formally bound to give effect to their principles and objectives. A general tenet of ecosystem conservation has been to set aside specific areas or representative examples of ecosystem types to be protected so that they can act as biodiversity "banks". The rationale for these approaches is based on the assumption that these ecosystems can and should be protected from excessive future modifications by humans, for example through harvesting, pollution, resource extraction, or the introduction of exotic species. Such conserved areas can then become heritage resources that allow a society to share its biodiversity heritage with future generations, as well as benchmarks against which the success or failure of ecosystem management actions can be measured in the long-term.

In South Africa, the responsibility for conserving inland water ecosystems is shared between several segments or sectors of society and departments of government, with the result that there is often a considerable overlap of mandates. Departments that are responsible for water resource protection and management, biodiversity conservation, land use management, and integrated development planning are all key role players and their cooperative actions are necessary if inland water ecosystems and their biodiversity are to be managed effectively.

All South African government departments have undertaken rigorous reviews and revisions of their policies and legislation during the past decade. Several enabling policies and pieces of legislation that are designed to promote biodiversity conservation objectives now exist; the most notable of these are the National Water Act (Act No. 36 of 1998) and the National Environmental Management: Biodiversity Act (Act No. 10 of 2004). Taken together, these statutes provide the broad legal environment to advance the practical implementation of inland water conservation measures across all relevant sectors. These Acts also express the explicit need for preventative measures such as the development of strategic or forward-looking spatial plans that focus on proactive (or preventative) rather than reactive (or remedial) management actions.

However, one aspect that has not been properly addressed in national policy and legislation is the setting of national conservation targets for inland water ecosystems in South Africa. In particular, there is no explicit guidance regarding the desirable number or proportion of ecosystems to be conserved or the mechanisms through which effective conservation could or should be achieved. The present approach by resource management authorities and agencies is to deal with this issue on a case-by-case basis. A shortcoming of this case-by-case approach has been highlighted by the monitoring results obtained from the national River Health Programme (RHP – www.csir.co.za/rhp). In the RHP, the results of river surveys are expressed in river health classes (natural, good, fair, poor) for each appropriate river segment or reach. For each of the river systems the acceptability of the monitoring outcome may be argued in terms of the particular context created by the social, economic and ecological considerations within the specific river basin. However, when the data are aggregated to obtain an overall picture of the rivers within a province or South Africa as a whole, there is no guideline or answer to the question as to whether or not these results are acceptable.

It is inevitable that trade-offs need to be made between the protection of inland water ecosystems (to achieve biodiversity conservation targets) and the achievement of economic development. Given the high degree to which society relies on ecosystem goods and services, it is simply not socially or economically possible to maintain all ecosystems in natural or even good states. Therefore, the key question that needs to be answered is: how many inland water ecosystems should reflect a high level of protection (natural and good states) in order to claim that South Africa is effectively conserving the biodiversity that is associated with these systems? A second question that can be posed is: which ecosystems are most suited for, and will give the best returns, when they are included in a national design for inland water conservation? Neither of these questions can be answered easily; the information needed to provide the possible answers for them forms the subject of this discussion paper.

1.2 Purpose and scope of this discussion paper

The primary purpose of this discussion paper is to support the development of shared (i.e. inter-departmental) policy objectives and guiding principles that will help to implement the practical conservation of inland water biodiversity across multiple sectors and spheres of government. The paper contains detailed discussions of both the policy and scientific contexts that underpin the conservation of freshwater biodiversity, in order to inform and support a process of shared learning and decision-making in this field. The paper reflects the outcomes that have been achieved to date from the processes of analysis, consultation and deliberation that have taken place amongst the representatives of the main agencies that have primary responsibility for biodiversity conservation. Ideally, this should lead to consensus on a common policy statement and cooperative implementation plan for the conservation of inland water biodiversity in South Africa.

With this paper, we intend to:

- **Facilitate national-level coordination in the conservation of inland water ecosystems**: In order to achieve horizontal alignment and agreement on the conservation of inland water biodiversity in South Africa, it is necessary for biodiversity and policy specialists, as well as other practitioners from across the water resource management, environmental and biodiversity management, land use, agriculture and integrated development planning sectors, to engage each other in a debate on policy options. This initiative focuses on finding common ground (including terminology, policy coherence, and strategic intent) across relevant sectors, primarily at the national sphere of government. It is acknowledged that strategic direction can only become operational reality with the full participation of implementation agents, most of whom operate within provincial and local spheres of government. This paper is therefore seen as the first step of a longer process, working towards a situation where all the relevant parties are able to combine their respective skills and resources to the development and implementation of scientifically sound conservation designs and implementation plans for managing water resources in general and inland water biodiversity in particular.

- **Establish a bridge between science and policy**: This discussion paper is also intended to fit within the often-uncomfortable space between science and policy. It attempts to draw key lessons from "*best available science*" (see Francis *et al*., 2005), so as to inform policy options regarding inland water conservation priorities, decisions, operations, plans and responsibilities.

- **Present a suggested set of objectives, guiding principles and implementation options**: The discussion paper does not intend to be prescriptive in terms of the choice of the most appropriate methods to use in conservation planning for inland water biodiversity. In a relatively new and rapidly evolving field such as inland water conservation planning, many different methods need to be applied and tested; attempts to standardise at this early stage on a single approach could cause an undesirable stifling of innovation.

1.3 Process to date

During the period 2002-2004, the Department of Water Affairs and Forestry (DWAF), Water Research Commission (WRC) and CSIR have funded closely-related initiatives that sought to develop a capability for systematic conservation planning of inland water ecosystems. The emphasis of developments to date has been on:

- Developing methods and generating data layers for the spatial representation of both biodiversity pattern and key ecosystem processes, so as to provide a visual and numerical basis for selecting examples or samples of biodiversity and ecosystem processes that can be considered for conservation;
- Testing a planning framework for generating alternative spatial options that could satisfy explicit and quantitative conservation targets; and
- Designing conservation plans and their implementation strategies to facilitate the mainstreaming of river conservation philosophies, approaches and plans at sub-national levels (Water Management Areas) across South Africa.

A key outcome of the above developments has been the current WRC-funded project to "develop cross-sector policy objectives for conserving inland water biodiversity" (WRC project number K8/642). A central feature of this project has been its focus on facilitating cross-sector engagement. To this end, a first cross-sector meeting was held on 8 September 2005. Representatives of various departments of national government and other organs of state (see acknowledgements) deliberated a draft set of policy objectives (Version 1 of this document).

Most significantly, at the meeting of 8 September 2005, the representatives present:

- Approved in principle a national conservation target of 20 % of each main inland water ecosystem type;
- Accepted most of the guiding principles that were presented, subject to some modifications;
- Recommended the involvement in future deliberations of the Department of Mineral and Energy Affairs (DME) and Department of Land Affairs (DLA); and
- Elected a task team, to be chaired by Mr Harrison Pienaar of DWAF, to develop an inter-departmental strategy that would help to ensure effective collaboration in the conservation of inland water ecosystems. The content of this discussion paper is likely to provide a basis for developing such a strategy.

The discussion paper was revised to incorporate the comments, discussion and recommendations arising from the meeting of 8 September 2005. The revised version (Version 2, Draft 1) was circulated to a number of national and international specialists and conservation practitioners for review. The comments and additions received from these reviewers (see acknowledgements for names) were incorporated into a further draft (Version 2, Draft 2) of the discussion paper. Draft 2 was then tabled for consideration by the cross-sector representatives during a second meeting that was held on 22 February 2006. The contents of this final version of the discussion paper have been approved by the representatives (see acknowledgements) that attended the February meeting.

Part 1
The Science of Biodiversity Conservation

2. BIODIVERSITY SCIENCE AND MANAGEMENT

2.1 Human dependence on biodiversity

It can be argued that biodiversity has intrinsic value in and of itself. One such perspective is that all living things possess inherent worth and their interests deserve respect. From this position it is only a short, but fundamental, step to the controversial claim that all living things, individually and collectively, possess rights (Baird Callicott, 1995). The intrinsic value of biodiversity and the need for its conservation is a component that is recognised by the United Nations Convention on Biological Diversity, to which South Africa is a signatory, as well as our National Environmental Management: Biodiversity Act (Act No. 10 of 2004). Both of these instruments strive to conserve a representative sample of biodiversity as a natural heritage for current and future generations.

More recently, sound arguments have been made for the need to recognize that biodiversity is fundamental for current and future social and economic livelihoods (see Scholes and Biggs, 2004; Millennium Ecosystem Assessment, 2005). Our individual and collective dependence on biodiversity is absolute; without it, humans would not be able to survive. All food is directly or indirectly obtained from plants and other photosynthetic organisms. Apart from the direct benefits of biodiversity to be gained from the harvest of domesticated or wild species for food, fibres, fuel, pharmaceuticals and many other purposes, humans also derive benefit from its influence on climate regulation, water purification, soil formation, flood prevention and nutrient cycling; while the aesthetic and cultural impact of biodiversity is obvious (Daily, 1997; Balmford *et al*., 2002). All of these benefits to people fall into the broad category of "ecosystem services" (see Text Box 1 below), and can be summarised into provisioning, regulating and cultural services that affect people directly, as well as indirect supporting services that maintain the other services. In combination, these services benefit human well-being through impacting on security, quality of life, health and social relations, all of which influence the degree of freedom and the choices that are available to people.

Loss of biodiversity inevitably leads to ecosystem degradation and subsequent loss of important ecosystem services (Holmlund and Hammer, 1999; Duraiappah *et al*., 2005). Moreover, this loss tends to harm poor rural communities more directly, since they have limited assets and infrastructure and are more directly dependent on common property resources for their livelihoods. In contrast, the wealthy are buffered against loss of ecosystem services by being able to purchase basic necessities and scarce commodities. Our path towards sustainable development, poverty alleviation and enhanced human well-being for all, is therefore completely dependent on how effectively we are able to manage and protect biodiversity.

The value of and need for biodiversity conservation is summarised by The Paris Declaration on Biodiversity (see Section 3.9) as follows: "*Biodiversity, as the natural heritage and a vital resource for all humankind:*

- *Is a source of aesthetic, spiritual, cultural, and recreational values;*
- *Provides goods that have direct use values, such as food, wood, textiles and pharmaceuticals;*
- *Supports and enhances ecosystem services on which human societies depend often indirectly, such as plant and animal production, crop pollination, maintenance of water quality and soil fertility, carbon sequestration, nutrient cycling, protection*

against pathogens and diseases, and resistance of ecosystems to disturbances and environmental changes; and

- *Provides opportunities for human societies to adapt to changing needs and circumstances, and discover new products and technologies*."

Text Box 1
Ecosystem services and human well-being

Ecosystem services are the benefits that humans derive from functioning ecosystems. These include provisioning services, such as food and water; regulating services such as water regulation and purification; supporting services required to maintain other services, such as nutrient cycling; and cultural services such as recreation and spiritual services.

Changes in these services affect human well-being through impacts on security, the basic material for a good life, health, and social and cultural relations. These constituents of well-being are, in turn, influenced by and have influence on the freedoms and choices available to people. When ecosystem services are impaired this inevitably leads to a narrowing of livelihood choices and an increase in the vulnerability of the poor.

Source: Millennium Ecosystem Assessment (2005)

2.2 Conserving biodiversity

Biodiversity is an abbreviated umbrella term for nature's variety and is defined by the Convention on Biological Diversity as:

"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

Essentially, biodiversity refers to the variety of all life on Earth, and encompasses genetic, species and ecosystem (including habitat) diversity. Today's biodiversity is the result of millions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. While some two million species have been identified and described to date, scientists estimate that there are between three and 100 million species on Earth.

Noss (1990) took the definition of biodiversity a step further to define structural, compositional and functional attributes of biodiversity, each of these being manifest across a hierarchy of organisational levels from genes to landscapes. Noss's attributes of biodiversity are the biodiversity terms most commonly used by freshwater ecologists in South Africa, where:

- **Composition** describes what is there and how abundant it is;
- **Structure** describes how the units are organised (structured) in space and time; and

- **Function** describes the roles the different units play in maintaining processes and dynamics.

Over-emphasis on structural and compositional biodiversity in the past (e.g. focussing conservation efforts only or primarily on species or habitats) has often led to disruptions of fundamental ecosystem processes that maintain healthy ecosystem functioning. For long-term conservation of biodiversity, an integrated perspective of all three elements is essential (Margules and Pressey, 2000).

Because of its broad scope and multi-dimensional nature, biodiversity studies have the potential to serve a unifying role that transcends different disciplines. For example, biodiversity integrates ecology with evolution and biogeography. At the ecological scale, biodiversity integrates structure with function and biotic variables with abiotic variables. It also links spatial and temporal phenomena across hierarchical scales and levels of biological organisation (Ward and Tockner, 2001).

2.3 State of inland water ecosystems globally and locally

The development and utilisation of water resources to meet human demands generally happens at the expense of the structure and functions of inland water ecosystems (Redford and Richter, 1999; Richter *et al*., 2003). Consequently, the pressures that arise from social and economic aspirations have resulted in a worldwide and progressive degradation and loss of inland water habitats, which has become more easily visible in recent decades. This is reflected in the index of the world's freshwater species that shows a decline of 50 % between 1970 and 2000 – a decline that is more rapid than that recorded for equivalent terrestrial and marine indices (WWF, 2004). Similarly, South Africa's first National Spatial Biodiversity Assessment (NSBA), dealing with the terrestrial, river, estuarine and marine environments, highlights the fact that the country's river ecosystems are in a much poorer overall state than its terrestrial ecosystems (Driver *et al*., 2005).

The NSBA for rivers considered main rivers only, which make up less than 45 % of rivers in South Africa. Main rivers were defined as the rivers which pass through a quaternary catchment (nested within primary, secondary and tertiary catchments) into a neighbouring quaternary catchment. In instances where no river passed through the quaternary catchment (e.g. in coastal quaternary catchments which often encompass relatively short, whole river systems), the longest river system was chosen as the main river.The river assessment highlighted the following problems (Nel *et al*., In preparation):

- River integrity: The majority of main rivers (47 %) have been moderately modified; a further 23 % of these rivers are considered to be irreversibly transformed in terms of their ability to support biodiversity, and these rivers are therefore deemed to be unsuitable for conservation.
- Ecosystem status (based on a 20 % conservation threshold): Of the 112 main river ecosystem types (based on biodiversity surrogacy) that were identified, 84 % are threatened – 54 % critically endangered, 18 % endangered, and 12 % vulnerable.
- Protected area gap analysis: Over 90 % of all main rivers in South Africa are located entirely outside Type 1 protected areas (National Parks, Provincial Nature Reserves, and Department of Water Affairs and Forestry Nature Reserves). Half of the remaining rivers in South Africa form the boundaries of protected areas; thus

less than 5 % of main rivers in the country fall within protected areas that receive protection on both banks.

2.4 New approaches to biodiversity protection are required

A central tenet of biodiversity conservation is to set aside representative examples of ecosystems to act as "biodiversity banks" as a proactive protection against potential future modifications. Such conserved areas become heritage resources for sharing the current biodiversity heritage with future generations, as well as benchmarks against which human modification of ecosystems can be measured in the long-term. Several international agreements address this issue at global and regional levels, and there is a range of relevant policy and legislation in place in South Africa (see Chapters 4 and 5 of this discussion paper).

Lawton and May (1995) have estimated that species are currently becoming extinct at a rate estimated to be 100 to 1,000 times greater than rates recorded through recent geological time. The so-called "extinction crisis" could even be worse than current data suggest, since other studies have indicated that the worldwide fragmentation and destruction of natural habitats may result in extinctions that will not be apparent to us for several generations, creating an "extinction debt" (Tilman *et al*., 1994). Amphibians and freshwater fishes are thought to be, respectively, the world's most and second-most threatened groups of vertebrates (Bruton, 1995). The future extinction rate of North American freshwater animals has been predicted to be five times greater than that for terrestrial animals and three times greater than that for coastal marine mammals (Ricciardi and Rasmussen, 1999).

Groves (2003) reported that poor or ineffective planning in the identification and designation of areas for biodiversity conservation has exacerbated the extinction problem. Historically, most of the areas designated for conservation purposes were selected in an *ad hoc* manner and were not chosen specifically for biodiversity conservation purposes (Pressey, 1994). More recently, and partly in order to avoid conflicts between conservation and developmental interests, conservation efforts have tended to focus on areas of relatively low human population or low economic potential – which in turn often resulted from factors such as unproductive soils, steep slopes or high altitudes. However, the majority of biological diversity (as measured by the number of species) tends to occur in lower elevations, warmer climates, and coastal areas that are also more attractive to human occupation and use (Dobson *et al*., 2001). Importantly, these areas tend to have a much higher associated opportunity cost to society, and they are generally more heavily modified from their original state in comparison to areas that are less densely populated.

Two factors make the conservation of inland water biodiversity particularly challenging in comparison to efforts aimed at conserving terrestrial biodiversity. Firstly, while protected areas can support partial cessation of inland water habitat degradation and associated biodiversity loss, the design of protected areas is generally biased towards terrestrial biodiversity features, with inland water ecosystems being addressed only incidentally as part of their inclusion within terrestrial reserves (Skelton *et al*., 1995). Even where inland water systems are included in such planning exercises, this is typically done to serve terrestrial conservation goals. For example, river corridors may be selected to link inland basins with coastal plains to allow migration and exchange between inland and coastal biota (Cowling and Pressey, 2001). However, there are exceptions to this general observation: Saunders and co-workers list a number of protected areas that have been established specifically to protect inland water species and habitats, ranging from a 29 km^2 wetland in India to an 88,000 km^2 lake in the Russian Federation (Saunders *et al*., 2002). Also, in South Africa, biological diversity features linked to specific rivers were given special emphasis in planning the expansion of the Greater Addo Elephant National Park (Roux *et al*., 2002).

Secondly, the longitudinal nature of rivers and the relatively large size of most river basins makes it difficult to include whole catchments or the entire length of a river (e.g. greater than third order) within formally protected areas. In addition, rivers are often used as a convenient way to designate the boundaries of parks or protected areas. This partial inclusion in a protected area is no guarantee for protection, since impacts that take place outside park boundaries can still have negative consequences for riverine biodiversity within the park (Saunders *et al*., 2002). A good example of this can be seen in the Kruger National Park, South Africa's flagship national park. Rivers in the region of the Kruger National Park flow in an east-west direction, whilst the park spans the landscape in a north-south direction. This means that all the larger rivers flow through the park, rather than being contained within the park.

Experiences around the world confirm that *ad hoc* conservation efforts have failed to conserve the diversity of our biodiversity heritage. Without the adoption of a new management philosophy and approach, this trend is likely to continue. To address the need for a more proactive and systematic focus on inland water biodiversity, a relatively new discipline of "freshwater conservation planning" has emerged. This requires truly trans-disciplinary approaches, and draws on insights from the fields of systematic conservation planning, ecology and conservation biology, aquatic ecology (including hydrology, biology, geomorphology), water resources planning and management, and spatial information technology.

2.5 Freshwater conservation planning as a new discipline

2.5.1 Conservation biology and systematic conservation planning

Conservation biology is the discipline that attempts to prescribe methods for maintaining and restoring biodiversity. Essentially, this field embraces four key objectives, namely to:

- Represent, in a system of protected areas, all native ecosystem types and stages across their natural range of variation.
- Maintain viable populations of all native species in their natural patterns of abundance and distribution.
- Maintain ecological and evolutionary processes, such as natural disturbance regimes, hydrological processes, nutrient cycles and biotic interactions.
- Manage landscapes and communities to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of the biota (Noss and Cooperrider, 1994).

Systematic conservation planning is an applied branch of conservation biology that seeks to identify spatially explicit options for the effective conservation of biodiversity (Cowling and Pressey, 2001). Biodiversity pattern and the ecological and evolutionary processes that generate and maintain species are the primary considerations of the planning process. Systematic conservation planning has several distinctive characteristics:

- It requires clear choices to be made about the features to be used as representative surrogates for overall biological diversity in the planning process.
- It is based on explicit goals, preferably translated into quantitative targets, derived from a consensus amongst stakeholders.
- It recognises the extent to which conservation targets have been met in existing reserves and protected areas.
- It uses simple, explicit methods for locating and designing new reserves to complement existing reserves in achieving conservation goals.
- It applies explicit criteria for implementing conservation action on the ground, especially with respect to the appropriate scheduling of protective management when not all of the candidate areas can be secured at once.
- It adopts explicit objectives and mechanisms for maintaining the conditions within reserves that are required to foster the persistence of key natural features, together with monitoring of those features and a process of adaptive management as required (Margules and Pressey, 2000).

2.5.2 Applying systematic conservation planning principles to inland water ecosystems

Conservation planning began as a discipline that was developed specifically for the purposes of selecting formal protected areas, with a focus on terrestrial biodiversity. Over the years this narrow focus has broadened in two significant ways that have made the field more accessible to conservation planning for inland water ecosystems. First, the process of selecting conservation areas began to consider a full range of conservation management options – as opposed to focusing on formal protected areas only, thereby supporting the concept of maintaining and utilising biodiversity within a multiple use landscape (Driver *et al*., 2003). This paradigm shift is more appropriate in the context of conserving inland water ecosystems, as conserving these ecosystems requires management of whole catchments, and it is seldom feasible to incorporate entire catchments into protected areas. Secondly, it became clear that representing a sample of all biodiversity patterns needed to be supplemented with explicit incorporation of biodiversity processes. This notion is particularly applicable to conserving inland water ecosystems, which rely heavily on the maintenance of processes that depend on longitudinal, lateral, and vertical connectivity.

