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**NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004
(ACT NO. 10 OF 2004)****BIODIVERSITY MANAGEMENT PLAN FOR THE CLANWILLIAM SANDFISH, LABEO SEEBERI**

I, Bomo Edith Edna Molewa, Minister of Environmental Affairs, hereby publish the Biodiversity Management Plan for the Clanwilliam Sandfish, Labeo Seeberi, in terms of section 43(3) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004), set out in the Schedule hereto.



**BOMO EDITH EDNA MOLEWA
MINISTER OF ENVIRONMENTAL AFFAIRS**

SCHEDULE
BIODIVERSITY MANAGEMENT PLAN-SPECIES (BMP-S) FOR THE
CLANWILLIAM SANDFISH (*LABEO SEEBERI*)



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TITLE : **BIODIVERSITY MANAGEMENT PLAN-SPECIES (BMP-S) FOR THE CLANWILLIAM SANDFISH (*LABEO SEEBERI*)**

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EXECUTIVE SUMMARY

1. INTRODUCTION

The Clanwilliam sandfish *Labeo seeberi* is listed by the IUCN Red Data List and by the South Africa's Threatened or Protected Species Regulations of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA) as Endangered B2ab(iii,v) (IUCN 2010). This recognises that species facing an extremely high risk of extinction and is therefore subject to the restrictions imposed by national legislation on its removal from the wild, transport, trade and use.

There are currently conservation initiatives aimed at protecting populations of the two larger cyprinids in the catchment (the Clanwilliam yellowfish and sawfin), but these initiatives will not secure populations of Clanwilliam sandfish, despite the fact that it ranks as one of the most threatened species in the Western Cape and has been identified as a high conservation priority by CapeNature. Adult populations of this species are restricted to the northern reaches of the Doring River and successfully recruiting populations are known to occur only in confined reaches of the Oorlogskloof-Koebee River system in the Northern and Western Cape.

Responsibility for the conservation and management of the sandfish are shared by the conservation authorities in the two provinces – the Western and Northern Cape – in which it occurs, i.e. CapeNature and Northern Cape Department of Environment and Nature Conservation. Responsibility also extends to municipalities, as well as to private landowners that fall both within and outside its distribution range where land-use practices impact on downstream aquatic habitat. Private landowners, through conservancies and stewardship programmes are expected to manage land and water resources in a manner consistent with national environmental legislation and to adhere to the restrictions imposed on the movement and introduction of alien invasive species. The following Vision and Desired State for the Clanwilliam sandfish BMP-S was agreed upon by the BMP-S team and at stakeholder meetings:

VISION AND DESIRED STATE
<p>To secure the long term survival of the Clanwilliam sandfish in the wild by:</p> <ul style="list-style-type: none"> (i) <i>elevating its status as an flagship species of the Doring and Oorlogskloof rivers – some of the last major free-flowing rivers in the country;</i> (ii) <i>consolidate extant populations by reducing the risks of further invasions by alien fish species, especially in the Oorlogskloof-Koebee Management Unit;</i> (iii) <i>reducing the risks posed by increasing water demand and unsustainable land management practices in all catchments that fall within its distribution range;</i> (iv) <i>increase knowledge of its biology and ecology and applying this knowledge to adaptive management strategies.</i> (v) <i>Identifying priority areas in its original distribution range which can be cleared of alien fishes, allowing for re-introduction of the species.</i>

The following five strategic domains for the BMP-S are considered to be:

- (a) Advocacy and Awareness; (b) Alien Invasive Fish Management; (c) Land and Water Resources Management; (d) Research and Monitoring; (e) Re-introduction.