Conservation planning also requires that biodiversity should be depicted in some operational way, generally requiring the use of biodiversity surrogates that can serve as proxies for biodiversity pattern. The derivation of meaningful surrogates for inland water biodiversity has been one of the main challenges in this newly developing field. There are inherent problems when using species data as biodiversity surrogates, primarily because these data are even less complete than the data available for terrestrial species. Problems with incomplete data, collection bias and incomplete taxonomic understanding can drive conservation planners to select areas that are well sampled, whilst ignoring areas that might be important but have no data. Terrestrial conservation plans have circumvented this by classifying the landscape according to vegetation types or broad habitat types and using this as the primary biodiversity surrogate in selecting areas (although ideally this should be supplemented with species data). However, classifying inland water ecosystems across the landscape has remained elusive, mainly because it is more difficult to depict inland water ecosystems in a spatially explicit manner because of the highly dynamic nature of water resources in both time and space. It is only in recent years that hierarchical procedures for systematically classifying inland water ecosystems have been developed, such as the ecoregion approach of Omernik (1987), and the hierarchical and systematic framework of Dollar *et al*. (In press). Deriving such classifications to depict biodiversity has provided further impetus for the application of conservation planning principles and tools to inland water ecosystems.

Text Box 2
To protect or to conserve

In South African water policy, the term water ***conservation*** is most often used to refer to water use efficiency, where water demand management approaches are used to improve efficiency. The term resource ***protection*** is more commonly used to refer to the protection of ecological features, the integrity or the ecological state of water resources. The term ***protection***, as used in water policy, is a pragmatic concept, which is applicable to all water resources and not only those located inside formally protected areas.

In terrestrial conservation science, the term ***conservation*** is used generically to incorporate the concepts of protection, preservation, management and restoration. On the other hand, the term ***protection*** in terrestrial disciplines generally implies restricted access, usually governed through the proclamation of some sort of formal protected area.

It is clear that the terms ***protection*** and ***conservation*** could have different and even directly opposite connotations when used by water resource and terrestrial land-use planners, respectively. Following the lead of South African water policy, protection of water resources is seen to refer to the efforts aimed at maintaining and improving the integrity of all water resources, and thus regaining or sustaining their capacity to provide services to society. The particular level of protection and the nature or portfolio of services derived will vary depending on which of three possible management classes is designated to a specific resource.

This discussion paper uses the term biodiversity **"conservation"** to refer to efforts to maintain or restore the ecological integrity (including structure, composition and function) of inland water ecosystems to levels that are in accordance with the most stringent (most highly protected) water resource management class. Initiatives to conserve inland water biodiversity would thus not apply to all water resources, but only to those water resources that are awarded the highest protection level based on the national water resource classification system (see Section 4.3.1). The use of formal protected area networks to effect such conservation is one of the implementation options available to water resource managers.

Part 2
Mandates, Obligations and Responsibilities Arising From International, Regional and National Policy and Legislation

3. BRIEF HISTORY OF INTERNATIONAL BIODIVERSITY GOVERNANCE

An extensive body of international, regional and national policies and treaties exists that relate to the conservation of inland water ecosystems. These treaties and policies reflect certain societal norms, values and aspirations; the nations that subscribe to them are legally and morally bound to give effect to their principles and objectives.

The following brief overview of the international institutional history of efforts to protect biodiversity is based largely on a report produced by the International Institute for Sustainable Development (IISD, 2005). South Africa has been, and continues to be, involved in these efforts to different degrees and in different ways. The nature of this involvement has influenced the development of national policy and legislation, as described in more detail in Section 4 of this document.

3.1 Ramsar Convention (1971)

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (also known as the Ramsar Convention – www.ramsar.org), signed in Ramsar, Iran in 1971, was the first modern intergovernmental treaty to provide a framework for action and international cooperation for the conservation and wise use of wetlands and their resources. Initially, the focus of the treaty was rather narrow, but over the years its scope has broadened to cover all aspects of wetland conservation and wise use, recognising wetlands as ecosystems that are extremely important for biodiversity conservation and for the well-being of human communities. There are presently 147 contracting parties to the convention, with 1,524 wetlands covering a combined area of 129.2 million hectares.

The Convention's mission is "*the **conservation and wise use** of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world*". The definition of "wetlands" is relatively broad and includes swamps and marshes, lakes and rivers, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans. One of its key obligations is to include wetland conservation in national land-use and water planning to promote "the wise use of wetlands in their territory". The principle of "***wise use***" is an important link to both the Agenda 21 (Section 3.4) and the Convention on Biological Diversity (Section 3.5), as it explicitly considers human needs. The Convention has set up joint work plans and other collaborative arrangements with the conventions on Biological Diversity, Combating Desertification, Migratory Species, and World Heritage, as well as the Framework Convention on Climate Change and UNESCO's Man and the Biosphere programme.

By ratifying the Ramsar Convention, South Africa has committed itself to:

- Designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance (referred to as the List hereinafter);
- Formulate and implement its planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory;

- Promote the conservation of wetlands and waterfowl by establishing nature reserves on wetlands, whether they are included in the List or not, and provide adequately for their wardening;
- Promote the training of personnel who are competent in the fields of wetland research, management and wardening; and
- Consult with each other about implementing obligations arising from the Convention especially in the case of a wetland that extends over the territories of more than one Contracting Party, or where a water system is shared by Contracting Parties.

Each Contracting Party is invited to designate a national governmental agency to act as the Administrative Authority of the Convention in the country. The Administrative Authority is the focal point for communications with the Ramsar Secretariat and the main agency responsible for the implementation of the treaty. The Department of Environmental Affairs and Tourism (www.deat.gov.za) plays this role in South Africa.

3.2 UNCHE and UNEP (1972)

The first United Nations Conference on the Human Environment (UNCHE, 5-16 June 1972, Stockholm, Sweden) led to the adoption of several regional and international agreements, including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Delegates to the Stockholm UNCHE meeting also resolved to establish the United Nations Environment Programme (UNEP), which was subsequently codified by the United Nations General Assembly in Resolution 2997 (XXVII) of 1972. As a key part of this mandate, UNEP administers a number of international instruments related to biodiversity, including the Convention on Biological Diversity (CBD), CITES, the Convention on Migratory Species, the Framework Convention on Climate Change, and the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities.

As a member of the United Nations, South Africa’s responsibilities in relation to UNCHE are to:

- Commemorate 5 June each year as World Environment Day and to undertake activities on that day publicly to reaffirm their concern for the preservation and enhancement of the human environment.
- Accept the responsibility to achieve the environmental goal “*to defend and improve the human environment for present and future generations - a goal to be pursued together with, and in harmony with, the establishment and fundamental goals of peace and of world-wide economic and social development*.”

3.3 Brundtland Report (1987)

In 1987, the World Commission on Environment and Development (also named the Brundtland Commission, after its Chair, Norwegian Prime Minister Gro Harlem Brundtland) concluded that economic development must become less ecologically destructive. In its landmark report, entitled “*Our Common Future*,” the Commission noted that “*humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs*.” It also called for “a new era of environmentally sound economic development.”

3.4 Earth Summit and Agenda 21 (1992)

At the 1992 United Nations Conference on Sustainable Development (3-14 June 1992, Rio de Janeiro, Brazil), also called the “Earth Summit”, world leaders agreed to launch a comprehensive strategy for sustainable development. Three key international instruments were adopted, namely the CBD, the United Nations Convention to Combat Desertification, and the Forest Principles. The Rio Declaration, which has now been adopted by more than 178 Governments, sets out 27 principles on environment and sustainable development, including the precautionary approach, the polluter-pays principle, and Agenda 21.

The water chapter (Chapter 18) of Agenda 21 requires countries "*to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature*”. The chapter provides guidance for the protection of water resources, water quality and aquatic ecosystems, and sets targets which include:

- Protection and conservation of water resources on a sustainable basis;
- Water pollution prevention and control;
- Establishment of biological, health, physical and chemical quality criteria for all water resources; and
- Adoption of an ***integrated approach*** to environmentally sustainable management of water resources, including the protection of aquatic ecosystems and freshwater living resources.

Although the water chapter provides a useful framework for water management and sustainability, it largely neglects biodiversity aspects in the management of transboundary (shared) water resources. It therefore does not provide a regulatory framework for interaction between countries which require cooperative management of common water resources and inland water biodiversity.

3.5 Convention on Biological Diversity (1994)

The Convention on Biological Diversity (CBD) (http://www.biodiv.org), to which South Africa is a signatory, came into force in 1994 and currently has 188 Contracting Parties. The Convention sets out three main objectives, namely:

- The conservation of biological diversity;
- The sustainable use of its components; and
- The fair and equitable sharing of the benefits arising from the use of genetic resources.

The CBD calls on the Contracting Parties to:

- Conserve representative samples of all major ecosystem types;
- Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sector or cross-sector plans, programmes and policies;
- Integrate consideration of the conservation and sustainable use of biological resources into national decision-making; and

- Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable uses of biological resources.

The CBD's Conference of the Parties (COP) has developed a series of work programmes to address ecosystem biodiversity, as well as work programmes and activities on cross-cutting themes, including invasive alien species, incentive measures, access to genetic resources and benefit sharing, traditional knowledge, technology transfer, education and public awareness, and protected areas.

Inland waters was adopted as a CBD thematic area at the fourth meeting of the COP (4-15 May 1998, Bratislava, Slovakia). The Convention's inland waters programme promotes the ecosystem approach (see Appendix A), including integrated watershed management, as the best way to reconcile competing demands for dwindling supplies of inland waters. It is essential that the maintenance of biodiversity is seen as a critical demand for freshwater use and is managed in coordination with other demands. The programme identifies the actions that Parties need to carry out to halt the trend of biodiversity loss, including: monitoring, assessment and evaluation of biological diversity of inland water ecosystems, conducting Environmental Impact Assessments of water development projects, development of pollution prevention strategies choosing and using appropriate technology, and promoting transboundary cooperation, ecosystem based management and the involvement of local and indigenous communities at all appropriate levels.

The sixth meeting of the CBD's COP (7-19 April 2002, The Hague, The Netherlands) adopted the Strategic Plan for the CBD. In its mission statement, Parties committed themselves to a more effective and coherent implementation of the three objectives of the Convention and to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and to the benefit of all life on Earth. The delegates to the COP-6 meeting also adopted a Ministerial Declaration, which recognizes the need for timetables and the need to review implementation mechanisms and targets, including a 2010 target to adopt measures to halt biodiversity loss.

The seventh meeting of the CBD's COP (9-20 February 2004, Kuala Lumpur, Malaysia) adopted a framework to:

- Facilitate and communicate an assessment of progress towards the 2010 target;
- Promote coherence among the Convention's programmes of work; and
- Provide a flexible framework, within which national and regional targets may be set and indicators identified.

Delegates to the COP-7 meeting specified several key indicators (http://www.biodiv.org/2010-target/indicators.aspx) for assessing progress towards the 2010 target at the global level. These indicators were supplemented with a series of goals and sub-targets for seven focal areas, as well as a general approach for integrating these into the CBD's work programmes.

3.6 Cartagena Protocol on Biosafety (2003)

The Cartagena Protocol on Biosafety, adopted by Parties to the CBD on 29 January 2000, entered into force on 11 September 2003. There are currently 111 Parties to the Protocol. The Protocol addresses the safe transfer, handling and use of living modified organisms that may have an adverse effect on biodiversity, taking into account human health, with a specific focus on trans-boundary movements of these organisms.

3.7 Millennium Summit (2000)

The UN Millennium Summit (6-8 September 2000, New York, USA) adopted the Millennium Development Goals (MDGs). The MDGs have been universally accepted as a framework for measuring progress in development at country (national) level.

Text Box 3
Millennium Development Goals (World Bank, 2002)

Goal 1 – Eradicate extreme poverty and hunger
- Halve, between 1990 and 2015, the proportion of people whose income is less $1 a day
- Halve, between 1990 and 2015, the proportion of people who suffer from hunger

Goal 2 – Achieve universal primary education
- Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

Goal 3 – Promote gender equality and empower women
- Eliminate gender disparity in primary and secondary education preferably by 2005 and in all levels of education no later than 2015

Goal 4 – Reduce child mortality
- Reduce by two-thirds, between 1990 and 2015, the under five mortality rate

Goal 5 – Improve maternal health
- Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio

Goal 6 – Combat HIV/AIDS, malaria, and other diseases
- Have halted by 2015 and begun to reverse the spread of HIV/AIDS
- Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases

Goal 7 – Ensure environmental sustainability
- Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources
- Halve, by 2015, the proportion of people without sustainable access to safe drinking water
- Have achieved, by 2020, a significant improvement in the lives of at least 100 million slum dwellers

Goal 8 – Develop a global partnership for development

- Develop further an open, rule-based, predictable, non-discriminatory trading and financial system
- Address the special needs of the least developed countries
- Address the special needs of landlocked countries and small island developing states
- Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term
- In cooperation with developing countries, develop and implement strategies for decent and productive work for youth
- In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries
- In cooperation with the private sector, make available the benefits of new technologies, especially information and communication technologies

In 2002, the United Nations launched the Millennium Project to devise a plan of implementation that would enable developing countries to meet their MDGs by 2015, and to assess progress towards their achievement by 2005. The protection and sustainable management of biodiversity – including genetic resources, species and ecosystem services that support human development – is central to achieving the Millennium Development Goals (MDGs). Although one of the MDGs (MDG 7, on ensuring environmental sustainability) deals explicitly with biodiversity, wise use of biological resources is recognised as important for the full range of development priorities encompassed by all eight MDGs.

3.8 World Summit on Sustainable Development (2002)

The World Summit on Sustainable Development (WSSD, 26 August - 4 September 2002, Johannesburg, South Africa) adopted the Johannesburg Plan of Implementation and the Johannesburg Declaration. The Plan of Implementation states that: "*Human activities are having an increasing impact on the integrity of ecosystems that provide essential resources and services for human well-being and economic activities. Managing the natural resources base in a sustainable and integrated manner is essential for sustainable development. In this regard, to reverse the current trend in natural resource degradation as soon as possible, it is necessary to implement strategies which should include targets adopted at the national and, where appropriate, regional levels to protect ecosystems and to achieve integrated management of land, water and living resources, while strengthening regional, national and local capacities*."

Chapter 4 of the WSSD Plan of Implementation acknowledges that biodiversity, which plays a critical role in overall sustainable development and poverty eradication, is essential to our planet, human well-being and to the livelihoods and cultural integrity of all people. However, it also recognised that biodiversity is currently being lost at unprecedented rates due to human activities. This trend can only be reversed if the local people benefit directly from the conservation and sustainable use of biological diversity in their countries, in particular in countries of origin of genetic resources, in accordance with Article 15 of the CBD.

3.9 Paris Declaration on Biodiversity (2005)

A full copy of this declaration is available online at website:
http://www.recherche.gouv.fr/biodiv2005paris/en/appelparisbiodiv.htm

The International Conference on Biodiversity Science and Governance met from 24-28 January 2005 at the headquarters of the United Nations Educational, Scientific and Cultural Organization (UNESCO), in Paris, France. Organized by the French Government and sponsored by UNESCO, the Paris Conference was attended by over 1000 participants representing governments, inter-governmental organizations and non-governmental organizations, as well as academia and the private sector. The delegates agreed on the Paris Declaration, dated 28 January 2005, the main points of which are summarised below.

- **Biodiversity is a natural heritage and a vital resource for all humankind.** Biodiversity, which is the product of more than 3 billion years of evolution, is an irreplaceable natural heritage and a vital resource upon which humankind depends in many different ways.
- **Biodiversity is being destroyed irreversibly by human activities**. The loss of species and genetic biodiversity is essentially irreversible, and therefore poses serious threats to sustainable development and the quality of life of future generations.
- **A major effort is needed to discover, understand, conserve and sustainably use biodiversity**. Strong actions must be taken now to inventory, understand and protect biodiversity in order to meet the Millennium Development Goals, and ensure food security, human health, and a good quality of life are enjoyed by all.

4. REGIONAL AND NATIONAL POLICY CONTEXT

4.1 Policy coherence

Where South Africa is a signatory to an international treaty or convention, all organs of state should embrace the associated responsibilities and implications. In the cascading down of policy from international to national contexts, and especially where an issue of concern may involve more than one sector, it is critically important to pay close attention to policy coherence. Policy coherence has two dimensions, namely vertical coherence and horizontal coherence. Vertical policy coherence entails ensuring that local and provincial authorities pursue policies that are aligned with and support, and do not undermine, national policies; and that individual nations pursue policies that support regional and/ or international policies and treaties. Horizontal policy coherence entails achieving a complementary consistency of policies across related sectors at any particular level. As an example, the policy interests of this discussion paper would require coherence in the expression of objectives regarding land use and ecosystem protection across the water, industry, health, biodiversity, environmental management and agricultural sectors.

4.2 Relevant regional agreements and associated responsibilities

The previous chapter introduced the most prominent international treaties that should guide vertical coherence in the field of inland water conservation and biodiversity management. The most relevant regional initiatives for achieving coherence at regional level are the New Partnership for Africa's Development (NePAD) and the Southern African Development Community (SADC):

4.2.1 New Partnership for Africa's Development

The New Partnership for Africa's Development (NePAD) spells out the vision of African leaders to eradicate poverty and to place their countries, individually and collectively, on a path of sustainable growth and development (NePAD, 2001). NePAD provides the overarching trans-national strategy that will influence future development and management of Africa's natural resource base. It has been recognized that a healthy and productive environment is a prerequisite for the success of NePAD, together with the need to systematically address and sustain ecosystems, biodiversity and wildlife. As such, six programmatic areas and related activities were identified:

- Combating land degradation, drought and desertification;
- Conserving Africa's wetlands;
- Preventing and controlling invasive alien species;
- Conservation and sustainable use of coastal and marine resources;
- Combating climate change in Africa; and
- Cross border conservation and management of natural resources.

4.2.2 Southern African Development Community

The Southern African Development Co-ordination Conference (SADCC) was formed in Lusaka, Zambia on 1 April 1980 following the adoption of the Lusaka Declaration.

SADCC was replaced by the Southern African Development Community (SADC – www.sadc.int), through signing of the SADC Treaty at the Summit of Heads of State or Government on 17 August 1992, in Windhoek, Namibia. Member states of SADC are Angola, Botswana, Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. SADC aspires to achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of southern Africa, and support socially disadvantaged groups through regional integration. Article 5(g) of the SADC Treaty aims to achieve the sustainable utilization of natural resources and to effectively protect the environment (SADC, 1992).

In recognition of the importance of a coordinated approach to utilization and preservation of water, SADC member States signed the **Protocol on Shared Watercourse Systems** at the 1995 SADC Summit in South Africa. A revised version of this protocol has since been signed at Windhoek, Namibia, on 7th August 2000. The main thrust of the Protocol, which is a legally binding document, is to ensure equitable sharing of water and also ensure efficient conservation of the region's scarce water resources. South Africa's obligations under the SADC Treaty are contained in the protocol and include: close cooperation with regard to the study and execution of all projects; the exchange of available information; sharing of a watercourse system in an equitable manner; and the respect for rules of general and customary international law related to the subject.

In order to address national priorities through regional action, member states have been allocated the responsibility of coordinating one or more sectors. This involves proposing sector policies, strategies and priorities, and processing projects for inclusion in the sectoral programme, monitoring progress and reporting to the Council of Ministers. Lesotho is responsible for the Environment, Land Management and Water Sector.

4.3 Current and emerging South African policies and legislation related to conservation of inland water biodiversity

South African environmental policies and legislation have been influenced by international trends in the environmental field, and by South Africa's obligations as a Contracting Party to several multi-lateral environmental agreements. In addition, domestic priorities have been equally significant in catalysing changes in policies. Since 1994, South African government policy has focused on equitable and sustainable social and economic development for the benefit of all South Africa's people. At the time (1994), many of South Africa's existing laws were not appropriate to achieving these objectives. Therefore, the policy and legal framework in South Africa has been thoroughly reviewed and re-aligned with the new direction set out by government. In the water and environmental sectors, previously fragmented policies have been consolidated and re-formulated in accordance with principles of sustainable development and equitable access, to allow all South Africans to benefit from improved access to and use of these resources.

The following sections provide a brief overview of the major post-1994 developments that took place, often concurrently, in the water and environmental sectors. Several of these developments are convergent in the sense that they share a common philosophy, and support the development of cross-sector policy for the conservation of inland water biodiversity. However, the necessary next step is to develop shared operational plans, objectives and approaches that are in accordance with the common philosophy – it is this step which is the focus of this discussion paper.

4.3.1 Managing water as a national resource

(a) White Paper on National Water Policy (1997)

Through a consultative process, 28 Fundamental Principles and Objectives for a new South African Water Law were accepted and published in 1996 (see Appendix B). The subsequent White Paper on a National Water Policy that was published in 1997 proposed ways that could best facilitate achievement of these principles and objectives. Specific proposals included the following:

- Water will be regarded as an indivisible national asset. National government will act as the custodian of the nation's water resources and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of administrative authorisations.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions. These will have appropriate community, racial and gender representation to enable all interested persons to participate.

(b) National Water Act (1998)

The National Water Act (Act No. 36 of 1998 - NWA) derives directly from the Fundamental Principles and Objectives for a New South African Water Law and White Paper on National Water Policy. The Act is the principal legal instrument relating to water resources management in South Africa and, as enabling legislation, contains comprehensive provisions for the protection, use, development, conservation, management and control of South Africa's water resources. It is these legal provisions that enable the proposals in the National Water Policy to be implemented.

(c) National Water Resource Strategy (2004)

The National Water Resource Strategy (2004 - NWRS) provides the framework within which the NWA will be implemented, i.e., within which water resources will be managed throughout the country. To give effect to the interrelated objectives of equitable access to water resources and their sustainable use, a dual management approach has been adopted. First, measures have been introduced to protect water resources by setting objectives for the desired ecological conditions of resources (referred to as resource-directed measures). Secondly, measures have been put in place to control water use to limit impact to acceptable levels (referred to as source-directed controls). Key to integrating these dual sets of measures in an operational environment is the proposed national water resource classification system.

The water resource classification system must provide a logical and consistent framework for classifying water resources, where each of the three proposed management classes represents a permissible but different balance between resource utilisation and resource protection. Each of the proposed management classes has specific implications regarding the way in, and extent to, which the resource can be utilised, as well as the types of services that can be provided by the resource on a sustainable basis. Each class or "state" of a water resource must be characterised in hydrological, physico-chemical, biological and geomorphological terms to enable goal-directed management and protection of the resource. Such ecological specifications would guide management decisions regarding options for sustainable and permissible resource use, where increasing restrictions on use will apply as the level of protection increases. The classes of the water resource classification system, as proposed by the NWRS are: natural; moderately impacted; heavily impacted (see Text Box 4 for specific descriptions of the classes).

Text Box 4
Proposed water resource classification system (NWRS, 2004)

Proposed class	Description
Natural	Human activity has caused no or minimal changes to the historical natural structure and functioning of biological communities, hydrological characteristics, chemical concentrations, and the bed, banks and channel of the resource.
Moderately used or impacted	Resource conditions are slightly or moderately altered from the Natural class due to the impacts of human activity and water use.
Heavily used or impacted	Resource conditions have been significantly changed from the Natural class due to human activity and water use, but these are nonetheless still ecologically sustainable.

Due to localised over-exploitation, some water resources are already in a state that is regarded as ecologically unsustainable. These resources are referred to as unacceptably degraded resources.

The Natural class is intended to provide a reference condition for describing the moderately and heavily used / impacted classes, while resources in other classes will be defined in terms of the degree of deviation from the Natural class. Where resources are unacceptably degraded, the management class of Heavily used / impacted would be set as a default goal towards which the specific resource must be managed. In some cases, rehabilitation may have to be undertaken in order to achieve this goal. Specific provisions may need to be developed to accommodate permanently modified rivers (such as canalised urban rivers) within the national classification system to ensure proper management of these resources, while also acknowledging that it may not be sensible or cost-effective to restore the physical, chemical and biological character of such "urban rivers" to levels or states that match any of the management classes.

The classification system will be applied to all surface water resources in South Africa, with specific provisions for the different characteristics of rivers, wetlands, impoundments and estuaries. The system can potentially be used as a tool to classify water resources based on their current condition, as well as a way to specify a desired future condition.

4.3.2 Valuing biodiversity as a national asset

(a) White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997)

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity was published in 1997 after a comprehensive public consultation process. This policy provides the mission, vision and principles that inform, guide and provide a context to South Africa's policy and strategy. Six goals have been formulated, each of which in turn comprises a number of relevant policy objectives and strategies that are required to attain these objectives. In addition, the implementation of the policy, including the roles of key players, the legislative framework, the institutional changes required, funding, and priority actions are all addressed in the White Paper.

(b) National Environmental Management Act (1998)

The primary objectives of the National Environmental Management Act (Act No. 107 of 1998 – NEMA) are to describe and clarify a series of basic National Environmental Management Principles that must guide decision-making about the environment; provide for cooperative governance with respect to the environment; and set out the requirements of integrated environmental management. Thirteen principles (see Appendix C) serve as guidelines that any organ of state must refer to when exercising any statutory function or when taking any decision in terms of any statutory provision that may concern the protection of the environment.

The content of NEMA also underscores a "duty of care" towards the environment, which is defined in terms of both abiotic and biotic elements. Section 28(2) of NEMA specifies that a person who is likely to cause significant degradation to the environment must take reasonable measures to prevent, minimise or rectify such degradation.

(c) The National Environmental Management: Protected Areas Act (2003)

Protected areas are seen as an extremely important tool for achieving biodiversity objectives, since these often provide greater security for conservation-worthy land than the agreements or land use limitations provided for in the National Environmental Management: Biodiversity Act (see below). The National Environmental Management: Protected Areas Act (Act No. 57 of 2003 – Protected Areas Act) creates a framework and management system for all protected areas in South Africa, as well as establishing the South African National Parks (SANParks) as a statutory board. The system of protected areas in South Africa consists of:

- Special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments;
- World Heritage Sites;
- Marine protected areas in terms of the Marine Living Resources Act (Act No. 19 of 1998);
- Specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act (Act No. 84 of 1998); and

- Mountain catchment areas declared in terms of the Mountain Catchment Areas Act (Act No. 63 of 1970).

(d) National Environmental Management: Biodiversity Act (2004)

The objectives of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004 – Biodiversity Act) are set out within the framework of NEMA and are designed to provide for:

- The management and conservation of biodiversity in South Africa, and the components of such biological diversity;
- The use of indigenous biological resources in a sustainable manner;
- The fair and equitable sharing among stakeholders of benefits arising from bio-prospecting that involves indigenous biological resources;
- To give effect to ratified international agreements relating to biodiversity;
- To provide for cooperative governance in biodiversity management and conservation; and
- To provide for the South African National Biodiversity Institute (SANBI) to serve as a national coordinating agency for biodiversity conservation and management.

The Biodiversity Act provides for the Minister to publish a notice in the Government Gazette that issues norms and standards, and indicators for monitoring progress, for the achievement of any of the objectives of the Act (Section 9). The Act applies throughout South Africa and is binding on all organs of state – at national, provincial and local levels (Section 4).

The Biodiversity Act also provides for the development of a National Biodiversity Framework to guide all strategic development planning processes regarding the integration of biodiversity planning and monitoring in South Africa (this framework is in preparation by DEAT at the time of writing). The Biodiversity Act also provides for the preparation of statutory bioregional plans – for which the National Spatial Biodiversity Assessment (NSBA) provides a national context – and statutory biodiversity management plans for threatened ecosystems or species.

One of the key provisions in the Act allows the Minister or an MEC to list threatened or protected ecosystems. This provision provides a powerful mechanism to address biodiversity conservation effectively and efficiently, at the ecosystem scale rather than a single species at a time. Importantly, the Act does not specify how threatened ecosystems should be identified; the NSBA provides a useful starting point for this, based on the best available science and information.

The categories of ***ecosystem status*** as listed in the Biodiversity Act are based on the IUCN threatened species categories, and are: Critically endangered; endangered; vulnerable; protected (see Text Box 5 for descriptions of the categories).

Text Box 5
Categories of ecosystem status recognized in the Biodiversity Act

Ecosystem status	Definitions in the Biodiversity Act
Critically endangered ecosystems	Ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation.
Endangered ecosystems	Ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems.
Vulnerable ecosystems	Ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems.
Protected ecosystems	Ecosystems that are of high conservation value or of high national or provincial importance, and that do not fall in any of the above categories.

(e) National Biodiversity Strategy and Action Plan (2005) and National Biodiversity Framework

South Africa has recently prepared its first National Biodiversity Strategy and Action Plan (NBSAP) led by the Department of Environment Affairs and Tourism (this is a formal requirement of South Africa as a signatory to the CBD, as well as in terms of the Biodiversity Act). South Africa's NBSAP provides a coherent common vision and long-term plan for the:

- The conservation of biodiversity;
- The sustainable use of its components; and
- The fair and equitable sharing of benefits arising from the use of genetic resources.

The focus of the NBSAP is on mainstreaming biodiversity priorities throughout the economy, and making links between biodiversity and socio-economic development. In a country like South Africa, with extraordinary biodiversity resources, there is no need to view the resolution of socio-economic development challenges and the conservation of biodiversity as opposing goals. Rather, they can reinforce each other, so that conserving biodiversity strengthens the national economy and contributes to social development. The NBSAP builds upon the firm policy foundation established by instruments such as the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity, by translating biodiversity-related policy goals and objectives into prioritised plans for integrated, coordinated and systematic action. South Africa also faces the challenge of giving effect to the outcomes of the World Summit on Sustainable Development. The NBSAP provides the road map for achieving the biodiversity-related targets contained in the Summit's Plan of Implementation.

Furthermore, the NBSAP provides the basis for the National Biodiversity Framework discussed in (d) above. Such a Framework will provide an integrated, coordinated and uniform approach to biodiversity management, identify priority areas for conservation and establish norms and standards to guide provincial and municipal environmental conservation plans.

(f) National Spatial Biodiversity Assessment (2004)

The NSBA represents South Africa's first national assessment of biodiversity for conservation action, integrating terrestrial, river, estuarine and marine ecosystems, based on available spatial data, biodiversity planning software and a series of expert and stakeholder workshops (Driver *et al*., 2005). The NSBA was undertaken as part of the National Biodiversity Strategy and Action Plan (NBSAP). As far as we know, South Africa is the first country to include a comprehensive spatial assessment of biodiversity as part of its NBSAP. This is an important step towards guiding bioregional planning at sub-national levels, as set out in the Biodiversity Act.

4.3.3 Promoting wise land use for sustainable livelihoods and agricultural production

(a) Conservation of Agricultural Resources Act (1983)

The Conservation of Agricultural Resources Act or CARA (Act No. 43 of 1983) covers all land except Mountain Catchment Areas and enables the Department of Agriculture to exercise control over the utilization of South Africa's natural agricultural resources. The Act provides for the conservation of these resources by maintaining the land's production potential, combating and preventing erosion, protecting vegetation and combating weeds and invaders. Regulation 7 of CARA deals specifically with the utilisation and protection of vleis, marshes, water sponges and watercourses. It stipulates that no land user shall utilize the vegetation in a vlei, marsh or water sponge or within the flood area of a watercourse or within 10 metres horizontally outside the flood area in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources. It further stipulates that, except on the authority of written permission by the Executive Officer of CARA, no land user shall drain or cultivate any wetland, or cultivate the land within the flood area of a watercourse including a 10-metre buffer zone outside the flood area.

(b) National LandCare Programme (1997)

This is a community-based and government-led initiative that seeks to improve the ability of land users and communal farmers to manage their natural resources in a sustainable and self-reliant manner. The programme offers provincial support, technical assistance and education awareness programmes to community groups who identify, implement and monitor conservation and management activities necessary to deal with land degradation problems while improving their livelihoods.

(c) Discussion document on agricultural policy in South Africa (1998)

This document outlines broad principles that govern policy on the agricultural use of natural resources. It emphasizes the government's responsibility in promoting the sustainable use of natural resources in agriculture, and enhancing the ecological integrity of natural systems, while simultaneously minimizing or avoiding risks that will lead to irreversible damage.

(d) Strategic Plan for South African Agriculture (2001)

This plan reflects a commitment to the realization of the sustainable use of agricultural natural resources. One of its three core strategies is sustainable resource management, which aims to enhance farmers' capacities to use resources in a sustainable manner and to ensure the wise use and management of natural resources. Central to this strategy is the objective to preserve agricultural biodiversity and to promote the sustainable use of soil and water through the enhancement of crop and livestock productivity and more sustainable farming systems.

(e) Sustainable Utilisation of Agricultural Resources Bill (2006)

This Bill will provide for the development of various incentive programmes and also prescribes standards, control measures and law enforcement aimed at assisting farmers and natural agricultural resource users to promote conservation practices that will improve the quality of the soil, water, and agro-ecosystems in their utilization process. Once approved, the Sustainable Utilization of Agricultural Resources Bill will replace CARA.

(f) Best Management Practices (BMP's)

Some farm practices have the potential to cause environmental harm, and this may affect rural and urban areas alike. For example, a significant portion of all pollutants entering streams, lakes, estuaries and groundwater results from agricultural activities; hence there is an urgent need to control agricultural non-point source pollution. Many of the negative impacts of farming can be reduced by the installation or utilization of "best management practices" (BMP's). These practical, "common sense" and affordable practices help to reduce risks to the environment and enhance sustainable utilization of natural resources without sacrificing economic productivity. Agricultural producers use BMP's to control the generation and delivery of pollutants from their agricultural activities to water resources, thereby improving water quality.

BMP's in agriculture include but are not limited to, the following general types:

- **Reducing / limiting inputs** – this applies most directly to fertilizers, manures, herbicides, pesticides and other agricultural chemicals. Nutrient management and pest management can be practiced as control measures.

- **Soil erosion and sediment control measures** – these include practices such as strip-cropping, use of cover crops, conservation tillage, sub soiling, surface roughening, land grading, crop rotation, grazing management, irrigation water management, soil salinity control, contour banks, animal feeding operations management, storm water control systems and residue management. These options are designed to prevent erosion and reduce movement of nutrients and pesticides from agricultural land.

- **Conservation barriers and buffers** – these include options such as grassed waterways, vegetative strips, field borders, floodways, floodwater diversion, crosswind trap strips and riparian buffers.

- **Prevention and mitigation against disaster** – including risk reduction measures such as: avoiding overstocking of livestock, grazing management, fencing, soil cover, control and prevention of veldfires, runoff management, cross-wind trap strips, and artificial wind barriers.

All BMP's yield positive results when they are implemented properly – in this, they help to ensure sustainable utilization of natural resources. Importantly, not all BMP's will work equally well on every farm because of variations in soils, cropping systems, moisture conditions and the management approaches of individual farmers.

4.3.4 Integrated spatial planning and development

(a) Municipal Systems Act (2000)

According to the Municipal Systems Act (Act No. 32 of 2000), all municipalities (i.e. Metros, District Municipalities and Local Municipalities) have to undertake an integrated development planning process to produce integrated development plans (IDPs). Integrated development planning is a process by which municipalities prepare 5-year (linked to the term of office of councillors) strategic plans that are reviewed annually in consultation with communities and stakeholders. An IDP seeks to promote integration by balancing social, economic and ecological pillars of sustainability and by coordinating actions across sectors and spheres of government.

An IDP includes the following core components:

- An assessment of the existing level of development, which includes identification of communities with no access to basic services;
- The municipality's vision (including internal transformation needs);
- The council's development priorities and objectives;
- The council's development strategies;
- A spatial development framework;
- Disaster management plan;
- Integrated financial plan (with both capital and operational budgets); and
- Key Performance Indicators and performance targets.

Since an IDP is a legislative requirement, it has a legal status and it supersedes all other plans that guide development decisions at local government level.

(b) Intergovernmental Relations Framework Act (2005)

The South African Constitution provides for a three-sphere government system, constituted as the national, provincial and local spheres of government. The spheres are characterised by their distinctiveness, interdependence and interrelatedness.

The primary location of the intergovernmental relation system is within the Department of Provincial and Local Government (DPLG). The DPLG has put in place the Intergovernmental Relations Framework Act (Act No. 13 of 2005). The overall purpose of this act is to provide, within the concept of cooperative government as set out in Chapter 3 of the South African Constitution, an institutional framework for the national, provincial and local governments and all other organs of state within those governments, to facilitate coherent government, coordinate implementation of policy and legislation, provide for effective delivery of services, promote general realisation of national priorities and strengthen monitoring of implementation of policy and legislation.

In the context of this discussion paper, there is an urgent need to align and integrate conservation priorities for inland water ecosystems with the spatial and development planning initiatives taking place at the three spheres of government: municipal IDP at the local sphere; Provincial Growth and Development Strategies (PGDS); and the National Spatial Development Perspective (NSDP).

Part 3
Common Principles, Goals and Objectives

5. SETTING AND ACHIEVING A COMMON CONSERVATION GOAL

5.1 Guiding principles for inland water conservation

In making decisions and taking actions that impact on inland water biodiversity, all sectors of government and society should be guided by three core principles derived from our own Constitution, as well as from the obligations that have arisen from South Africa having acceded to international agreements and Conventions (see Part II, Section 3 of this document).

These core principles are:

- Ecologically sustainable development;
- Equity; and
- Efficiency.

The three principles are discussed in more detail below, and the implications of adherence to each principle are explored briefly.

5.1.1 Ecologically sustainable development

The concept of sustainable development is explicitly promoted by South Africa's Constitution (Act No. 108 of 1996) and the NWA, and is given formal status in legislation by NEMA. Sustainable development endeavours to ensure that the needs of the current generation can continue to be met without compromising the ability of future generations to meet their own basic needs. Natural resources should be used within the ability of these resources to satisfy the need for their services (ecosystem services), both now and in the future.

The expression and concept of sustainable development originated from a realisation that the earth's natural resource base is finite and that it can pose limits to development. Although the concept originated from an ecological school of thought, it is often used outside of this context; for example in expressions such as economic and social sustainability. For the purpose of this document, we refer specifically to ecologically sustainable development (ESD), where the economic system exists within and because of the social system, while the social system and human existence is only possible within the ecosphere or ecological system (Minns, 1995; Mebratu, 1998). Following from this, the goals of societies must reflect the constraints and boundaries that are inherent to natural ecosystems. Ecosystem management therefore requires a proactive planning approach in which ecological well-being and functioning is the governing factor and the permissible level of developmental use is the dependent variable (Cocklin *et al*., 1992).

In South Africa, both positive and negative pressures stimulate the need for ESD. Positive pressures include a democratic government system that supports the rights of people, an active civil society that demands care of both people and the environment, and world-class natural resources of international significance. Negative pressures include pervasive poverty, high unemployment and rapid rates of environmental degradation. The need to face both positive and negative pressures has provided a strong stimulus for the uptake of sustainable development thinking into all aspects of the South African government's activities (Binedell *et al*., 2004).

It is acknowledged that, due to both social and ecological complexity, a pathway to sustainability cannot easily be charted in advance, but should rather be navigated through iterative processes of learning and adaptation. Therefore, sustainable development should not be seen as a destiny but rather as a journey that is based on an ethos that shapes the behaviour of individuals, institutions and nations. The degree to which the ethos of sustainable development is embraced will determine the trajectory of the pathway or journey that is selected from the array of various trajectory options.

While there is a need for policies and strategies that enable the application of an ethic of sustainable development at the national level, it is sometimes necessary to make trade-offs between the needs of different human users and the needs of the environment at more local levels. Along a continuum of options for the sustainability journey, strong and weak sustainable development represent two approaches at opposite ends of the continuum. In the context of this paper:

- "Strong" sustainable development means striving for strict protection of water resources by always using these resources within their ability to satisfy human needs now and in the future. Equivalently, natural capital is not irreversibly substituted (*i.e.* traded off, transformed or compromised) for social and/or economic capital. Strong sustainability involves a strong commitment to environmental protection.
- "Weak" sustainable development refers to a less stringent protection of water resources in which some natural capital is irreversibly substituted for social and/or economic capital. The greater the degree of such substitution, the weaker the sustainable development and the greater are the risks that the development will not be truly ecologically sustainable in the long-term.

For example, in terms of the proposed water resource classification system, the natural class would equate to a trajectory of strong sustainability while weak sustainability is exercised where the heavily used / impacted class is attained and maintained. The moderately used / impacted class falls in-between the two extremes. Unacceptably degraded resources should, by default, be improved to at least the heavily used / impacted class.

5.1.2 Equity

Implicit with the principle of sustainable development is the principle of equity, which can be divided into two sub-principles namely equity between generations and current equitable access and allocation. Equity between generations promotes current socio-economic enhancement that does not compromise the rights of future generations. Current equitable access and allocation of resource services strives to fairly and justly balance national responsibilities and priorities with the socio-economic needs and preferences of the current generation. A phrase that is often used is the fair and equitable sharing of benefits arising from genetic resources.

Following from the above principle are three guiding statements:

- Future generations have the same basic rights as the present generation;
- The present generation has a responsibility to conserve its biodiversity heritage; and
- The present generation should strive to achieve equity in their access to and benefits derived from biodiversity resources.

Since inland water ecosystems are highly variable in time and space, so too is the availability and demand for ecosystem services. Consequently, equity in the distribution of costs and benefits tends to be dynamic. At any one time, equity can be seen as a multi-dimensional tension between: quantitative and qualitative costs and benefits; present and future generations; different groups of stakeholders; and different geographic scales (Breen *et al*., 2003).

5.1.3 Efficiency

Water should be used to the best possible social, ecological and economic advantage. Conservation planning recognises the principle of efficiency through selecting complementary, rather than duplicate, natural resources for high levels of protection (Margules and Pressey, 2000).

5.2 Establishing a common conservation goal for inland water biodiversity

From a purely practical perspective, it is simply not possible to allocate a high level of protection to all resources throughout the country without prejudicing social and economic development. Equally, it is not desirable for all resources to be classified at a uniformly low level of protection that would permit them to be used and exploited to the maximum extent possible. For water resources, this aspect has been addressed through the water resource classification system, which provides for the development of a framework for assessing and managing water resources in terms of their selected class, level of protection, or "ecological state". Each ecological state has implications for the way and extent to which that water resource is utilised (see Section 4.3.1).

This discussion paper is concerned with the identification of those water resources that should receive a high level of protection in order to serve the objective of effectively conserving inland water biodiversity. The water resource classification system provides the primary rationale and implementation tool in this respect, and in applying the system it is necessary to address questions such as:

- How many inland water ecosystems should be maintained in the "natural class", or in other words, should be awarded a high protection status?
- Which inland water ecosystems are best suited to being designated as a natural class?
- How should inland water ecosystems with a high protection status be integrated or linked into an overall (national) conservation design to provide optimal efficiency and benefit?
- Should rehabilitation targets be set for inland water ecosystems that may be heavily used / impacted or that are unacceptably degraded, but are critical for achieving overall inland water conservation targets?