SPECIES BACKGROUND

Clanwilliam sandfish are endemic to the mainstem and tributaries of the Olifants and Doring Rivers, Western Cape, South Africa. They were formerly distributed throughout the catchment but now only occur in the middle and northern reaches of the mainstem Doring River and some of its tributaries, notably the Koebee River, called the Oorlogskloof in its upper reaches. Historical evidence suggests that their current distribution ranges have shrunk considerably from former ranges. They are one of only two indigenous Labeine cyprinid species to be found in Western Cape freshwater ecosystems; the other being *L. umbratus* which is found in the Gouritz River system. As a consequence of their rarity, conservation status and lack of research on the species, little is known regarding the life history of the Clanwilliam sandfish. They are more than likely rheophilic, requiring fast-flowing waters for spawning and deep pools for feeding, over-wintering and over-summering. Surveys undertaken in 2001 suggested that although adults were present in the mainstem Doring River and appeared to be reproducing, very few recruits were surviving their first year of life due to alien fish predation. The main source of recruits appeared to be non-invaded tributaries, notably the Oorlogskloof-Koebee catchment. Surveys by CapeNature and the Northern Cape Department of Environment and Nature Conservation in 2010 showed that populations of sandfish are successfully recruiting in the Oorlogskloof River above the upstream limit of bass invasion, but that banded tilapia had invaded from the Nieuwoudtville Municipal Dam upstream.

THREATS TO THE CLANWILLIAM SANDFISH

Alien invasive fish species: As with many of the other indigenous fish species in the Doring River, the primary threat to the persistence of the sandfish is predation and competition by alien invasive fish species, notably, smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*) and bluegill sunfish (*Lepomis macrochirus*) which were introduced as sport fish by the then Department of Inland Fisheries during the earlier half of the twentieth century.

Water quantity: The sandfish is considered a synchronous rheophilic spawner requiring optimal flow and temperature conditions for successful reproduction. Natural hydrological variability, together with water regulation and abstraction is therefore likely to play a major role in year-class strength. Water resources in both the Olifants and Doring Rivers are heavily exploited. This is especially true of the Olifants River where run-of-river abstractions and flow regulation by dams in the Olifants River valley (notably the Clanwilliam Dam and Bulshoek Weir) have had a major effect on the hydrological regime.

Water quality: The absence of heavy industry in the Olifants and Doring Rivers' catchment and the predominantly rural-agricultural nature of the economy in the region mean that water quality in both systems is relatively unimpacted. However, salinity levels in the Olifants River downstream of Vredendal are too high for irrigation as a consequence of agricultural return flows.

Physical habitat degradation: In 2005, the Olifants-Doring Rivers Ecological Water Requirements study identified bulldozing the river channel, cultivation on alluvial floodplains and encroachment by alien riparian vegetation species as continuing to compromise the geomorphological integrity of the riparian corridor on the Olifants River. Although opportunities for cultivation along the banks of the Doring River are limited by the nature of the topography; localised impacts are apparent at Uitspankraal and Elandsvlei where overgrazing, trampling and eutrophication by livestock are sufficient to warrant concern.

Instream barriers: Endemic fish species have all but disappeared from the middle and lower reaches of the Olifants River where large scale water resource infrastructure and water abstraction has interrupted spawning migrations and degraded aquatic habitat. In contrast, for the most part, the Doring River is still free-flowing. Careful consideration should therefore be given to the removal of barriers in instances where it may promote invasion. This is particularly noteworthy in the light of potential invasions by sharptooth catfish.

Socio-economic issues: History of utilisation: The extent to which the indigenous fish were harvested for consumption by people living in the Olifants and Doring Rivers basin in the past is not clear. Reports from farmers in the catchment suggest that in the earlier half of the 20th century, when fish were more abundant, both farmers and farm labourers would club fish in the shallows when they spawned. Although the Clanwilliam yellowfish is highly prized as an angling species, the Clanwilliam sandfish is difficult to catch on either bait or a fly and has therefore never been a targeted angling species.

Past conservation measures: No conservation measures have been directed specifically towards conserving the Clanwilliam sandfish in the past. However, the only known viable breeding population occurs in the Oorlogskloof Nature Reserve where surveys have been conducted by the reserve staff since 2000.

4. CLANWILLIAM SANDFISH BMP-S ACTION PLAN

At the BMP-S inception meeting it was decided to divide the Extent of Occurrence (EOO) of the Clanwilliam sandfish into three Management Units (MUs): 1) the Lower-Middle Doring River; 2) the Oorlogskloof-Koebee and 3) the Biedouw Valley. These MUs provided the spatial context for management actions, with specific challenges being associated with each unit.

Once the stakeholder groups were identified, an invitation to participate in the development to the BMP-S was sent out. The venue and dates for each of the stakeholder meetings were as follows:

- (1) **Lower-Middle Doring River MU:** 16 Sep 2011, DWA Head Office Bellville, Western Cape, Sigma Building Conference Room
- (2) **Oorlogskloof-Koebee MU:** 26 Aug 2011, Indigo Development and Change Offices, 1 NeethlingStr, Nieuwoudtville
- (3) **Biedouw Valley MU:** these actions were addressed by stakeholders at the Lower-Middle Doring MU meeting.

OORLOGSKLOOF-KOEBEE MANAGEMENT UNIT (NORTHERN CAPE) ACTIONS

Threat 1: Alien Invasive fish species

- ACTION 1(a) Memoranda of Agreement (MOA) to be signed by Hantam Local Municipality and selected landowners
- ACTION 1(b) Interpretive signage at the Nieuwoudtville Municipal Dam, Papkuilsfontein farm and OKNR (Brakwater and at the entrance to the reserve)
- ACTION 1(c) Eliminate populations of banded tilapia (*Tilapia sparrmanii*) from the Nieuwoudtville Municipal Dam
- ACTION 1(d) Eliminate populations of mirror carp (*Cyprinus carpio* var. *specularis*) from the Kranskloof and Driefontein Dams

Threat 2: Increasing water demand and climate change

- ACTION 2(a) Source funding to install a stage logger and gauging plate on the Oorlogskloof River

Threat 3: Deteriorating water quality in the Oorlogskloof River

- ACTION 3(a) Water quality monitoring in the Groen and Oorlogskloof Rivers

Threat 4: Alien Invasive Plants

- ACTION 4(a) Clear AIP from the Oorlogskloof River and Bokkeveld Plateau wetlands

Threat 5: Lack of environmental awareness

- ACTION 5(a) Engage actively in outreach and advocacy

Threat 6: Unsustainable land-use patterns

ACTION 6(a) Sustainable land-use practices encouraged through stewardship programmes and environmental departments

Threat 7: Lack of governance and lack of capacity and resources in conservation

ACTION 7(a) Conservation authorities to become more involved in strategic development planning by ensuring Bioregional Plans are given due consideration

Threat 8: Lack of biological information and monitoring

ACTION 8(a) Annual monitoring of sandfish populations in the Oorlogskloof Reserve

Threat 9: Epizootic Ulcerative Syndrome (EUS)

There are currently no known means of controlling EUS in wild fish populations, however vigilance with regards to its outbreak in the Oorlogskloof Nature Reserve needs to be exercised and landowners need to be informed about the risks of translocation.

LOWER-MIDDLE DORING AND BIEDOUW RIVER MANAGEMENT UNIT ACTIONS*Awareness and Advocacy*

ACTION 9(a) Awareness and advocacy activities among conservancies, angling and interest groups

Ecological research and monitoring

ACTION 10(a) Initiate monitoring and research programmes on the Clanwilliam sandfish

ACTION 10(b) Annual monitoring of populations in the mainstem Doring and Biedouw Rivers

Translocation and re-introduction of Clanwilliam sandfish

ACTION 11(a) Translocate Clanwilliam sandfish populations to un-invaded or restored and secured river reaches

Ecological Water Requirements in the Doring River

ACTION 12(a) Ecological Water Releases from the Upper Doring tributaries (Groot and Leeu)

Re-evaluate conservation status

ACTION 13(a) Re-evaluate conservation status of the Clanwilliam sandfish

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DEFINITIONS

“Alien Invasive species” an introduced or ‘non-native’ species (i.e. not indigenous) that has been introduced into a region as a result of human intervention; that is an effective colonizer of new habitats and that has a detrimental effect on indigenous species of the region.