The above questions can only be answered if we know what we would like to achieve, i.e. we need a vision or goal statement. For example, a simple goal statement would be to "s*ave some of everything; save enough to last"* (Shaffer and Stein, 2000, cited in Groves, 2003). In line with the aspiration of modern society to sustain the diversity of life on earth, we propose that the goal for inland water conservation should be:

to conserve a sample of the full variety or diversity of inland water ecosystems that occur in South Africa, including all species as well as the habitats, landscapes, rivers and other water bodies in which they occur, together with the ecosystem processes responsible for generating and maintaining this diversity, for both present and future generations.

5.3 Achieving the goal through operational objectives

While it may be relatively easy to share a common philosophy and goal, little will be achieved in reality unless the common goal is cascaded down into a comprehensive set of common operational objectives, where all agree on what must be done, and who will take responsibility and accountability for which tasks/aspects. These operational objectives must be clearly understood by all, collaboratively developed, and cooperatively implemented.

A set of five core objectives and associated implementation principles are presented in Part IV of this document as imperatives to achieving the inland water biodiversity conservation goal stated above. Objectives one to three deal with planning and design issues, while objectives four and five deal with implementation issues. The five objectives and their respective implementation principles are to:

- Set and entrench quantitative conservation targets for inland water biodiversity:
    - Set and endorse national targets for conservation of inland water biodiversity;
    - Cascade the national targets differentially to sub-national implementation levels; and
    - Improve and refine national and sub-national targets over time.
- Plan for representation of inland water biodiversity:
    - Use appropriate surrogate measures as indicators to describe and classify inland water biodiversity;
    - Define the appropriate scales; and
    - Incorporate local ecological knowledge.
- Plan for persistence of inland water biodiversity:
    - Select inland water ecosystems of high integrity;
    - Ensure connectivity;
    - Include large-scale ecosystem processes; and
    - Select areas of sufficient size.
- Establishing a portfolio of inland water conservation areas (IWCAs):
    - Legislate IWCAs through complementary legal mechanisms;
    - Design for optimal land-use efficiency;
    - Prioritise and initiate conservation actions timeously;
    - Conserve first where appropriate, rather than restore or rehabilitate later; and
    - Provide explicit selection options and management guidelines.
- Enable effective implementation:

- Facilitate stakeholder adoption of inland water conservation targets and priority areas;
- Reflect the conservation of inland water biodiversity as an explicit function in institutional design;
- Enable cooperative governance in the conservation and management of inland water biodiversity;
- Facilitate a science-management continuum; and
- Promote discovery, inventory and improved understanding of inland water biodiversity.

Part 4
A Recommended Set of Cross-Sector Policy Objectives for Conservation of Inland Water Biodiversity

6. BACKGROUND AND OVERVIEW OF THE SET OF OBJECTIVES

The following sections contained in Part IV of this discussion paper set out a suggested set of five core policy objectives which, when considered with their associated implementation principles, are intended to provide a blueprint for cross-sector coordination and cooperation in achieving the national goal of conservation of inland water biodiversity.

Each objective is covered in a separate section. First, a statement and brief description of the objective is provided; this is then supported by a summary of the associated implementation principles. Secondly, since the implementation principles are necessarily quite technical in nature, in each case a considerable amount of information is provided on the scientific basis and rationale for the implementation principles. Thirdly, a set of cross-sector policy recommendations is presented. These recommendations were discussed and agreed at the meetings of cross-sector representatives on 8 September 2005 and 22 February 2006 (see Section I – Introduction to this report).

7. OBJECTIVE 1: SET AND ENTRENCH QUANTITATIVE CONSERVATION TARGETS FOR INLAND WATER BIODIVERSITY

This objective addresses the ***setting of minimum requirements for inland water biodiversity conservation*** in order to: allow an evaluation of whether existing conservation efforts represent the biodiversity of a region adequately; provide guidance for planners who are balancing a number of competing demands for natural resources in a region; and provide water resource management and biodiversity conservation agencies with common quantitative measures for which to aim (Groves, 2003).

There are three implementation principles associated with this objective, namely to:

- Set and endorse national targets for conservation of inland water biodiversity;
- Cascade the national targets differentially to sub-national implementation levels; and
- Improve and refine national and sub-national targets over time.

7.1 Set and endorse national targets for conservation of inland water biodiversity

This implementation principle acknowledges that there is a need for explicit and quantitative conservation targets at national level.

7.1.1 Rationale

Provincial and local governments make daily decisions about land use. It is only natural that these decision-makers should have a decision-making agenda that is determined by the political boundaries of their particular jurisdictions (Groves, 2003). These political demarcations rarely if ever follow natural patterns of biodiversity occurrence or the natural paths and spatial extent of ecological processes. Without appropriate information at relevant spatial scales, provincial and local governments may unknowingly make decisions that result in the degradation or destruction of some of the best examples of ecosystems in South Africa or southern Africa.

Furthermore, South Africa’s obligation to adhere to and give effect to international agreements is a national responsibility. As such, a target for conserving inland water biodiversity should be set and endorsed at national level, for implementation at sub-national levels (e.g. a province, catchment, or district municipality).

A recommendation by the World Conservation Union’s Caring for the Earth Strategy (IUCN, 1991) stipulates that a minimum of 20 % of a country’s natural aquatic assets require protection. Dropping below this threshold (i.e. failing to meet a minimum target of 20 %) implies that the ecosystems are inadequately represented in the country, and have become critically endangered. In a desktop conservation assessment for main rivers in South Africa, 54 % of the 112 identified main river ecosystems were found to be critically endangered (Nel *et al*., In preparation). It must be noted that this assessment considered main rivers only, which make up less than 45 % of rivers in

South Africa; the remainder of the country's rivers are smaller tributaries, which are often less heavily impacted by human activities.

In a sub-national conservation planning exercise for the Fish-to-Tsitsikamma Water Management Area (Nel *et al*., 2006), 90 % of main river ecosystem types (based on biodiversity surrogacy) associated with main rivers were found to be critically endangered. This excluded the contribution that ecosystem types associated with healthy tributaries can make to achieving conservation targets. The inclusion of tributaries that have a high ecological integrity within the same analyses lowered this proportion to 21 % of the ecosystem types being critically endangered in the Fish to Tsitsikamma Water Management Area. This highlighted the importance of maintaining high ecological integrity in tributaries within this area. However, it also highlighted the extremely poor state of main rivers in the area, and the need for main river integrity to be improved if longitudinal connectivity, so vital for maintaining river functioning, is to be maintained.

In another sub-national conservation design undertaken for both main rivers and tributaries in Mpumalanga, South Africa, Maree *et al.* (In preparation) assessed the feasibility of achieving 10, 20 and 40 % conservation targets (based on total length of rivers within the study area). It was found that 10 % is not sufficient to achieve representation and could not cater for biodiversity persistence. A target of 40 % of the total river length was difficult to achieve in terms of management feasibility and the availability of ecosystems that are still sufficiently intact. The 20 % target "felt sufficient" for a panel of experienced riverine ecologists, and at the same time could be selected with minimal conflict, both in terms of existing land uses and on existing ecological intactness.

7.1.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- The quantitative target for inland water biodiversity conservation in South Africa should be to maintain (and restore where necessary) at least ***20 % of each inland water ecosystem type*** (determined at the appropriate scale – see Section 8.2) in a Natural Class, where Natural Class refers to the highest level of protection afforded by DWAF's Water Resource Classification System.
- The national government departments responsible for water resources, biodiversity, land management and integrated planning should officially endorse the national conservation target for inland waters and integrate this target into their respective policy and strategic processes.
- National government is, and should remain, accountable for achieving the 20 % conservation target. However, all spheres of government (national, provincial and local) should have a role in prioritising inland water ecosystems for conservation, and share a responsibility for achieving effective conservation of identified systems. National government should be responsible for driving the process of harmonising conservation prioritisation and implementation between national, provincial and local spheres of government.
- The conservation of inland water ecosystems that are shared with neighbouring countries should be addressed through the development of bi-national or multi-national agreements.

7.2 Cascade the national targets differentially to sub-national implementation levels

This implementation principle acknowledges the need for ownership and achievement of the conservation target at all levels of operational responsibility. It also acknowledges that it may not be feasible to achieve conservation targets uniformly across the administrative landscape because of current levels of ecological transformation, and because different inland water ecosystems do not contribute uniformly to the overall biodiversity of the country. In practice, the informed judgement of specialists needs to be evaluated against the practical attainability of conservation targets in a specific region to allow realistic and achievable targets to be set (Groves, 2003).

7.2.1 Rationale

In essence, two implementing agencies are responsible for ownership and achievement of sub-national conservation targets for inland waters, namely provincial conservation agencies and Catchment Management Agencies (CMAs). Nineteen Water Management Areas (WMAs) have been delineated in South Africa to serve as the sub-national units within which integrated water resource management takes place under the auspices of Catchment Management Agencies (CMAs). The WMAs can be subdivided along topographical features into catchments or drainage regions, which are areas within which rainfall will drain into the watercourse(s) where surface runoff will flow to a common point.

Inland water ecosystem types are more often than not shared between administrative units that would be responsible for their management. For example, using the river ecosystem types associated with main rivers, it is possible to identify river ecosystem types that are confined mostly to one WMA, as well as the more widespread river ecosystem types, which occur across several WMAs (Nel *et al.*, In preparation). This enables an assessment to be made of the degree of cooperation that is needed between the different Catchment Management Agencies for them to conserve inland water biodiversity in the country. The results indicate that only 43 % of the river ecosystems types associated with main rivers fell within a single WMA. Of the remaining river ecosystem types, 38 % required coordinated conservation actions between two to three WMAs, while 19 % will require close coordination between four or more WMAs (Figure 1).

The need for a coordinated response to conservation of inland water ecosystems is demonstrated clearly by the example of the Fish-to-Tsitsikamma Water Management Area (Nel *et al.,* 2006). Because of the poor ecological integrity of main rivers within this water management area, longitudinal connectivity is severely degraded, making it difficult to find river systems of sufficient viable size to conserve several ecosystem types within the area. In instances where such ecosystems are confined to the Fish-to-Tsitsikamma Water Management Area (e.g. Eastern Cape Fold Mountains 5; see Nel, 2006), there is a need for rehabilitation to meet national targets, since losing the ecosystem type within this area would result in a losing this in the country. However, in instances where the ecosystem type is shared with other water management areas (e.g. Southern Coastal Lowlands 2; Nel, 2006), there may be an opportunity to refer conservation responsibility to the adjacent water management areas which have more opportunity for conserving this ecosystem type. This referral of responsibility should however be formally coordinated to ensure that national targets are met differentially within the different water management areas.

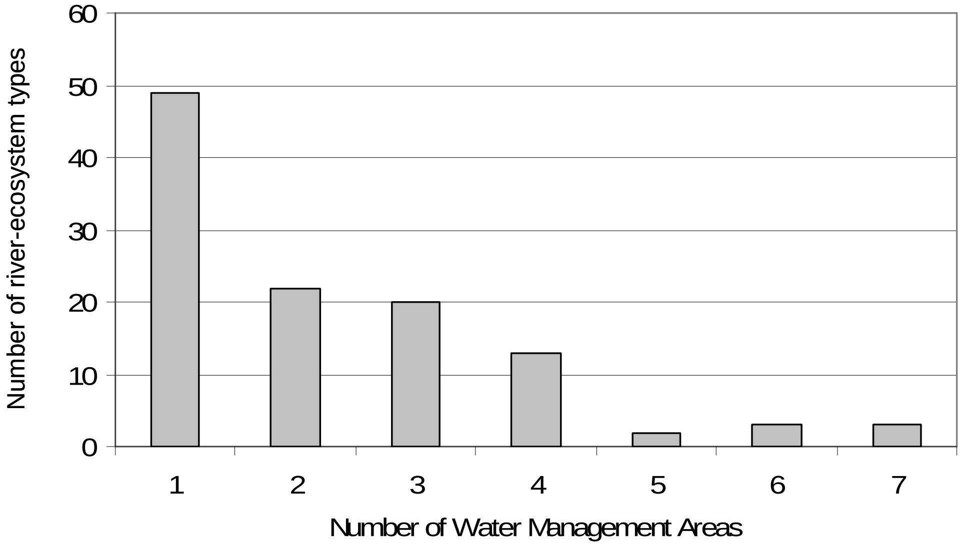

Figure 1

The degree of cooperation required between catchment management agencies for conserving river biodiversity in South Africa. Fort-four percent of river ecosystem types are unique to a single management area (i.e. occur in only one water management area). Conserving the rest of the ecosystem types will require the coordinated effort of between two and seven of the catchment management agencies.

The main advantage of cascading the national conservation target down to the 19 WMAs is that each of these management areas corresponds to surface hydrological boundaries, which are the most meaningful administrative boundaries for managing inland water resources. The main advantage of cascading the conservation target downwards to the nine provinces is that most of the provincial authorities, who act as key implementing agencies for biodiversity management, have appropriate biodiversity and conservation planning expertise and experience. Furthermore, district and local municipality boundaries, nested within provinces, are key areas for site-specific biodiversity management interventions through the integrated development planning processes and spatial development frameworks, and ideally they should be provided the resources necessary to help meet national biodiversity objectives.

7.2.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- The national inland water conservation target should be cascaded down as sub-national targets to correlate with the 19 WMAs set out by the NWRS.

- Where specific inland water ecosystems are shared between two or more WMAs, the national target need not necessarily be met uniformly across these areas of administrative responsibility. Rather, the constitution of the national target through sub-national component targets may reflect variation in the richness of inland water biodiversity as well as achievability due to present levels of ecological transformation across the landscape. Overall, a fair and equitable distribution of responsibility regarding biodiversity conservation should be achieved; and responsibilities should be matched with appropriate resources (in terms of skilled staff, equipment, information and funding).
- Sub-national targets should be set in collaboration with the relevant sub-national government agencies, ideally these should be juxtaposed with biodiversity assessment and conservation planning exercises. It should be the overall responsibility of national government, and specifically DEAT (primarily through SANBI), to facilitate and oversee the spatially nested processes of biodiversity assessment, conservation planning and target setting.
- It should be the responsibility of DWAF, primarily through its CMAs and the practice of integrated water resource management (IWRM), to implement the conservation targets at sub-national level. CMAs should be responsible for fostering horizontal and vertical coherence and coordination of conservation actions. For example, planning for the conservation of inland water biodiversity should engage with the National Biodiversity Framework and its responsible parties, the relevant Catchment Management Strategy(s) and its responsible parties, and local development planning and decision-making structures including municipalities within the jurisdiction of the relevant Catchment Management Agency (or DWAF Regional Office where a CMA has not been established).

7.3 Improve and refine national and sub-national targets over time

This implementation principle acknowledges that, at the landscape level, it may not be possible to determine a direct relationship between a percentage conservation target and the degree to which the overall (national) conservation goal is achieved. It also acknowledges that knowledge and understanding related to ecological thresholds and conservation targets should increase over time, as the science of setting conservation targets advances, based partly on information fed back from implementers to scientists.

7.3.1 Rationale

The setting of conservation targets reflects scientific best judgement, while the adoption and implementation of these targets is a reflection of societal norms and values. At best, setting and adoption of these targets should be informed through our evolving understanding of the effect of anthropogenic activities on the structural, compositional and functional elements of biodiversity. Each target that is set should therefore be subject to thorough periodic review.

7.3.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- The national conservation targets for inland water ecosystems should be subject to review every five years. Review should be coordinated by SANBI, with inputs from all of the relevant national custodians and stakeholders of these targets, for example DWAF, DEAT, NDA, DPLG, and SANParks.
- The national custodians of the inland water conservation targets should identify and support the research needed to enable informed revision of the national targets over time.

8. OBJECTIVE 2: PLAN FOR REPRESENTATION OF INLAND WATER BIODIVERSITY

The objective of representing inland water biodiversity is to ensure ***adequate representation of the full spectrum of inland water biodiversity, based on the systematic description and depiction of the inland water biodiversity within the region of concern***.

In terms of current legislation, the NWRS proposes that, for a resource to be classified as Natural, at least one of the following criteria should apply: (i) the resource is situated in a national or international heritage site or wilderness area; (ii) it has compelling biodiversity characteristics; (iii) it is a protected site under the Ramsar Convention on Wetlands; (iv) it is situated in an area that has economic importance for tourism or the harvesting of medicinal plants; (v) it has social and/or cultural significance; (vi) it is an area designated as Natural under other legislation, such as priority areas within bioregional plans published in terms of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004 – Biodiversity Act).

However, implementation of the above criteria will not necessarily lead to representative conservation of inland water biodiversity, as the criteria are *ad hoc*, as opposed to systematic, in nature. A key objective of conserving representative examples of inland water biodiversity is the promotion of a systematic approach to the identification, prioritisation and conservation of inland water ecosystems, as opposed to a focus on well studied, relatively unmodified, or biologically more diverse systems.

Three implementation principles inform the achievement of the objective of representing inland water biodiversity, namely:

- Use appropriate surrogate measures as indicators to describe and classify inland water biodiversity;
- Define the appropriate scales; and
- Incorporate local ecological knowledge.

8.1 Use surrogate measures as indictors to describe and classify inland water biodiversity

This implementation principle acknowledges the need for systematic conservation planning as opposed to *ad hoc* or reactive identification of conservation priorities. Furthermore, it acknowledges that it is impractical to identify and classify all the elements of biological diversity.

8.1.1 Rationale

(a) Coarse filter surrogates

The compilation of a complete taxonomic inventory for any ecosystem is a formidable task. To demonstrate this point, in an intense effort that spanned almost two decades, a small German stream has produced a list of 1,044 species of invertebrates from a relatively small study area – and this number is likely to increase with further study (Allan and Flecker, 1993). Every stream, and in fact every pool of the same stream, can be shown to be distinct in its biophysical characteristics. However, representing inland water biodiversity implies the use of data layers that are uniform for the whole of the area of concern – allowing systematic assessment and conservation planning.

Due to a general shortage of uniform biological data at species, population or community levels, it is more common for landscape and ecosystem parameters to be used as surrogates for overall biodiversity. Ecosystem geography is the hierarchical study of pattern and process distribution across ecosystems at different spatial scales, from sites through landscapes to ecoregions (Bailey, 1996). A patch dynamics perspective can be used as a framework for delineating pattern and processes at different spatial and temporal scales (Poole, 2002). The patch dynamics perspective segments landscapes into sets of relatively homogenous units. Hierarchy theory separates systems into nested subsystems, often based on process rates between the subsystems. Each subsystem can then be considered a complete system when viewed at a finer spatial or temporal scale within the hierarchy (see Figure 2).

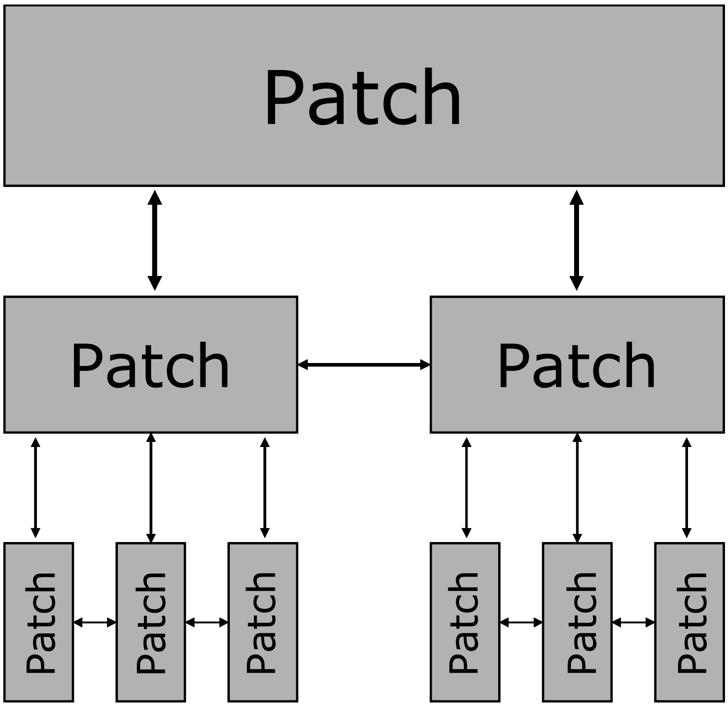

Figure 2
A patch hierarchy, where each row represents the same landscape divided into relatively homogenous patches but at different spatial scales. Arrows represent processes that create interactions and feedbacks between patches both within and across scales (after Poole, 2002).

In this context, ecoregions can be defined as relatively large areas of land and water that contain geographically distinct assemblages of natural communities (Omernik, 1987; Omernik and Baily, 1997). Still other classification systems have merged the concept of the ecosystem with the cultural and social landscape, to define units of governance that match social and ecological functions – referred to as bioregions – to promote sustainability (Brunckhorst, 2000). The Biodiversity Act promotes bioregional planning and an ecosystems approach (see Appendix A), as opposed to a species-only approach. Bioregions are very loosely defined in the Biodiversity Act as regions that contain whole or several nested ecosystems that are characterised by landforms, vegetation cover, human culture and history.

In essence, surface water resources are a reflection of the landscapes that they drain. Catchment geology, soils, climate, vegetation types, and landscape changes dictate the character of inland water ecosystems in terms of flow pattern, channel morphology, water temperature and nutrient regimes, and substratum character. In turn, these variables interact to shape and control the biological attributes of water resources (Stanford, 1998). Accordingly, inland water biodiversity can be represented, at least at a coarse level, by the heterogeneity of the landscape in which they occur.