“Biological diversity or biodiversity” the variability among living organisms from all sources including, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems.

“Ecological Reserve” the quantity and quality of water which would be required to sustain the particular ecosystem so that the water resource can in turn sustain people and development. The National Water Act defines it as: “the quantity and quality of water required ... to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource”.

“Endemic species” a species that is unique to a specific geographic region.

“Genus” a low-level taxonomic rank used in biological classification to name organisms, higher level than a species, but lower than a family.

“Indigenous species” a species that is native to a particular region and occurs there purely as a result of natural processes without human intervention, i.e. not a species that has been introduced into a region as a result of human activity.

“IUCN Red Data List” a global or national list providing information on a species’ risk of extinction (usually by taxonomic group), and prepared under the auspices of the International Union for the Conservation of Nature.

“Natural distribution range” the spatial extent of the historical occurrence as can be determined through all available records and publications.

“Recommended Ecological Category” specific objectives for water resources that define levels of protection into the future and maintains a desired state of ecosystem health and functioning.

“Resource Quality Objectives” water quality and a quantity management objective set as standards to support aquatic ecosystems and define levels of protection.

“Species” a kind of animal, plant or other organism that does not normally interbreed with individuals of another kind, and includes any sub-species, cultivar, variety, geographic race, strain, hybrid or geographically separate population.

“Stakeholder” a natural or juristic person(s) that has an interest in, or may be affected by, a particular obligation or decision or activity, relating to or resulting from a management plan, either as individuals or representatives of a group, and include landowners where appropriate.

“Threat” any action that causes a decline and compromises the future survival of a species or anything that has a detrimental effect on a species. Threats can be human induced or natural. BMP-S should focus on mitigating human induced threats to species.

“Viable” relation to a species or population means the ability to survive or persist and develop or multiply over multiple generations or a long time period.

ACRONYMS

AI	Alien Invasive
BMP-S	Biodiversity Management Plan for Species
CapeNature	Western Cape Nature Conservation
CARA	Conservation of Agricultural Resources Act
CITES	Convention on International Trade in Endangered Species
CMA	Catchment Management Agencies
CMS	Catchment Management Strategies
DEA	Department of Environmental Affairs
DENC	Department of Environment and Nature Conservation, Northern Cape
DME	Department of Minerals and Energy
DWA	Department of Water Affairs
EOO	Extent of Occurrence
EUS	Epizootic Ulcerative Syndrome
EWR	Environmental Water Requirements
GCBC	Greater Cederberg Biodiversity Corridor
IUCN	International Union for Conservation of Nature
LUMS	Land Use Management System
MAR	Mean Annual Runoff
MU	Management Unit
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
NWRCS	National Water Resource Classification System
OKNR	Oorlogskloof Nature Reserve
PGWC	Provincial Government of the Western Cape
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RSDF	Rural Spatial Development Framework
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute

SRTM	Shuttle Radar Topography Mission
TMF	Table Mountain Fund
WfW	Working for Water
WUA	Water User Associations

1. INTRODUCTION

1.1 The need for a Biodiversity Management Plan for the Clanwilliam sandfish

The freshwater fish fauna of the Olifants-Doring Rivers Basin is remarkable in the Western Cape for its diversity and high levels of endemism. Out of the freshwater fish species that occur here, eight are entirely endemic to the basin itself. All eight are red-listed by the IUCN, including three large cyprinids: the Clanwilliam sandfish (*Labeo seeberi*) (Endangered EN B2abiii,v); Clanwilliam sawfin (*Barbus serra*) (Endangered B2 ab iii,v) and Clanwilliam yellowfish (*Labeobarbus capensis*) (Vulnerable B2 ab iii,v)(IUCN 2010). The scientific and conservation value of these species is inestimable and they form an important component of the freshwater biodiversity of the Cape Floristic Region.