(b) Environmental gradients

In addition to landscape patches, the diversity of inland water ecosystems (especially lotic or river systems) are characterised by multi-dimensional environmental gradients. For example, river heterogeneity is produced by interactions and transitions between surface waters, subsurface waters, inundated sediments and riparian systems, all of which are integral components of river ecosystems. Three dimensions of environmental gradients are of particular relevance (Ward and Tockner, 2001), namely:

- ***Longitudinal dimension***: Upstream-downstream changes, especially for river systems that cross altitudinal gradients or physiographic units, contribute to structural diversity of river landscapes at the catchment scale. Longitudinal changes also occur at finer scales of resolution, such as between reaches or as riffle-pool transitions.
- ***Lateral dimension***: In narrow valleys or gorges, the lateral gradient may be an abrupt aquatic-terrestrial transition across a narrow riparian corridor. In alluvial reaches, a flood plain may consist of a complex gradient of aquatic and riparian habitats that collectively contribute high structural diversity.
- ***Vertical dimension***: Sub-surface water and aquifers are integral parts of river ecosystems. Alluvial aquifers contribute substantial structural heterogeneity to these ecosystems.

Several landscape-level or ecoregional classification systems have been developed for South African rivers, for example Biogeographic Regions (Eekhout *et al*., 1997), Ecoregions (Kleynhans *et al*., 2005) and Geomorphic Provinces (Partridge *et al*., In preparation). A Hydrological Index (Hannart and Hughes, 2003) provides a further means of classifying landscape patches that reflect the relative homogeneity of river ecosystem types in terms of their flow variability. The geomorphological zonation of Rowntree and Wadeson (2000) is an example of a system that describes the longitudinal gradients of rivers. In another approach, independent classifications (ecoregions, flow and geomorphic river zones) were linked via a multi-scaled hierarchical framework to identify representative rivers (Roux *et al*., 2002).

(c) Fine filter surrogates

Lombard *et al*. (2003) have found that whilst coarse surrogates for biodiversity may perform well at representing wide-ranging and common species, their performance is lower, and therefore less useful, for range-restricted species that are often endemic and naturally rare. For this reason, wherever it is feasible, coarse landscape-level surrogates should be supplemented by the use of “fine filter” surrogates, which are commonly based on species or species groups. Species data should be assessed for use based on criteria of:

- National geographic coverage with limited survey bias;
- Taxonomic completeness i.e. records for all or most species within the taxon;
- Sound taxonomic knowledge i.e. high levels of confidence in the taxonomy of the species within the dataset; and
- Spatial resolution of at least a quarter degree grid square.

Apart from rare and endemic species, other species groups that are useful in conservation planning include keystone species, umbrella species, species guilds and meta-populations. These are defined below:

- ***Keystone species*** are those species on which the persistence of a large number of other species in the ecosystem depends; their removal from a system results in a domino effect of extirpation of numerous dependent species (Paine, 1966; see Text Box 6). A keystone species has been defined as one whose impact on its community or ecosystem is large, and disproportionately large relative to its abundance (Power *et al*., 1996).
- ***Umbrella species*** serve as surrogates for other species since their minimum spatial requirements are likely to be at least as comprehensive as those for the remainder of the community (Wilcox, 1982).
- ***Flagship species*** are identified for their ability to arouse public interest and sympathy and in doing so leverage support for conservation action (Simberloff, 1998).
- ***Species guilds*** are groupings of species based on specific characteristics, for example feeding behaviour or habitat requirements (Wilson, 1999).
- ***Meta-populations*** consist of a group of sub-populations linked together by the dispersal patterns of individuals and gene flows. Meta-populations are often characterised by sources and sinks: sources consist of suitable or optimal habitat and generally produce excess individuals; sinks refer to marginal habitat in which population size cannot be maintained without immigration from source areas (Poiani *et al*., 2000). As little as 10 % of a population may be located in source habitats and still be responsible for maintaining 90 % of the population found in sink habitats (Pulliam, 1988).

Text Box 6
The importance of conserving keystone species

The impact of a keystone species is demonstrated by the classic experiment conducted by Prof Robert Paine in the 1960s, concerning food web complexity and species diversity (Paine, 1966). Paine selected two adjacent stretches, approximately 7.5 by 2 metres, of intertidal rock along the northern coastline of Washington State. Each month he removed from one stretch its top predator, the husky starfish or *Pisaster ochraceus*; the other stretch of rock he left untouched. Within a year, the number of species on the rock where the starfish had been evicted had shrunk from 15 to 8. Within a decade, only a monoculture of mussels (*Mytilus californianus*) remained on this stretch of rock.

Source: Paine (1966)

8.1.2 *Cross-sector policy recommendations*

The following policy recommendations support this implementation principle:

- As a pragmatic consideration, landscape or ecoregion-level measures of heterogeneity in inland water ecosystems may be used as surrogates for achieving representation of inland water biodiversity features in conservation planning;
- Surrogates should be tested and validated through proper hypothesis testing to ensure their scientific rigour; and
- Ecoregional surrogates (as coarse filters of biodiversity) should be supplemented wherever possible with fine filter surrogates (such as species or community level data).

8.2 Define the appropriate scale

This implementation principle acknowledges that the spatial scale of conservation interest will determine the resolution (fine or coarse filters) at which inland water biodiversity could and should be described. The finer the scale of interest, the finer the resolution of the data layers (both coarse filter and fine filter) will need to be. Coarse-filter surrogates (e.g. landscape classification) may be sufficient to answer the general questions of broad-scale plans. However at finer scales, where conservation plans are used to inform conservation action or management intervention at the site level, it may be necessary to increase the resolution of the landscape classification as well as supplement these coarse-filters with fine-filters (e.g. species data).

8.2.1 *Rationale*

Conservation planning and assessment can be undertaken at a range of scales from broad global assessments, to regional, national and catchment-based assessments. The scale of the exercise will depend on the types of questions that need to be addressed and how the outcome is to be used. For example, WWF has worked with partners to delineate freshwater ecoregions as a basis for prioritising conservation activities at both the global and African scale (Thieme *et al*., 2005). In a separate typing exercise, 30 Level I Aquatic Ecoregions were delineated for South Africa (Kleynhans *et al*., 2005). These aquatic ecoregions would be appropriate for conservation planning at the national scale and to identify broad national priorities. A refinement of Level I Ecoregions produced 134 Level II Ecoregions (Kleynhans, pers. comm.), which are appropriate for inland water assessment and planning at sub-national levels for informing decision-making regarding the use of natural resources. At the management plan level for a particular primary catchment, it would be best to supplement these Level II Ecoregions with geomorphological zonation (e.g. Rowntree and Wadeson, 2000) and species data.

Text Box 7
Temporal or successional patterns of biodiversity in temporary waters

In addition to spatial variation in biodiversity pattern, the biodiversity of inland water ecosystems also displays temporal variation. This is demonstrated well in the case of temporary pools and pans that fill up only episodically after heavy rains and then contain water for varying lengths of time (from several weeks to several months) before drying up again.

The crustacea found in these temporary pools have adapted in a most amazing way to life in very harsh conditions. As the water in a temporary pool evaporates and its salinity increases, the animals become more concentrated. This seems to stimulate breeding and the development of drought-resistant eggs. When the pool has dried up completely the crustacean inhabitants die and only the small drought-resistant eggs remain. These are easily dispersed by wind or carried in mud on animals' feet and bodies to other depressions that form temporary waters in the wet season. It is believed that most of the eggs require a prolonged exposure to the air and need to be heated to temperatures in excess of 50 ºC before they will hatch on becoming moistened again.

After they have filled up, the succession of crustacean colonisation of temporary pools can be divided into two phases. The first phase within the first few weeks of inundation is dominated by large tadpole shrimps, *Triops granarius* (Notostraca), several species of clam shrimps (Conchostraca) and fairy shrimps (Anostraca). These invertebrates are moderately large macroinvertebrates ranging from 10-50 mm in size. They grow rapidly to sexual maturity in about 5-7 days. After about two or three weeks there is a succession of different species of seed shrimps (Ostracoda) commencing with large species (c. 5 mm) at first to progressively smaller species (less than 1 mm). Unlike the three groups of entirely temporary pool crustaceans discussed above certain species of seed shrimps are also found in rivers and other more permanent water bodies. The interesting aspect to observe is that time for rapid development and the window of opportunity to develop a large size and produce abundant offspring is limited. Predatory aquatic insects such as Odonata, Hemiptera and Coleoptera also rapidly colonise temporary waters and will feed on the larger Crustacea. An assessment of the diversity of species must therefore take into account the temporal aspect of the water bodies being surveyed. It would in fact be more appropriate to collect sediments from dried out temporary water bodies and, after moistening these sediments, rear the animals that hatch and emerge from eggs and resting stages over a period of time in the laboratory to assess species diversity from such ecosystems.

Contributed by Dr Ferdy de Moor, Makana Biodiversity Centre, Albany Museum
January 2006

8.2.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- Conservation planning should follow a spatially nested approach with coordination and alignment between at least three scales:

- National planning: The CBD calls for the development of ***countrywide*** conservation plans and conservation of representative samples of all ***major ecosystem types***. As such, the delineation, analysis and representation of inland water biodiversity at a national scale should be viewed as a priority.
- Sub-national planning: Since planning and allocation of water resources takes place at a sub-national and catchment level, catchment-based biodiversity representation and planning should be closely aligned with and complement national-level plans.
- Regional planning: The regional significance (e.g. uniqueness) of inland water ecosystems should also be considered. In this regard the region of the Southern African Development Community (SADC) becomes a relevant planning unit. At present, there are serious data discrepancies between South Africa and its neighbouring countries. This should be addressed through the development of minimum data and monitoring requirements for the region, and by spelling out shared responsibilities and time frames for generating basic and uniform data layers for the region.

8.3 Incorporate local ecological knowledge

This implementation principle acknowledges the value and importance of local ecological knowledge to supplement the uniform data layers required by a broader scale, systematic conservation planning approach, especially at the fine scale.

8.3.1 Rationale

Systematic conservation planning is an explicit rather than an objective process. Expert judgement plays an important role in the rationale for identifying, selecting and implementing conservation options. Although computer models do extend the analysis of large data sets, the systematic approach should encompass/integrate the professional judgements of experts and dialogue with affected communities (Pressey and Cowling, 2001). In fact, the systematic approach and the expert workshop approach should be seen as complementary, and the value of both approaches should be combined.

Local ecological knowledge (see Gilchrist *et al*., 2005) is crucial for mapping biodiversity surrogates and special features within the planning region. Special features can often be captured from the knowledge of experts or local inhabitants, even though such knowledge may not be uniform over time and space. This information should be used to *supplement* coarse filter biodiversity surrogates, which represent the systematic landscape classification of biodiversity, rather than as the primary data that drives the planning exercise.

Special features to be included in the planning exercise may range from sites of ecological importance (e.g. centres of endemism and rarity, or sites that are important refuge areas or migration routes), to geomorphological importance (e.g. sites of distinctive archaeological history such as the Cradle of Humankind – see www.cradleofhumankind.co.za).

Text Box 8
Incorporating unique geomorphological features using expert knowledge

South Africa's rich geodiversity (including its distinctive archaeological history e.g. Cradle of Humankind) warrants a systematic approach that conserves this heritage. Unique and threatened geomorphic sites of specific scientific interest represent remnants of millions of years of landscape evolution (cf. Partridge and Maud, 1987). For example, the current Vaal and Orange River systems follow glacial valleys excavated during the Dwyka Period. The long-term evolution of this system has included the erosion of diamond-bearing kimberlite pipes and the subsequent transportation and deposition of diamond-rich gravels that have created the Lichtenberg and Griqualand West alluvial diamond fields. Important sites of specific scientific interest include the 250 million year old Nooitgedacht Glacial Pavings near Barkly West, and the magnificent paired terraces of the Vaal and Orange Systems that record the last 20 millions years of the system's evolution. These terraces (especially the lower terraces) are rich in archaeological remains that contain evidence of human and faunal history and evolution (cf. Van Riet Lowe, 1952; Mason, 1967; Helgren, 1979). However, these diamondiferous terraces are threatened by alluvial diamond mining (e.g. as in Richtersveld and at Windsorton). These threatened heritage features need to be given the same level of attention and care as rare and endangered species.

Contributed by Dr Evan Dollar, CSIR Natural Resources and the Environment, June 2005

8.3.2 Cross-sector policy recommendations

The following policy recommendation supports this implementation principle:

- People with local ecological knowledge – whether experts that have worked in the area or local inhabitants such as farmers or community members – should be involved wherever possible to point out areas of special interest and to review planning outputs; this is especially important for fine-scale inland water conservation plans. To facilitate its use in conservation planning, this knowledge must be recorded in a spatially explicit manner with clear explanations as to why each mapped feature is important, and options for how they could be managed in a conservation-friendly manner.

9. OBJECTIVE 3: PLAN FOR PERSISTENCE OF INLAND WATER BIODIVERSITY

The objective of planning for biodiversity persistence addresses the need to ***conserve the ecological and evolutionary processes that generate and maintain inland water biodiversity***. Conserving species and habitats, as considered under biodiversity representation, provides a snapshot of the biodiversity that currently exists. If we wish this biodiversity to persist and naturally evolve over time, we also need to make sure that: populations, communities or ecosystems that are both viable (Shaffer, 1981) and of high ecological integrity (Angermeier and Karr, 1994) are selected; natural ecological processes (functional elements) and disturbance regimes such as floods, droughts and fires continue to operate within their natural ranges of variability (Landres *et al*., 1999); and the size of a conservation design is sufficient to allow a system to recover from natural disturbances.

There are four implementation principles associated with achieving this objective, namely to:

- Select inland water ecosystems of high integrity;
- Ensure connectivity;
- Include large-scale ecosystem processes; and
- Select areas of sufficient size.

9.1 Select inland water ecosystems of high integrity

This implementation principle acknowledges that ecosystems that are currently of high integrity should ideally be selected for the purposes of conserving biodiversity, since these are the ecosystems that accurately represent the biodiversity of the region and within which ecological and evolutionary processes operate within their natural ranges; i.e. ecosystems of high integrity protect all components of biodiversity (Redford and Richter, 1999). From a practical point of view, selecting ecosystems that are currently regarded as having a high level of integrity also (a) facilitates operational management since ecosystems operating close to natural conditions tend to be more self-sustaining, requiring less conservation management, and (b) improves the cost efficiency of conservation management as no rehabilitation is required.

9.1.1 Rationale

Karr and Dudley (1981) defined biological integrity as "*the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organisation that is comparable to that of natural habitat of the region*". Biological integrity refers to the "wholeness" of a system; to conditions under little or no adverse influence from human actions. A system with high biotic integrity would closely reflect natural evolutionary and biogeographic processes (Angermeier and Karr, 1994).

Biological integrity reflects both the biotic elements within a system and the processes that generate and maintain those elements. Inherent in the concept of biological integrity is that naturally evolved assemblages of organisms possess integrity but artificial assemblages do not. Thus adding alien species, or water that has been transferred from another system to a particular river, may increase the biodiversity of the recipient system but will reduce the integrity of that system. Similarly, variation in elements based on natural processes (e.g. a natural extinction or a natural disaster) does not represent a variation in integrity, whilst variation that is caused by human activities does represent a decline in integrity (Angermeier and Karr, 1994).

The concept of biological integrity provides the basis for biotic assessments of surface waters worldwide. As an example, the indices, assessments and reporting frameworks used in the South African River Health Programme (RHP) are based on the concept of biological integrity. Most ecological (biological and habitat) indices that are used for surface water assessments in South Africa are calibrated along six categories that reflect varying degrees of integrity, from A (natural) to F (critically modified) (see Kleynhans, 1996 and 1999). The approximate relationship between these ecological assessment categories and the different classes proposed for the water resource classification system is indicated in Figure 3. Ecological assessment categories are used to indicate the ***present ecological integrity*** of an ecosystem.

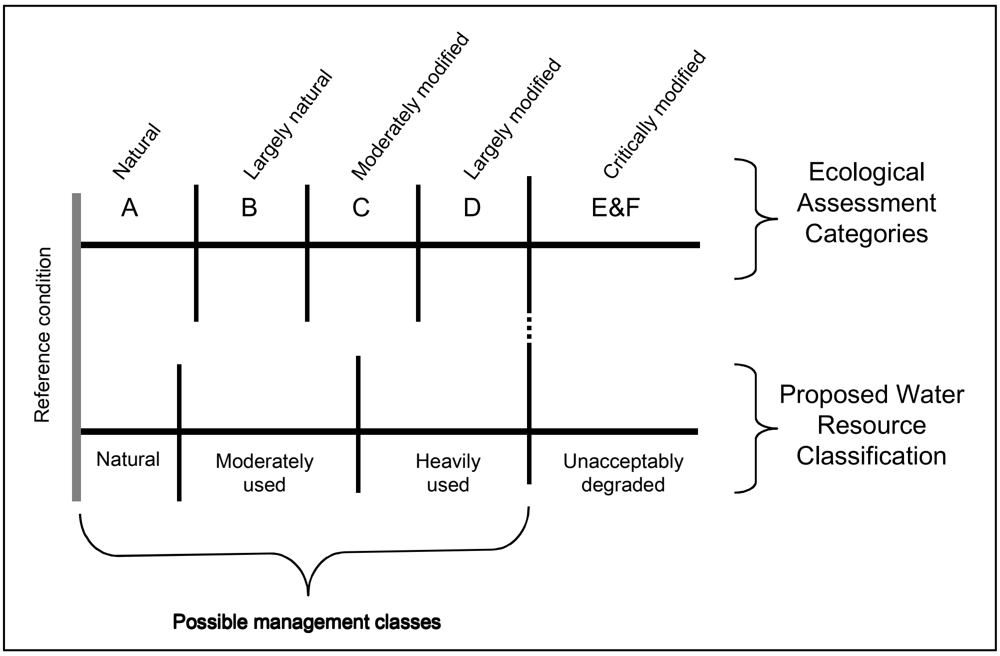

Figure 3
The approximate relationship between ecological assessment categories (A to F) and the proposed classes of the water resource classification system.

9.1.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- Only ecosystems that reflect a present ecological state of A or B will contribute to achieving inland water conservation targets; and
- Where necessary, and subject to feasibility, ecological restoration or rehabilitation should be undertaken to achieve the set conservation target.

9.2 Ensure connectivity

A loss of longitudinal, lateral and vertical connectivity reduces inland water biodiversity by interfering with successional trajectories, habitat diversification, migratory pathways and several other ecosystem processes. Connectivity refers to the transfer of energy and matter (including biota) across ecotones. This implementation principle aims to ensure ecological connectivity along all three spatial dimensions (longitudinal, lateral and vertical) as well as the temporal dimension.

9.2.1 Rationale

(a) Longitudinal connectivity

Rivers are continuous ecological units, and conservation of their lower reaches is largely dependent on the conservation of reaches further upstream and vice versa – if we conserve upper reaches, we need their lower reaches to be in a state that supports continuity. Given that river communities represent a longitudinal continuum, an anthropogenic disturbance, such as excessive water abstraction or the construction of a dam, creates a discontinuity. A certain distance downstream from the disturbance is needed for the river to recover from the effects of the disturbance. Selecting discontinuous representative segments of a river is therefore not appropriate for the conservation of river ecosystems.

Of relevance here is the River Continuum Concept (RCC – Vannote *et al*., 1980), whereby rivers are perceived as resource gradients along which biota are predictably structured. For example, in river systems that traverse deciduous forests, biodiversity in the headwaters is typically limited by low light (thick canopy) and low nutrient supplies. In the middle reaches, biodiversity is highest due to adequate light and nutrient levels; the substratum consists of a mosaic of habitat patches; thermal heterogeneity is higher than in upper reaches (dominated by ground water) and lower reaches, which are buffered from change by sheer volume of water (Ward, 1998).

Text Box 9
The need for river connectivity: example of eel migration

There are only 16 species of freshwater eels in the world. All of these species breed at sea but spend a large proportion of their lifetime, up to 20 years, in freshwater systems. In southern Africa we have four of these 16 species. These four species breed off the northern coast of Madagascar. After the embryonic stage the young larval eels, called leptocephali, which are leaf like, float in the ocean currents along the African coast. They then undergo a metamorphosis into glass eels as they get closer to the freshwater systems along the southern African coast. They need a pulse of freshwater flowing into the ocean to trigger their upstream migration. On their migration up the various rivers they change into grey/brown pigmented elvers, which can make their way past many natural obstacles such as waterfalls and some man-made weirs. However, some weirs and dams are not ‘elver friendly’ and disrupt this truly amazing migration. River connectivity is essential for the continuing existence of these four eel species. We should ensure that some of the rivers are left open for their passage. While others that have been dammed should be investigated for elver passage as well as the safe migration of mature eels back to their spawning grounds. Research has shown that male eels stay closer to the estuaries whereas females, which spend much longer in freshwater, penetrate further upstream. What we may in fact be doing by disrupting female eel migrations upstream is shifting the sex ratio in favour of males of the eels that mature and migrate back to the spawning grounds. Eventually, these migrations may come to an end, as the critical number of females is not available to make the return journey.

When all goes well the males mature in 8-10 years and the females in up to 20 years. They then migrate back to the sea, their eyes grow bigger, their gonads develop for the first time, they become silvery and they eventually stop eating as their intestinal tract atrophies.

The dynamics of the prey items that the freshwater eels feed on would also be altered with the removal of eels from the ecosystem possibly resulting in negative trophic cascades. Young eels feed on invertebrates such as blackfly larvae whereas freshwater crabs are an important part of the diet of the adult freshwater eels. The population dynamics of these prey species would change if one of their top predators, freshwater eels, no longer occurs in a system. Also the shape and ability of eels to swim into smaller crevices makes them unlike other freshwater fish predators in that they can hunt in the narrow crevices along rocky stretches of rivers.

A major part of the freshwater eel’s lifetime is spent in freshwater systems. We need to ensure that there is sufficient connectivity between the ocean, estuaries and river systems to enable these species to survive and undertake this truly wonderful migration.

Contributed by Dr Jim Cambray, Makana Biodiversity Centre, Albany Museum
June 2005

(b) Lateral connectivity

The state of river ecosystems depends not only on what happens in rivers themselves and on their banks, but also on how land is managed throughout their entire catchments. Lateral connectivity is important for maintaining all of the processes mentioned above. In a drainage basin, several ecological boundaries can be observed from the river course to the watershed: the fringing vegetation, wider riparian zone, and a number of further boundaries or zones (or patches) that are observable in terms of changes in vegetation and soil type. Whether gradual or distinct, each of these boundaries affects the functioning of populations, landscapes and ecosystems by modulating fluxes (Pickett and Cadenasso, 1995), e.g. filtering the flux of seeds that flow from the catchment to the river.

Many human-induced alterations to rivers have, intentionally or accidentally, led to a profound disruption of lateral connectivity. “*The disruption of lateral connectivity is so pervasive, especially in Europe and North America, that many lotic [river] ecologists failed to appreciate until quite recently the extent to which the lower reaches of managed river systems have been modified from the natural state* (Ward, 1998).”

Since the lateral zones of a drainage basin are all interconnected, the integrity of the whole basin needs to be conserved in order to conserve inland water biodiversity. Designation of a river as Natural would thus require appropriate land use practices, which may include non-transformational agriculture. A biodiversity conservation design for inland water resources cannot fence off entire drainage basins, but land use in a priority area needs to be managed according to the high level of protection awarded to the water resource. Implementation of a biodiversity conservation design will be fully dependent on the ability to achieve appropriate ***land management practices within catchments***.

(c) Vertical connectivity

Vertical connectivity refers to the link between surface water and groundwater, and in particular the alluvial aquifers beneath rivers and floodplains. The hyporheic zone is the area of the aquifer penetrated by surface water or by riverine fauna. This zone forms an ecotone between surface waters and true phreatic groundwaters. The hyporheic zone commonly is only a few centimetres in depth and extends only metres away from the river channel. However, under some conditions it may be many metres thick and extend kilometres away from the channel (Ward, 1998).

In many parts of the country, groundwater contributes significantly to the surface flow of rivers and is responsible for sustaining surface water flows during dry seasons or droughts. The delineation of hydrogeological terrains has been proposed as a means of classifying the groundwater dependence of inland water ecosystems (Colvin *et al*., 2003). An implication of this connection between groundwater and surface water is that, in order to conserve the natural features of a groundwater dependent ecosystem, the contributing groundwater aquifer would need to be conserved as well.

9.2.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- In many instances it is virtually impossible to find an un-dammed, or un-regulated river system. Given that virtually all of South Africa's main rivers have been dammed or regulated in some way, longitudinal connectivity for selected rivers should be enhanced as far as possible, for example through construction of appropriate fish ladders and adoption of water release regimes that adhere to environmental flow requirements.
- In order to optimise the protection of the functional elements of inland water ecosystems, adjacent river reaches rather than isolated reaches should, wherever possible, be selected for contributing towards conservation targets. Where this is not attainable, river ecosystems that are designated for conservation (in an A or B ecological state) should, where relevant, be connected through river ecosystems that are in an ecological state that will support ecological connectivity. This functionality commonly concurs with ecological assessment category C. However, this relationship should not be seen as a given and each potential connecting river should be assessed carefully, based on process attributes such as its ability to allow the migration of a key species.
- Where ecosystems are in an ecological state that is lower than A or B but are deemed important for providing connectivity, such ecosystems should be considered part of an overall design for inland water conservation. The maintenance of their ecological state will be necessary for achievement of the overall conservation target. However, they should not contribute towards satisfying the quantitative conservation target.
- The management and conservation of inland water ecosystems must address maintenance or re-establishment of environmental gradients along longitudinal, lateral and vertical dimensions.

- The need for lateral connectivity emphasises the importance of aligning land and water biodiversity priorities and management strategies. Similarly, the need for vertical connectivity emphasises the importance of aligning surface and groundwater management strategies.

9.3 Include large-scale ecosystem processes

This implementation principle acknowledges that natural disturbance regimes and ecological and evolutionary processes are responsible for generating and maintaining nature's diversity. These processes operate over different and often highly variable spatial and temporal scales that should be explicitly accounted for in planning and conservation efforts.

9.3.1 Rationale

Examples of ecological processes include decomposition, nitrogen cycling, pollination, seed dispersal, energy capture, food web dynamics, migration and predation. A change in the rate of a specific process is likely to always result in a change of biotic elements whereas the reverse is not always true (Howarth, 1991, as cited by Angermeier and Karr, 1994). Many of the relatively small-scale ecological processes would be conserved by selecting rivers of high integrity. However, some ecological processes operate mainly at large spatial scales and may require large contiguous areas for them to continue functioning effectively.

In past decades, biodiversity was viewed largely in terms of species richness, and the ecosystems that supported these species were usually seen as static, predictable and manageable systems (Poiani *et al*., 2000). More recent non-equilibrium theories of community structure and ecosystem processes identify environmental regimes and disturbances as major contributors to the maintenance of biodiversity on ecological time scales (Ward, 1998). Environmental regimes include hydrologic and water quality regimes, geomorphic processes, climatic regimes (temperature and precipitation), fire regimes and many kinds of natural disturbance. Natural disturbance, as a key aspect of environmental regimes, can be defined as any relatively discrete event in time that disrupts ecosystem, community or population structure and that changes resources, availability of substratum, or the physical environment (White and Pickett, 1985). When environmental regimes and natural disturbances are pushed outside their natural ranges of variability by human influences, changes in ecosystems and species will follow.

9.3.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- Where appropriate (in catchments that are designated for conserving inland water biodiversity), natural disturbance regimes, such as floods, droughts and fires, should be allowed to operate within their natural ranges of variability (Landres *et al*., 1999); and
- There are few places in the world where completely unaltered environmental regimes and natural disturbances currently exist. Therefore the potential to restore

regimes and disturbances through active management (Poiani *et al*., 2000) (e.g., releases from dams according to in-stream flow requirements, including floods) should be evaluated when selecting conservation areas.

9.4 Select areas of sufficient size

Any inland water conservation area should be sufficiently large to allow biodiversity features to recover from natural disturbances and have populations that are large enough and reproduce in sufficient numbers to remain viable. The actual extent of what constitutes "sufficient size" will vary between systems and species, and should be assessed on a case-by-case basis.

9.4.1 Rationale

In addition to having components of composition, structure and function, biodiversity occurs along different spatial or geographic scales. One way of looking at this is through alpha, beta and gamma scales of biodiversity (Whittaker, 1975). Alpha diversity refers to the number and types of species that occur at a particular site or area. Beta diversity (between-area diversity) refers to turnover of species composition along a gradient. The diversity of species within an entire landscape is referred to as gamma diversity.

Assessing biodiversity at local scales may be misleading. For example, at many sites around the world, alpha diversity is increasing as a result of the spread of alien species, while beta and gamma diversity are generally declining (Groves, 2003). This emphasises the importance of planning for biodiversity representation at larger scales, while implementation of such large-scale plans may still take place at smaller scales. Also, political boundaries do not follow but cross natural processes at a landscape scale.

Poiani and co-workers present a framework that distinguishes species and ecosystems at four geographic scales, namely local, intermediate, coarse, and regional (Poiani *et al*., 2000). The local and intermediate geographic scales are of particular relevance to inland water ecosystems:

- ***Local geographic scale***: Small-patch ecosystems and local-scale species, often closely connected with each other, exist at this geographic scale. Examples of small-patch ecosystems are pans, desert spring pools and many types of wetlands. Local-scale species are restricted to a particular habitat, are immobile or poor dispersers.
- ***Intermediate geographic scale***: Large-patch ecosystems and intermediate-scale species exist at this scale. Large-patch ecosystems are relatively discrete, defined by distinct physical factors and environmental regimes, and are significantly larger than small-patch ecosystems. These ecosystems reflect variable structure, composition, internal habitat types, and serial stages that shift and rearrange over time and space. Intermediate-scale species depend on the multiple habitats of large patch ecosystems, for example flood-plain spawning fish uses a number of habitats along a lateral gradient between the main river channel and floodplain backwaters.

Conservation of biodiversity at multiple levels of biological organisation and spatial scales requires (a) explicit identification and protection of the focal ecosystem and species in a given area, and (b) adequate identification and protection of the associate multiscale ecological processes that support and sustain those ecosystems and species. Poiani and co-workers define ***functional conservation areas*** as geographic domains that maintain focal ecosystems, species and supporting ecological processes within their natural ranges of variability (Poiani *et al*., 2000). These authors list four characteristics of functional conservation areas, namely:

- Size, configuration and other design characteristics are determined by the focal ecosystems, species and supporting ecological processes;
- A conservation area is functional when it maintains the focal biotic and abiotic patterns and processes within their natural ranges of variability over time frames relevant to conservation planning and management (100-500 years);
- Functional conservation areas do not necessarily preclude human activities, although their functionality or integrity may be greatly influenced by such activities; and
- Functional conservation areas at all scales may require ecological management or restoration to maintain their functionality (e.g., removal of invasive species).

The area needed to ensure survival or recolonisation has also been called the ***minimum dynamic area*** (Pickett and Thompson, 1978). The concept also relates to patchiness, where one may prefer to consolidate on a number of patches to constitute one conservation area rather than to have a highly fragmented system. Alternatively, one may prefer to select for replication and connectedness, for example in the conservation of small-patch ecosystems and local-scale species.

If we consider what might constitute a sufficient or appropriate size for a conservation area in terms of the above functionality characteristics, it is clear that functionality can be achieved at different spatial scales. Poiani and co-workers distinguish between functional conservation areas at site, landscape and network scales (Poiani *et al*., 2000). Functional sites aim to conserve small-patch ecosystems and local-scale species within their natural ranges of variability. Functional landscapes will also conserve large-patch ecosystems and intermediate-scale species and typically encompass inland water to terrestrial (and sometimes marine) gradients. Functional landscapes usually exist within a multiple land use context. Functional networks provide the spatial context, configuration and connectivity for conserving regional-scale species and processes with or without explicit consideration of biodiversity at finer scales.

Text Box 10
Evolutionarily significant units

The concept of evolutionarily significant units (ESUs) has been used to assign distinctiveness to populations. These distinct assemblages represent segments of biological diversity that share a common evolutionary lineage and contain the potential for a unique evolutionary future. Classification of ESUs is usually based on a combination of ecological and genetic data.

Moritz (1994) states that the purpose of defining ESUs is to “ensure that evolutionary heritage is recognized and protected and that evolutionary potential inherent across the set of ESUs is maintained.” This author’s view of ESUs emphasises historic population structure rather than current adaptation.

The idea is that historically isolated populations are likely to have distinct potential.

Crandall *et al*., (2000) are critical of overemphasising historical isolation and genetic measures in delineating ESUs. These authors believe that the potential for the evolutionary success of a particular species is maximised through the maintenance of adaptive diversity, by preserving the maximum diversity of functionally divergent gene copies across the geographic range of a species.

Wishart (2000) argues that river catchments provide a mechanism for the isolation of freshwater populations, resulting in divergence and differentiation of genetic, morphological and behavioural attributes such that they come to represent distinct and unique assemblages. However, the minimal viable population size for some species may extend across catchment boundaries. The existence of populations in adjacent catchments provides a source for recolonisation and a potential buffer against the effects of natural environmental stochasticity. Rare events of interbreeding between isolated populations may even help to maintain the overall genetic fitness of the particular species.

9.4.2 Cross-sector policy recommendations

The following policy recommendations support this implementation principle:

- Inland water conservation actions should cover multiple spatial scales, from local (e.g. small-patch ecosystems) to large landscapes. At least some larger scale efforts should interface with terrestrial and marine conservation plans.
- Since administrative boundaries are often smaller than, or poorly aligned with, the span of ecological processes, a national conservation planning framework should provide clear guidance regarding the conservation of ecological and evolutionary processes at sub-national levels. Such a planning framework for conserving inland water processes should form part of South Africa's National Biodiversity Framework (discussed in Section 4.3.2-e).

10. OBJECTIVE 4: ESTABLISH A PORTFOLIO OF INLAND WATER CONSERVATION AREAS (IWCAs)

The objective of establishing inland water conservation areas addresses the incorporation of the first three objectives into *spatial configurations that will constitute the portfolio of inland water conservation areas (IWCA) of South Africa***.**

There are five implementation principles associated with achieving this objective:

- Legislate IWCAs through complementary legal mechanisms;
- Strive for optimal land-use efficiency;
- Prioritise and initiate conservation actions timeously;
- Conserve first where appropriate, rather than restore or rehabilitate later; and
- Provide explicit selection options and management guidelines.

10.1 Legislate IWCAs through complementary legal mechanisms

Due to the *ad hoc* nature and terrestrial bias of historic conservation efforts, inland water ecosystems are drastically under-represented within the portfolio of formally protected areas (Nel *et al*., In preparation). For those inland water ecosystems that are represented in protected areas, many (especially the longitudinal river systems) lack the assurance of conservation persistence due to the partial inclusion of their ecological process ranges. To satisfy the representation component of the conservation target, ecosystems located outside formally protected areas should be selected as part of a portfolio of IWCAs. It should be noted that IWCAs are not analogous to formal protected areas where no use of the resource is allowed, but rather are based on a philosophy of multiple land-use options that support a defined conservation objective.

10.1.1 Rationale

In order to satisfy the objectives of achieving targets for representation and persistence of inland water biodiversity, it is necessary to use complementary legal mechanisms. Ideally, these mechanisms should link the conservation of inland water ecosystems through both public (national, provincial and local) and private protected areas, as well as land-use management plans and strategies (e.g. integrated development plans and catchment management strategies).

This guiding principle also speaks to the need for vertical and horizontal coherence in inland water conservation policy and actions. Vertical coherence refers to the need for coordination and harmonisation between spheres of government (national, provincial and local) as well as between political and operational levels. Horizontal coherence refers to coordination and harmonisation, at any one (or all) of these levels, across sectors. Of special importance is the coordination between land and water sectors. Since inland water ecosystems are impacted by activities that happen throughout their entire drainage areas, their integrity and effective conservation is critically dependent on sound land management practices.

Rivers that flow through protected areas often show significant recovery (i.e. their health is in a much better condition downstream of their entrance into the protected area than upstream of the protected area). This highlights the positive impact that good land management of the surrounding landscape can have on river condition – and emphasizes the importance of adopting an integrated resource management approach that considers the combined needs of terrestrial and inland water biodiversity, both inside and outside of protected areas (Driver *et al*., 2005).

Legal mechanisms that can be used include:

- National Water Act (Act No. 36 of 1998) – to classify inland water ecosystems based on a designated level of protection;
- National Environmental Management: Protected Areas Act (Act No. 57 of 2003) – to create special nature reserves, national parks, nature reserves (including wilderness areas), protected environments, world heritage sites, specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act (Act No. 84 0f 1998), and mountain catchment areas declared in terms of the Mountain Catchment Areas Act (Act No. 63 of 1970).
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004) – to provide for cooperative governance in biodiversity management and conservation, and to include inland water biodiversity priority areas in published bioregional plans.
- Conservation of Agricultural Resources Act (Act No. 43 of 1983) / Sustainable Utilisation of Agricultural Resources Bill – to protect land, soil, wetlands and vegetation and for the control of weeds and invader plants.

10.1.2 Cross-sector policy recommendations

The following policy recommendations were discussed and agreed at the meeting of cross-sector representatives on 8 September 2005:

- Departments responsible for biodiversity conservation, water resource management, land use (agriculture) and integrated development planning should promote coherence between their respective policies and strategies. Coherence can be enhanced by actively incorporating the policy objectives and principles of this document into their future policy and strategy processes.
- Inland water conservation priorities should be linked to appropriate legal mechanisms for implementation.

10.2 Strive for optimal land-use efficiency

This implementation principle acknowledges that there are many conflicting demands for a limited natural resource. It supports the realisation of optimal conservation benefit for the least opportunity cost or conflict.

10.2.1 Rationale

Ecosystems are actually social-ecological systems, and in addition to ecological viability and resilience it is important to consider the social viability and resilience of a conservation design. Examples of “optimisation rules” are to: give priority to areas that contain the most inland water ecosystems (biodiversity hotspots); consolidate conservation efforts by selecting adjacent areas or through expanding existing protected areas (as opposed to selecting areas in spatial isolation); link existing protected areas through conservation corridors; and integrate terrestrial, marine, estuarine and inland water conservation wherever possible.

It should be noted that existing protected areas confer varying levels of protection to inland water ecosystems, depending on the type of inland water ecosystem and its location within the protected area. It is generally easier to properly conserve pans and wetlands through their inclusion within a protected area, than to conserve a river segment that flows into and out of the protected area. Many rivers that flow through protected areas are hydrologically altered, with dams or weirs either outside or within the protected area, and do not confer full protection to all inland water species. Partial inclusion of rivers in a protected area is also no guarantee of protection, as impacts that take place outside the boundaries of protected area can still have negative consequences for inland water biodiversity within the protected area (Saunders *et al*., 2002). In other instances rivers form the boundaries of protected areas, again exposing the river to impacts from its drainage area outside of the protected area. Development of tourist or visitor facilities in protected areas, such as roads for game viewing and lodges, are often located close to rivers and disturb river ecosystems.

It is interesting to note that some existing Ramsar sites might also not qualify as inland water conservation areas, for example where such sites are largely artificial water bodies that cater primarily as habitat for aquatic birds. By definition, such an ecosystem would be of low biological integrity and would not contribute to achieving representation targets for natural inland water ecosystems. However, such sites are likely to play a critical role as “connectors”: they can provide an important physical link, for example on a migratory route between two conserved habitats that might once have been joined. Alternatively, they can provide a seasonal or perennial refuge for particularly important species until such time as appropriate and sufficient habitat can be restored to sustain that species. The connection role is critical and should not be discounted in planning for conservation areas.

Text Box 11
Catering for redundancy versus selecting for efficiency

Where possible, elements or features to be conserved should be represented several times within a conservation design to avoid extinction or endangerment caused by naturally occurring stochastic events (e.g., disease, predation, floods, fires) and human-related threats (Groves, 2003). However, inland water conservation planning in South Africa has also indicated that the achievement of redundancy is seldom feasible as (a) there are often no options available; and (b) where an option does exist, it created a much less efficient conservation design (Nel *et al*., 2006). Also see Moyle and Yoshiyama (1994). Catering for redundancy therefore should not be incorporated lightly into a conservation plan, although in some special cases it may be necessary.

10.2.2 Cross-sector policy recommendations

The following policy recommendations were discussed and agreed at the meeting of cross-sector representatives on 8 September 2005:

- Integrated planning and management of natural resources (both aquatic and terrestrial) should be regarded as a priority for achieving efficient conservation of inland water ecosystems. Appropriate mechanisms for achieving this, for example the appointment of natural resource management coordinators at district levels, should be carefully investigated.
- Since the conservation of inland water ecosystems is dependent on an ability to achieve appropriate land management practices within associated drainage areas, the least conflicting cross-sector options should be sought wherever possible; i.e. to steer away from allocating inland water conservation priorities in catchment areas designated for types of development that conflict with conservation objectives.
- Ideally, inland water conservation plans should be carried out in parallel to terrestrial, and marine conservation plans and all plans should be well-integrated.
- Inland water conservation planners should design, in collaboration with terrestrial and marine conservation planners, one or two large conservation areas that would focus on integrating conservation objectives for terrestrial, inland water, estuarine and marine ecosystems.
- Prioritisation systems that consider biodiversity together with social and economic realities should be developed and tested.

10.3 Prioritise and initiate conservation actions timeously

Acknowledging that limited financial and human resources are available to achieve conservation objectives and targets, this implementation principle promotes the identification of ecosystem vulnerability and the scheduling of conservation actions in order to maximise the likelihood of achieving targets for representation and persistence of inland water biodiversity.

10.3.1 Rationale

In the context of biodiversity conservation, vulnerability is a measure of the imminence or likelihood of biodiversity in an area being lost to current or impending anthropogenic pressures; i.e. it is a measure of the urgency with which an area or system should be conserved.

Practicalities may necessitate the gradual phasing in of conservation action over many years or even decades, during which time the agents of biodiversity loss would continue to operate. It is thus important that a plan for maximising representation on paper must be complemented by one that also maximises “retention” in the face of ongoing loss or degradation of habitat (Cowling and Pressey, 2001). The objective of this implementation principle is to minimize the extent to which representation targets are compromised by ongoing loss of habitats and species.

A crucial consideration in maximising retention is the assignment of priorities based on the availability of options (irreplaceability) for conserving a particular ecosystem and its vulnerability to biodiversity loss as a result of current and impending anthropogenic pressures (Pressey *et al*., 1996). Areas with no or few options and that regarded as being highly vulnerable, may be regarded as the highest priority for conservation action. Alternatively, a case can be made for focussing on areas of high irreplaceability (low options) and low vulnerability – in order to conserve ecosystems before they become difficult to secure due to impending developments. There are many other management factors that should influence scheduling, for example areas where staff and resources are easily available, where implementation dovetails with existing activities and programmes, and where it is possible to pilot new approaches with low risk and high demonstration value.

Text Box 12
Use of biodiversity hotspots in conservation planning

Due to limitations in funding and few spatial options for conservation, prioritisation of ecosystems often aims for the highest conservation return at the least cost. An approach that has often been used is to identify biodiversity hotspots – areas where exceptional concentrations of species occur. For example, Myers *et al*. (2000) found that 44 % of all species of vascular plants and 35 % of all species in four vertebrate groups are confined to 25 global hotspots comprising only 1.4 % of the land surface of the Earth. These species are also highly threatened, having lost 88 % of their primary habitat to development.

Biodiversity hotspots can be determined on the basis of total species richness, endemic species richness, threatened species richness (Orme *et al*., 2005); and even habitat richness (Hoekstra *et al*., 2005). Various taxa have been used to determine hotspots, for example frogs, freshwater fish, tortoises and terrapins, snakes, mammals, birds (Lombard, 1995) and vascular plants (Myers *et al*., 2000). In some instances hotspots show congruence among species categories, for example between endemic plants and endemic vertebrates at the global scale (Myers *et al*., 2000). Lombard (1995) found mammal hotspots, followed by snake hotspots, the best predictor of hotspots of other taxa in a study undertaken for South Africa.

Criticism for the use of biodiversity hotspots arises from the arbitrary nature of deciding on the constitution of a hotspot (e.g. the top 5 % of data containing assessment units); they usually do not represent all species; endemic or range restricted species frequently do not occur in hotspots; a lack of congruence among species richness, endemism, and rarity within taxa; and a lack of congruence among taxa – emphasising that one cannot assume that richness in one taxon translates to richness in another (Lombard, 1995). They are also more likely to undermine the principle of representation if used as the only method of conservation.

However, biodiversity hotspots could play a prominent role in identifying areas of exceptional biological wealth. Such areas may influence spatial priorities in an overall drive to achieve biodiversity representation. Aspects that would add value to hotspot delineation include to: determine cost of associated conservation action which may vary several orders of magnitude from place to place (Possingham and Wilson, 2005); address spatial requirements associated with population dynamics and ecological processes – hotspots may overlap with ecotones where the ranges of many species overlap, but for some species this may represent the edge of their natural ranges; relative threat to species and ecosystems; and define the most appropriate conservation mechanism (of which protected areas is only one) to be used (Lombard, 1995).

10.3.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- The allocation of resources for conserving inland water biodiversity should be guided by (a) an assessment of the vulnerability of each inland water ecosystem to threats or resource use pressures; and (b) an assessment of the options available for conserving each inland water ecosystem.
- Investigative research should be initiated to improve our understanding of the vulnerability of inland water ecosystems.

10.4 Conserve first where appropriate, rather than restore later

Acknowledging that the loss of biodiversity is in many cases irreversible, that ecological restoration activities are often excessively expensive, and that restoration efforts seldom achieve their original ecological objectives, this implementation principle promotes the conservation of ecologically intact ecosystems wherever this is appropriate and possible, rather than to allow short-term degradation of such systems with the view that they will be restored at some later date.

10.4.1 Rationale

In many parts of South Africa, options for conservation still exist. In some other parts of the world, such options are rare or do not exist. For example, the Fiume Tagliamento in Italy is regarded as the last morphologically intact large river in the European Alps (Ward and Tockner, 2001).

Many restoration initiatives fail despite tremendous expense and sustained effort. The reasons for this failure include (Hilderbrand *et al*., 2005): extrapolation of the same method or “recipe” to a setting for which it is not suited; treatment of symptoms as opposed to true drivers of ecological change; unrealistic time expectations - ecological restoration cannot achieve in years what normally happens over decades or centuries in nature. These authors suggest that, due to the uncertainties associated with ecological restoration, adaptive restoration initiatives should allow for multiple approaches (to test multiple hypotheses) and regular assessments to allow further intervention options.

It must be noted that, in the South African context, there may be areas of historic underdevelopment where inland water ecosystems are still relatively unmodified. From purely social and political perspectives such areas are often in dire need of economic development. This implementation principle does not advocate standing in the way of such development, as long as ways can be found to achieve biodiversity representation and persistence along with development goals.

10.4.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- Inland water ecosystems that are ecologically intact should receive priority in the selection for achieving representation (this relates to the implementation principle of "selecting ecosystems of high integrity" – Section 9.1).
- In instances where the sub-national conservation target cannot be met owing to past or current over-utilisation of certain inland water ecosystems, the restoration of these ecosystems should be considered on the basis of ecological feasibility and affordability.

10.5 Provide explicit selection options and management guidelines

Acknowledging that natural resource planners and managers must commonly consider a multitude of conflicting user requirements and that they often make decisions under extreme uncertainty, this implementation principle requires that these planners and managers should be presented with a range of explicit options to aid their decision-making and resource allocation. These selection options should be supported with practical guidelines as to the specific management actions that would be required for a selected ecosystem.

10.5.1 Rationale

This principle is about making the lives of resource planners and managers easier rather than more complicated. It aims to help resource planners understand what they are conserving, what they need to be aware of, and the resource and time implications associated with selecting a specific ecosystem for conservation. Conservation planners should provide a "bigger picture" of the significance of conserving specific biodiversity features in the study area. For example, it may not be necessary to conserve a sample of all the inland water ecosystems that occur in a particular Water Management Area if these also occur in other parts of the country.

Similarly, resource planners and managers need to be aware of the likely impacts on biodiversity associated with different choices, and have some idea of the management actions that would be required to achieve the conservation objectives in different catchments. Regarding the latter, a number of generic management actions may be applicable across the landscape. However, there may also be recommendations for actions that are specific to each selection.

Saunders *et al*. (2002) list the three main causes of inland water biodiversity loss as land-use disturbances, altered hydrological regimes, and introduction of alien species. This correlates with the findings of river health surveys in South Africa, where destruction of riparian zones, regulated flows and the presence of alien species (terrestrial and riparian flora as well as aquatic biota) are typically found to be the major factors that have an adverse impact on river health (River Health Programme, 2005). Three generic management actions that would go a long way to conserving inland water biodiversity are to:

Mitigate the effects of deleterious land-use activities

A first consideration for inclusion in an inland water conservation area (IWCA) is the current and future land-use options. Saunders *et al*. (2002) suggest the following alternatives, starting with the most desirable:

- Whole catchment conservation should be for the first choice, with catchment boundaries or watersheds defining the boundaries of IWCAs. Since it is rarely possible to include entire river systems (especially those that are larger than third order) within protected areas, the reality is that integrated catchment management will form an essential component of an inland water conservation system.
- Create multiple-use modules, where the catchment is zoned from the river or priority inland water ecosystem to the watershed in modules that allow progressively higher impact. Only low-impact activities, such as backpacking and canoeing, are permitted near the target system. Secondary zones could be used for relatively low impact activities such as selective harvesting of flora, low-density eco-friendly resort development, and organically produced crops. Potentially detrimental practices are either excluded or relegated to the most distant zone.
- Use the river continuum concept (Vannote *et al*., 1980) to determine which portions of the catchment would bring about the highest biodiversity returns from conservation action. The functioning of headwater streams is strongly influenced by external or allochthonous energy inputs, i.e. organic matter received from terrestrial production. Further downstream, in-stream productivity increases whereby dependence on terrestrial material as an energy source is reduced. Downstream reaches primarily require riparian vegetation to provide shading, dampen hydrological fluctuations, and prevent erosion and nutrient loading. Based on these considerations, conservation efforts should include whole headwater catchments and at least the riparian zones of downstream river reaches.
- Where the above options are not available, intact riparian buffer strips may be used to reduce the effects of deleterious land-use practices. Widths of 10-50 m have been found to be effective in maintaining ambient stream temperatures and retaining sediments and nutrients. The effective width of a riparian buffer strip should be determined on a site-specific basis, after considering factors such as varying vegetation types and terrain slope.

Retain natural flow regimes

A second consideration is to focus on inland water ecosystems where there is a realistic chance of maintaining or restoring natural hydrological regimes. Hydrological alterations represent one of the top threats to inland water species and habitats (Poff *et al*., 1997; Richter *et al*., 1997; Postel and Richter, 2003). Although species diversity is typically higher in downstream habitats, the hydrology of these downstream areas depends directly on what occurs upstream. Conservation benefits can, therefore, be maximised by focussing on upstream hydrology. This may, however, not hold true for inland water ecosystems in which upstream and downstream flows have become disconnected (e.g. due to dam construction) (Saunders *et al*., 2002).

Remove and control invasive alien species

The introduction of alien species is widely recognised as one of the most serious threats to native biodiversity (Cambray, 2003). Inland water ecosystems without alien species should be given priority in the design of inland water conservation areas. Once an IWCA is established, every effort should be made to prevent the invasion of alien species by regulating all activities associated with intentional and accidental introductions and by creating barriers to the spread of alien species.

10.5.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- When prioritising inland water ecosystems for conservation, explicit information should be provided about the biodiversity features contained by these ecosystems as well as the regional significance of these features, e.g. are they endemic to the Water Management Area or to the country.
- For each potential selection, some information should be provided on the main pressures on biodiversity and how best to mitigate these.
- Catchment zoning, in which the most deleterious activities for the resource are relegated to the furthest part of the catchment, should be investigated as a management option in instances where whole catchments cannot be conserved.
- All selected catchments should have management plans for the removal and management of alien species.

11. OBJECTIVE 5: ENABLE EFFECTIVE IMPLEMENTATION

Acknowledging that the value of a conservation design is only realised through its effective application, the objective of effective implementation addresses the ***creation of an institutional environment that can ensure sustained conservation actions for all designated inland water conservation areas***.

There are five implementation principles underpinning this objective, namely to:

- Facilitate stakeholder adoption of inland water conservation targets and priority areas;
- Reflect the conservation of inland water biodiversity as an explicit function in institutional design;
- Enable cooperative governance in the conservation and management of inland water biodiversity;
- Facilitate a science-management continuum; and
- Promote discovery, inventory and improved understanding of inland water biodiversity.

11.1 Facilitate stakeholder adoption of inland water conservation targets and priority areas

Operational adoption requires the translation of science into awareness, political will, and capacities, where the adopter has both the absorptive capacity (critical level of related knowledge) as well as the necessary emotional and financial commitments to allow sustained use of the acquired knowledge (e.g. associated with an inland water conservation design).

11.1.1 Rationale

Effective stakeholder engagement is one intervention that would promote stakeholder adoption. Stakeholder engagement strives to sustain ongoing and mutually beneficial interactions between all stakeholders or their representatives. It aims to create an enabling environment for constructive dialogue and knowledge exchange during all stages of projects and processes, and to draw benefit from the diversity of experiences, perspectives and preferences of these stakeholders. Stakeholders are people, institutions or any type of social group involved in or affected by the outcomes of a regional biodiversity planning process (WWF, 2000).

Examples of effective stakeholder engagement are to: promote stakeholder readiness and buy-in through their effective engagement during target setting, prioritisation and design phases; and provide flexibility in how conservation targets are achieved through making options explicit. The latter would allow resource planners and decision-makers to consider the options in the context of trade-offs such as equity, socio-economic benefits, management practicalities and future development plans.

11.1.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- Stakeholders (key decision makers and water user groups) should be engaged at the outset of the planning process, and at various stages through the planning process rather than only at the end of the process.
- Conservation plans for inland water ecosystems need to be aligned with the frameworks and terminology used by the targeted resource managers, e.g. Bioregional Plans and Catchment Management Strategies.

11.2 Reflect the conservation of inland water ecosystems as an explicit function in institutional design

This implementation principle acknowledges that the conservation of inland water biodiversity will not receive due attention and resources if it is not reflected as a line function in the business plans and budgets of responsible agencies.

11.2.1 Rationale

A lead implementation agency can only maintain its leadership role within a cross-sector governance setting if it is perceived to have a certain level of competence credibility regarding inland water conservation. Competence credibility describes the degree to which an individual, group or organization is perceived to be knowledgeable or expert. It is a function of record of accomplishment, of originality, technological superiority and the relevance of their projects, as well as perceived experience and their ability to communicate (Cullen *et al*., 2001).

This does not mean that any one agency needs to be self-sufficient in everything that needs to be done, but that it should be in a position to effectively coordinate, integrate where necessary, and evaluate a variety of technical inputs from several sources.

11.2.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- Every sub-national implementation agency responsible for conserving inland water biodiversity should plan for and acquire internal capacity for effectively executing their responsibilities in this regard. Capacity implies both the skills to facilitate networking and collaboration among relevant agencies, as well as sufficient depth of knowledge in aquatic ecology and conservation science to harness external knowledge in this regard and to effectively apply such knowledge.
- CMAs, provincial conservation departments / agencies, and district and local municipalities should plan and budget for the financial and human resource implications associated with effective implementation of their agreed component of the inland water conservation objectives and targets in their geographic areas of responsibility.

11.3 Enable cooperative governance in the conservation and management of inland water biodiversity

No single organisation can claim the ability to implement on its own all facets of an inland water conservation plan. The integrated nature of inland water conservation planning and implementation requires the combination and integration of a highly diverse and specialised cluster of skills, and spans the mandates of a number of sectors and spheres of government. Achievement of sub-national conservation targets will rely on the combined efforts of various implementation agencies, coordinated at the level of a Water Management Area. This challenge is also an opportunity to give effect to the principles of cooperative governance.

11.3.1 Rationale

Collaboration and performance management can be used as two mutually-reinforcing strategies to promote cooperative governance. Performance management motivates organisations to work together to achieve collective goals and encourage partners to adhere to agreements that were developed using collaborative processes. On the other hand, the interactive nature of collaborative processes promotes information sharing and encourages the development of performance measures to enhance individual and organizational accountability.

In the context of inland water conservation planning and implementation, performance management relates to the responsibilities and actions that are necessary to progress towards, or to maintain, a set conservation target. Such action and responsibilities may include a particular sampling frequency, method of data management, style of reporting, and the implementation of various management actions (e.g. rehabilitation).

Text Box 13
Performance management for effective collaboration

Collaboration – two or more organisations working together to produce more value than could be produced individually, i.e. when the organizations act alone.

Performance management system – a system that includes agreed goals, performance measures, and reporting processes that are designed to improve service delivery and enhance accountability.

The following lessons have been documented for cooperative governance in watershed management:

Lesson 1 – Performance management can raise questions of competing interests and values
The various public organisations involved with river health monitoring and management invariably have different and sometimes even conflicting management objectives and priorities due to different enabling statutes, competing public interests, and the expectations of their respective constituency groups. Competing interests and values complicate the process of reaching agreement on suitable performance measures, e.g. what constitutes a viable as well as achievable river health goal. However, the improved dialogue and trust that is created through collaborative processes is essential for reaching a shared understanding of problems and jointly tackling those problems.

Lesson 2 – There can be complexity, cost and attribution problems
The complexity of natural processes, difficulty of discerning human-induced changes from natural variations in environmental data, difficulty of establishing cause and effect relationships [and

longitudinal linkages], and long time lags between action and observable environmental changes, all compound the challenge of river monitoring and management. An overall lesson is that a proper performance management system can help to attract resources, which in turn would help to address these difficulties. A further complexity is that some impacts may originate from outside a catchment and network partners may have limited ability to influence these outcomes. A general guideline is to focus performance management on those problems or actions that network participants can actually influence or control.

Lesson 3 – Performance management systems can be used to motivate joint action
Performance management can be a strong motivator for joint action. Performance management should strategically focus on those issues where joint action is desired by stakeholders, politicians and the general public; as well as opportunities where there is a high likelihood of a win-win outcome. It is important that measures create a shared sense of purpose among network actors.

Lesson 4 – Performance management enhances collaborative processes
Human interaction promotes the understanding of personalities, goals and preferences of other participants. Repeated interactions provide the time required for the development of personal and inter-organisational relationships and trust. Actors engaged in frequent, recurring interactions are more likely to develop specialised governance structures such as inter-organisational alliances or partnerships. Over time, performance management generates the behavioural norms that govern much of our political and social lives. Relationships between individuals and organisations participating in collaborative processes can be structured by formal agreements, but more often than not they are based on tradition, implicit personal commitments, and shared norms and expectations due to communication processes embedded in interpersonal relationships. These norms provide the foundation for peer pressure at the individual, organisational, political and public level to comply with agreements. Thus, it is an important accountability mechanism in networks of autonomous actors.

Peer pressure is likely to be enhanced when performance assessment allows network participants to know how much effort or creativity fellow participants invest in collaborative efforts and goal achievement. This can be achieved by:

- Routine monitoring of biological integrity;
- Individual or joint reporting of programmatic activities;
- Preparation of individual or joint work plans; and
- Regular meetings to discuss progress toward shared goals.

Lesson 5 – Accountability is a two-edged sword
Performance management provides information that improves accountability by managing the diverse expectations that are generated both from within and from outside the network. Holding networks accountable for their performance is particularly important when resources are allocated to supplement network operations or where responsibility for achieving outcomes is delegated to an inter-organisational partnership. However, there is a constant tension in networks between organisational autonomy and accountability. On the one hand, performance monitoring processes help enforce collaborative agreements. On the other hand, excessive performance monitoring and enforcement creates a disincentive in that participants may fear reprisal and criticism.

Care must be taken when establishing performance measures and associated monitoring and reporting processes. If targets are set too low, almost any agency will be able to meet the goals and such goals will lack meaning. Similarly, if goals are too difficult to achieve and network participants find it difficult to demonstrate progress, then organisations may fear reprisal and feel that they are set up for certain failure. In the latter situation, organisations may become reluctant to commit to collaborative ventures.

Lesson 6 – Leadership is critical
Given the political and complex nature of collaborative processes, leaders with the necessary political and persuasive skills are critical to sell the potential benefits of performance management and gain adoption (emotional and financial commitment) by network participants.

Source: Imperial (2004)

11.3.2 Cross-sector policy recommendations

The following policy recommendation is presented:

- Performance management in a cooperative governance setting should be promoted through the development, testing and demonstration of suitable quantitative and qualitative indicators.
- The establishing of regular interaction with counterparts in cooperative agencies should be encouraged. Regular and quality interactions are necessary for building personal and professional relationships; especially where stakeholders are geographically dispersed.

11.4 Facilitate a science-management continuum

This implementation principle acknowledges that development of cross-sector policy objectives and the execution of these objectives through the implementation of inland water conservation designs are based on current understanding from within a scientific and planning discipline that is relatively young. It furthermore acknowledges that action based on available but incomplete knowledge is better than no action.

11.4.1 Rationale

Senge et al. (2005) stated that all learning integrates thinking and doing. A major advantage of doing or action is that it facilitates further learning or the acquiring of relevant knowledge and skills in a developmental and dynamic process of learning-by-doing. The dual need of theory and practical experience can be achieved through action research, where research is achieved through intervening in what is being researched. In fact, unless we intervene, we will not learn what some of the essential dynamics of the system really are. Through action research, the development of a theoretical discourse enables new ways of understanding and doing, while reflective practice becomes a source of theorising (Roux *et al.*, 2006).

The implementation of this policy for inland water biodiversity conservation should, as far as possible, be structured around an adaptive monitoring, planning and management philosophy, which involves research, policy review and natural resource planning and management. Science and management represent two different communities of practice that are complementary only to the degree that they interface (Roux *et al*., 2006). In essence, a formal partnership is needed between those who are involved with development of a theoretical discourse (scientists) and a community of strategic and operational practitioners (management).

This partnership can be assisted and supported through the establishment and nurturing of a relevant national research, development and implementation programme. In fact, the groundwork for such a programme, referred to as the National Freshwater Biodiversity Collaboration (NFBC), started during 2004 with inputs from DWAF, DEAT, DoA, DST, WRC, NRF, WWF-SA, SANBI, SAIAB and CSIR.

11.4.2 Cross-sector policy recommendations

The following policy recommendation is presented:

- National custodian departments should institute and support suitable mechanisms and processes that will promote an adaptive management framework for conservation of inland water biodiversity.

11.5 Promote discovery, inventory and improved understanding of inland water biodiversity

Acknowledging that our understanding of inland water biodiversity is incomplete, this implementation principle promotes ongoing discovery, basic inventory and research into questions related to inland water biodiversity.

11.5.1 Rationale

The “typing” of ecosystems based on their ecological similarities is one attempt at making sense of the infinite complexity of the biological world. However, we cannot ignore the value of primary species-occurrence data. There is a massive amount of observational and survey data held in universities and museum collections, by non-governmental organisations and by private individuals, and these data add valuable additional knowledge about our environment. They are not competing data resources but complementary, and each have their strengths and weaknesses in supplying the information that the world needs (see Chapman, 2005).

Much of the available species-occurrence data have been collected opportunistically rather than systematically and this can result in large spatial biases – for example, collections that are highly correlated with road or river networks (Chapman, 2005). An important component to ensuring improved understanding and management of inland water biodiversity is to improve the ways in which we collect, capture, manage and make basic biodiversity data available.

Improved species data sets will also promote better understanding and validation of coarse-filter surrogates (see Section 8.1.1).

Although university and museum records cannot alone be used to monitor the status of populations and species into the future, they can help to establish baseline species distributions against which to evaluate current and future conditions. Measuring the change in status of a species over time can serve to indicate not only condition of the individual species, but also of the ecosystems in which they live. It is important to note, though, that changes in species status may reflect past disturbances, because time lags may occur between the occurrence of a stress and its effect on habitats and species populations.

Text Box 14
The taxonomic status of freshwater fishes of southern Africa

The most recent assessment of the southern African freshwater fish fauna (Skelton 2001) gives a total of 280 species for the sub-continent. The list includes primary and secondary freshwater fishes, marine stragglers and exotic species and it is changing all the time with new records and taxonomic amendments.

Taxonomic research has benefited in two ways during the last decade.

- Access to many regions in southern Africa has become easier, enabling the collection of more comprehensive sets of comparative material.
- New genetic techniques have given alternative ways to analyze complex inter-relationships, especially those between closely related species.

The result has been the recognition of much greater fish diversity in southern Africa than previously considered.

New species likely to be described in the near future comprise:

- newly discovered taxa (especially in poorly explored regions of southern Africa);
- species previously thought to have split distributions e.g. the papermouth (*Barbus mattozi* of the Kunene and Limpopo Rivers); and
- populations of previously widespread species are now being split on the basis of genetic and morphological variation.

Much of this 'new' diversity remains to be formally described; examples of the magnitude of the changes that are likely for the Western Cape (RSA), South and Southern Africa are provided below:

<u>Western Cape.</u> Recent genetic studies on the genus *Pseudobarbus* have shown that 16 unique genetic lineages exist amongst the seven currently recognised species. Most of these lineages will soon be described as new species or sub-species, potentially doubling the number of threatened species in this genus. In fact, renewed taxonomic investigations into the Cape Floristic Region's (CFR) fish fauna, could lead to an increase of 130 % in the number of taxa recognised (mainly in the genera *Pseudobarbus*, *Galaxias* and *Sandelia*).

<u>South Africa.</u> We estimate that of the approximately 100 species in South Africa there could be more than 30 taxonomic changes, ranging from the resurrection of original names to the description of new taxa that occupy very localized sets of habitats.

<u>Southern Africa.</u> For the rest of southern Africa, it is more difficult to estimate how many new taxa remain to be discovered, because there has not been the same level of investigation as in the Cape Floristic Region of the Western Cape.

- In recent surveys of the upper Zambezi River in Zambia, the number of known species was 88; A total of 82 of these species was collected, as well as a further 37 species that had not previously been recorded from the system. The latter group are a mixture of new species and possibly 'Congo' species that have not been recorded previously in the Zambezi River system.

- In the Rovuma River system of northern Mozambique, 46 species had been recorded prior to 2003. A single two-week survey identified numerous taxonomic changes to the checklist and included 10 new distribution records, 18 new species and raised the checklist total to 56. New species ranged from small *Barbus* and *Aplocheilichthys* to large commercially important Clariid catfishes.

Clearly, we are not out of the alpha-taxonomic stage of our knowledge of southern African fishes and this has important implications for scientists, conservation managers and governments. Scientists involved in field work should routinely keep voucher specimens so that the species they identify can be verified. Managers need to be open-minded to the potential for isolated populations of widespread species to comprise unique genetic lineages that may be worthy of special conservation measures. These issues need to be borne in mind when assessing species conservation issues and environmental impact assessments.

Contributed by Mr. Roger Bills & Dr. Ernst Swartz, South African Institute for Aquatic Biodiversity - January 2006

Text Box 15
State of invertebrate taxonomy

Museum collecting surveys regularly turn up species of aquatic invertebrates that cannot be placed in any known species or, sometimes, in known genera. However, it is not the routine sampling techniques such as SASS5 (Dickens and Graham, 2002) or collecting in large rivers that turn up the new species. It really requires a specialist who is searching for a particular group of animals to uncover significant new discoveries, either range extensions for known species or undescribed species that are new to science. As an example, the discovery of a new Order of Insects in South Africa, the Mantophasmatodea, required a German scientist with a thorough understanding of the basic systematics of a select few groups of closely related insects to recognise that certain insects that had been set aside as “unplaced” in Museum collections over a period of more than 100 years were actually a major undiscovered taxonomic entity.

The discovery of a new genus and species of Anostraca (fairy shrimp) *Rhinobranchipus martensi* in a temporary pool in the Thomas Baines Nature Reserve near Grahamstown was a major new finding. Unfortunately, this discovery was followed by a well-intentioned “conservation action” that turned the temporary pool into a permanent waterbody in order to attract birds. This resulted in the destruction of the only known habitat of this new species and may have resulted in the extinction of the genus - all within the confines of a Provincial Nature Reserve!

Contributed by Dr Ferdy de Moor, Makana Biodiversity Centre, Albany Museum
January 2006

11.5.2 Cross-sector policy recommendations

The following policy recommendations are presented:

- Clear responsibilities should be established regarding biodiversity collections and inventories, as well as the means to coordinate actions and responsibilities at national level.
- Priority monitoring gaps and limitations should be identified, responsible parties should be identified, and appropriate interventions should be developed.
- A protocol for the systematic collection and curation of species data should be drawn up to guide museums and other collectors.

Part 5
Conclusion and Next Steps

12. CONCLUSIONS

Water is a cross-sector issue that affects every level and activity of society and life on Earth. Therefore, water policy must also be cross-sectoral in character if it is to correctly reflect the complex nature of water management. As a result, the successful achievement of water policy goals requires close and sustained cooperation and coordinated effort amongst all of the agencies that are responsible for policies and activities that affect, or are influenced by, water (MacKay and Ashton (2004). In a similar way, biodiversity issues span several different sectors and biodiversity policy therefore also qualifies as cross-sectoral policy. Importantly, where the area of management focus is inland water biodiversity, the overlapping sectoral roles and responsibilities of both water and biodiversity must apply. In this situation, it is extremely important to ensure that the respective sets of policies and management instruments are both coherent and properly aligned with each other, in order to avoid the confusion that could arise as a result of conflicting objectives and contradictory management approaches.

Acknowledging the above complexity, the development of this discussion paper was based on a process of searching for and negotiating a shared understanding of key concepts related to the conservation of inland water biodiversity. An important part of this process was to make explicit all those issues or characteristics that are fundamental to future visions that exist within the respective sectors that share responsibility for the conservation of inland water biodiversity. A broad cross-section of representatives from the different sectors, organizations and government departments that have line responsibilities for water resource management, environmental and biodiversity management, agriculture and land use planning, were brought together to engage in a wide-ranging set of debates regarding cross-sector policy objectives for inland water biodiversity conservation.

The convergence in thinking that emerged from these debates was quite remarkable – particularly in the way that a shared vision was achieved for the conservation and management of inland water biodiversity. Most importantly, special attention was paid to ensuring that the recommended policy instruments were coherent and practical, and could be implemented effectively by the different organizations and agencies responsible for specific issues. This focus on the effective ***implementation*** of policy instruments will help to avoid the type of situation where consensus-seeking approaches ignore important management realities and create policy instruments that are either difficult or impossible to implement. In such situations, the respective end-users or operational managers become frustrated by their inability to implement the respective instruments and are likely to revert to older, “tried and trusted” operational methods.

In this study, an effort was made to address the philosophical aspects of policy whilst also ensuring that practical recommendations could be made for the effective implementation of this policy. For this reason, a carefully structured, hierarchical approach was followed. First, a high-level national goal was formulated, followed by clear and unambiguous statements of the five necessary conditions or broad policy objectives that underpin the achievement of this goal. These key objectives were then linked to 20 implementation principles that characterize effective policy implementation. Finally, approximately 50 policy-related recommendations were made to support the practical implementation of the principles.

Several bold decisions were made by the participating government departments, for example to set a quantitative target of conserving 20 % of each major inland water ecosystem type. The uncertainty and lack of scientific validation around this and some other decisions were noted, as well as the need for directed research and the establishment of appropriate feedbacks between research and conservation practice.

Several of the policy recommendations that are made in this paper have institutional and capacity implications. For example, Catchment Management Agencies were identified as primary agencies responsible for achieving conservation targets at the level of a Water Management Area. This will require significant coordination of activities and resources within provincial and local spheres of government, which in turn can only happen if these agencies have an appropriate level of internal knowledge and capacity in the fields of conservation science and aquatic ecology. There is also the intricate issue of coordinating biodiversity assessment, conservation planning and target setting between a national and various sub-national scales; where river catchment and water management area boundaries are not aligned with provincial and district municipality boundaries. The overall responsibility for ensuring this kind of spatial alignment has been allocated to DEAT, primarily through SANBI.

In South Africa, DWAF is the government department with line function responsibility for dealing with water management, while DEAT has the overall line function responsibility to deal with biodiversity management. However, it is clear that neither of these departments can effectively manage inland water biodiversity on its own. The conservation of inland water biodiversity can only be achieved through a comprehensive analysis and understanding of the areas of overlap and the effective sharing of expertise and resources. In fact, while these two departments may be the primary role players representing national government, there are a number of secondary role players that also need to be engaged, including: DoA, DME, DPLG, and DLA. In addition, provincial and local government authorities, conservation agencies such as SANParks, and research facilities such as SAIAB, also need to form an integral part of growing a national capability for the effective management of our biodiversity resources associated with inland waters. Figure 4 demonstrates the multifaceted nature and multiple spatial scales of inland water biodiversity issues and management concerns.

A most important finding, and critical for taking the recommendations in this paper forward, is the need for cooperation across sectors (horizontal) and spheres (vertical) of governance. Conservation planning and the governance of inland water biodiversity takes place in a complex environment where decision-making is typically associated with low levels of certainty and potentially high levels of disagreement among stakeholders. In this environment, active and respectful negotiations are required (Kinnaman and Bleich, 2004) to ensure that organisations, departments and agencies with different professional identities and mandates can successfully agree to and achieve shared objectives related to the conservation of inland water ecosystems.

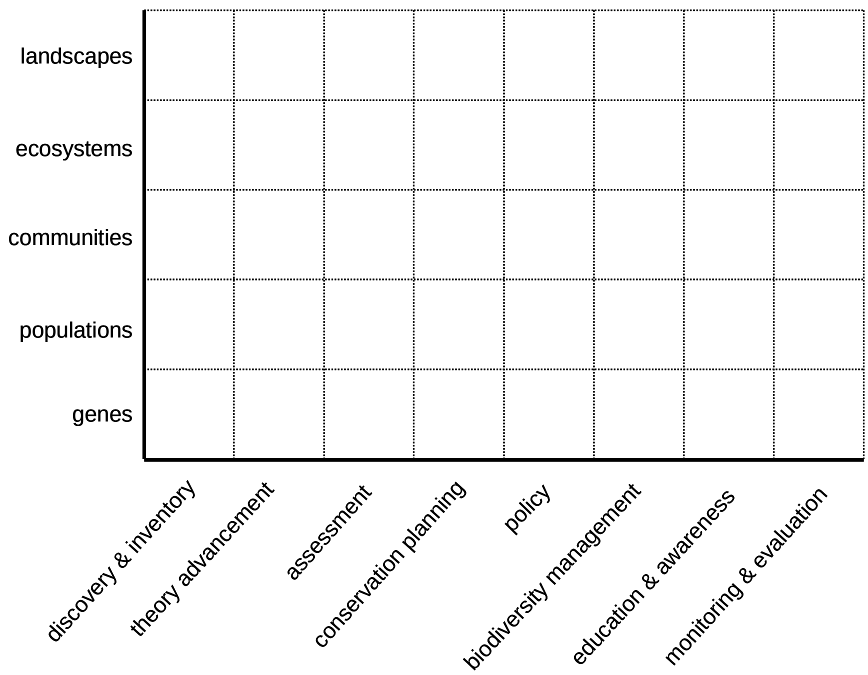

Figure 4

A matrix indicating the many areas of research and application that need to be resourced and aligned in order to give affect to the goal of conserving a sample of the full diversity of inland water ecosystems that occur in South Africa.

Ironically, with the current focus of government on service delivery and tangible outcomes, effective cooperation requires intangible inputs; for example, people need to spend time together developing relationships and learning to communicate with, respect, and trust one another. An overall recommendation of this paper is, as a matter of urgency, to develop a clear understanding of cooperation as a strategy: when is it appropriate; what does it cost; what conditions are necessary for it to exist; and what benefits can it realistically generate (see Kinnaman and Bleich, 2004).

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APPENDIX A

THE ECOSYSTEM APPROACH

The following description and principles of the ecosystem approach were endorsed during the 5th meeting of CBD's Conference of the Parties (COP-5; 15-26 May 2000, Nairobi, Kenya – https://www.biodiv.org/convention/cops.asp):

Description of the ecosystem approach

1. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
2. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.
3. This focus on structure, processes, functions and interactions is consistent with the definition of "ecosystem" provided in Article 2 of the Convention on Biological Diversity: "'Ecosystem' means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit." This definition does not specify any particular spatial unit or scale, in contrast to the Convention definition of "habitat". Thus, the term "ecosystem" does not, necessarily, correspond to the terms "biome" or "ecological zone", but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.
4. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet been fully established scientifically.
5. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.

Principles of the ecosystem approach

The following 12 principles are complementary and interlinked:

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice.
Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.

Principle 2: Management should be decentralized to the lowest appropriate level.
Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:
(a) Reduce those market distortions that adversely affect biological diversity;
(b) Align incentives to promote biodiversity conservation and sustainable use;
(c) Internalize costs and benefits in the given ecosystem to the extent feasible.
The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations, and provide perverse incentives and subsidies to favour the conversion of land to less diverse systems. Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.

Principle 6: Ecosystems must be managed within the limits of their functioning.

In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favour short-term gains and immediate benefits over future ones.

Principle 9: Management must recognize that change is inevitable.
Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential "surprises" in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, *inter alia*, any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.
Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.

Operational guidance for application of the ecosystem approach

In applying the 12 principles of the ecosystem approach, the following five points are proposed as operational guidance.

1. ***Focus on the functional relationships and processes within ecosystems***: The many components of biodiversity control the stores and flows of energy, water and nutrients within ecosystems, and provide resistance to major perturbations. A much better knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand: (i) ecosystem resilience and the effects of biodiversity loss (species and genetic levels) and habitat fragmentation; (ii) underlying causes of biodiversity loss; and (iii) determinants of local biological diversity in management decisions. Functional biodiversity in ecosystems provides many goods and services of economic and social importance. While there is a need to accelerate efforts to gain new knowledge about functional biodiversity, ecosystem management has to be carried out even in the absence of such knowledge. The ecosystem approach can facilitate practical management by ecosystem managers (whether local communities or national policy makers).

2. ***Enhance benefit-sharing***: Benefits that flow from the array of functions provided by biological diversity at the ecosystem level provide the basis of human environmental security and sustainability. The ecosystem approach seeks that the benefits derived from these functions are maintained or restored. In particular, these functions should benefit the stakeholders responsible for their production and management. This requires, *inter alia*: capacity-building, especially at the level of local communities managing biological diversity in ecosystems; the proper valuation of ecosystem goods and services; the removal of perverse incentives that devalue ecosystem goods and services; and, consistent with the provisions of the Convention on Biological Diversity, where appropriate, their replacement with local incentives for good management practices.

3. ***Use adaptive management practices***: Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by the interaction with social constructs, which need to be better understood. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. Ecosystem management needs to recognize the diversity of social and cultural factors affecting natural-resource use. Similarly, there is a need for flexibility in policy-making and implementation. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses. This "learning-by-doing" will also serve as an important source of information to gain knowledge of how best to

monitor the results of management and evaluate whether established goals are being attained. In this respect, it would be desirable to establish or strengthen the capacities of Parties for monitoring.

4. ***Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate***: As noted above, an ecosystem is a functioning unit that can operate at any scale, depending upon the problem or issue being addressed. This understanding should define the appropriate level for management decisions and actions. Often, this approach will imply decentralization to the level of local communities. Effective decentralization requires proper empowerment, which implies that the stakeholder both has the opportunity to assume responsibility and the capacity to carry out the appropriate action, and needs to be supported by enabling policy and legislative frameworks. Where common property resources are involved, the most appropriate scale for management decisions and actions would necessarily be large enough to encompass the effects of practices by all the relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. Some problems and issues may require action at still higher levels, through, for example, transboundary cooperation, or even cooperation at global levels.

5. ***Ensure intersectoral cooperation***: As the primary framework of action to be taken under the Convention, the ecosystem approach should be fully taken into account in developing and reviewing national biodiversity strategies and action plans. There is also a need to integrate the ecosystem approach into agriculture, fisheries, forestry and other production systems that have an effect on biodiversity. Management of natural resources, according to the ecosystem approach, calls for increased intersectoral communication and cooperation at a range of levels (government ministries, management agencies, etc.). This might be promoted through, for example, the formation of inter-ministerial bodies within the Government or the creation of networks for sharing information and experience.

APPENDIX B

FUNDAMENTAL PRINCIPLES AND OBJECTIVES FOR WATER LAW IN SOUTH AFRICA

LEGAL ASPECTS OF WATER

Principle 1
The water law shall be subject to and consistent with the Constitution in all matters including the determination of the public interest and the rights and obligations of all parties, public and private, with regards to water. While taking cognisance of existing uses, the water law will actively promote the values enshrined in the Bill of Rights.

Principle 2
All water, wherever it occurs in the water cycle, is a resource common to all, the use of which shall be subject to national control. All water shall have a consistent status in law, irrespective of where it occurs.

Principle 3
There shall be no ownership of water but only a right (for environmental and basic human needs) or an authorisation for its use. Any authorisation to use water in terms of the water law shall not be in perpetuity.

Principle 4
The location of the water resource in relation to land shall not in itself confer preferential rights to usage. The riparian principle shall not apply.

THE WATER CYCLE

Principle 5
In a relatively arid country such as South Africa, it is necessary to recognise the unity of the water cycle and the interdependence of its elements, where evaporation, clouds and rainfall are linked to groundwater, rivers, lakes, wetlands and the sea, and where the basic hydrological unit is the catchment.

Principle 6
The variable, uneven and unpredictable distribution of water in the water cycle should be acknowledged.

WATER RESOURCE MANAGEMENT PRIORITIES

Principle 7
The objective of managing the quantity, quality and reliability of the Nation's water resources is to achieve optimum, long-term, environmentally sustainable social and economic benefit for society from their use.

Principle 8
The water required to ensure that all people have access to sufficient water shall be reserved.

Principle 9
The quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved so that the human use of water

does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems.

Principle 10
The water required to meet the basic human needs referred to in Principle 8 and the needs of the environment shall be identified as “The Reserve” and shall enjoy priority of use by right. The use of water for all other purposes shall be subject to authorisation.

Principle 11
International water resources, specifically shared river systems, shall be managed in a manner that optimises the benefits for all parties in a spirit of mutual cooperation. Allocations agreed for downstream countries shall be respected.

WATER RESOURCE MANAGEMENT APPROACHES
Principle 12
The National Government is the custodian of the nation’s water resources, as an indivisible national asset. Guided by its duty to promote the public trust, the National Government has ultimate responsibility for, and authority over, water resource management, the equitable allocation and usage of water, and the transfer of water between catchments and international water matters.

Principle 13
As custodian of the nation’s water resources, the National Government shall ensure that the development, apportionment, management and use of those resources is carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects its public trust obligations and the value of water to society, while ensuring that basic domestic needs, the requirements of the environment and international obligations are met.

Principle 14
Water resources shall be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water. Conservation and other measures to manage demand shall be actively promoted as a preferred option to achieve these objectives.

Principle 15
Water quality and quantity are interdependent and shall be managed in an integrated manner, which is consistent with broader environmental management approaches.

Principle 16
Water quality management options shall include the use of economic incentives and penalties to reduce pollution, and the possibility of irretrievable environmental degradation as a result of pollution shall be prevented.

Principle 17
Water resource development and supply activities shall be managed in a manner which is consistent with the broader national approaches to environmental management.

Principle 18
Since many land uses have a significant impact upon the water cycle, the regulation of land use shall, where appropriate, be used as an instrument to manage water resources within the broader integrated framework of land use management.

Principle 19
Any authorisation to use water shall be given in a timely fashion and in a manner which is clear, secure and predictable in respect of the assurance of availability, extent and duration of use. The purpose for which the water may be used shall not arbitrarily be restricted.

Principle 20
The conditions upon which authorisation is granted to use water shall take into consideration the investment made by the user in developing infrastructure to be able to use the water.

Principle 21
The development and management of water resources shall be carried out in a manner which limits to an acceptable minimum the danger to life and property due to natural or manmade disasters.

WATER INSTITUTIONS
Principle 22
The institutional framework for water management shall as far as possible be simple, pragmatic and understandable. It shall be self-driven and minimise the necessity for State intervention. Administrative decisions shall be subject to appeal.

Principle 23
Responsibility for the development, apportionment and management of available water resources shall, where possible and appropriate, be delegated to a catchment or regional level in such a manner as to enable interested parties to participate.

Principle 24
Beneficiaries of the water management system shall contribute to the cost of its establishment and maintenance on an equitable basis.

WATER SERVICES
Principle 25
The right of all citizens to have access to basic water services (the provision of potable water supply and the removal and disposal of human excreta and waste water) necessary to afford them a healthy environment on an equitable and economically and environmentally sustainable basis shall be supported.

Principle 26
Water services shall be regulated in a manner which is consistent with and supportive of the aims and approaches of the broader local government framework.

Principle 27
While the provision of water services is an activity distinct from the development and management of water resources, water services shall be provided in a manner consistent with the goals of water resource management.

Principle 28
Where water services are provided in a monopoly situation, the interests of the individual consumer and the wider public must be protected and the broad goals of public policy promoted.

APPENDIX C

NEMA'S NATIONAL ENVIRONMENTAL MANAGEMENT PRINCIPLES

- Environmental management must place people and their needs at the forefront of its concern.
- Development must be socially, environmentally and economically sustainable.
- Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated.
- Environmental justice must be pursued.
- Equitable access to environmental resources to meet basic human needs and ensure human well-being must be pursued.
- Responsibility for the environmental health and safety consequences of a project or activity exists throughout its life cycle.
- The participation of all interested and affected parties in environmental governance must be promoted.
- Decisions must take into account the interests, needs and values of all interested and affected parties.
- The social, economic and environmental impacts of activities, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration and assessment.
- Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.
- The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.
- The costs of remedying pollution, environmental degradation and consequent adverse health effects must be paid for by those responsible for harming the environment.
- Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.