Their threatened conservation status is primarily attributable to the introduction of invasive alien fish species that compete with and predate upon them (Impson et al. 2000, Woodford *et al.* 2005, Paxton et al. 2002). Apart from the upper reaches of the Olifants River gorge, recruitment of young fish in main stem rivers no longer occurs and the fish found in these reaches therefore represent an aging population. Viable recruiting populations of all the endemic fish species therefore only reside in tributary refugia upstream of the upper limit of alien fish invasion. Exacerbating the threats from alien invasive fish species is excessive agricultural and domestic demands on water resources in this arid to semi-arid region and poor farming practices, especially along the riparian belts of rivers. Water resource infrastructure and abstractions have altered natural flow regimes, degraded instream habitats and obstructed migration corridors (Paxton et al. 2002, King et al. 1998).

There are currently conservation initiatives aimed at protecting populations of the two larger cyprinids in the catchment (the Clanwilliam yellowfish and sawfin), but these initiatives will not secure populations of Clanwilliam sandfish, despite the fact that it ranks as one of the most threatened species in the Western Cape and has been identified as a high conservation priority by CapeNature (Impson 2007). Adult populations of this species are restricted to the northern reaches of the Doring River and successfully recruiting populations are known to occur only in confined reaches of the Oorlogskloof-Koebee River system in the Northern and Western Cape (Paxton et al. 2002). Although two invasive fish species, i.e. smallmouth bass (*Micropterus dolomeiu*) and bluegill sunfish (*Lepomis machrochirus*), were known to have penetrated some distance upstream on this river, the upper reaches of this system were initially thought to be free of invasive species. A survey in 2010 by CapeNature and the Northern Cape Department of Environment and Nature Conservation (DENC), however, confirmed that banded tilapia (*Tilapia sparrmanii*) had been introduced into the municipal dam in Nieuwoudtville and have subsequently invaded Clanwilliam sandfish breeding habitat in the Oorlogskloof River. It is beyond question that the introduction of bass or bluegill sunfish from water bodies upstream will render this most crucial reproductive habitat unfit for Clanwilliam sandfish, as well as for the other endemics with which they co-occur in this river, i.e. the Clanwilliam sawfin, Clanwilliam yellowfish, as well a genetically important lineage of chubbyhead barb (*Barbus anoplus*).

A coordinated set of actions is required that targets landowners, governing authorities, including the DWA, Water User Associations (WUAs), organised agriculture and angling bodies to promote sustainable land and water use practices in the catchment and to control the spread of invasive aquatic species.

1.2 Aims and objectives of the BMP-S

The down-listing of the species from its current Endangered status to 'Vulnerable' in terms of the IUCN criteria is considered unrealistic for the Clanwilliam sandfish since; (1) very limited success can be effectively achieved by increasing its geographical range because of the expense and risks associated with clearing river systems of alien fish species, and (2) there is a likelihood that it may need to be assigned a higher threat category (Critically Endangered). The 2009 IUCN Conservation Assessment was undertaken based on the assumption that

there were strong recruiting populations in the Koebee, Gif and Biedouw Rivers. A survey of sandfish populations in 2011 conducted as part of this BMP-S proved this not to be the case and presented evidence to suggest that population numbers have declined by $\geq 80\%$ and that mainstem populations are no longer viable. It is proposed therefore that the Vision and Desired State for the BMP-S for the Clanwilliam sandfish be as follows:

VISION AND DESIRED STATE
<p>To secure the long term survival of the Clanwilliam sandfish in the wild by:</p> <p><i>(vi) elevating its status as an flagship species of the Doring and Oorlogskloof rivers – some of the last major free-flowing rivers in the country;</i></p> <p><i>(vii) consolidate extant populations by reducing the risks of further invasions by alien fish species, especially in the Oorlogskloof-Koebee Management Unit;</i></p> <p><i>(viii) reducing the risks posed by increasing water demand and unsustainable land management practices in all catchments that fall within its distribution range;</i></p> <p><i>(ix) increasing knowledge of its biology and ecology and applying this knowledge to adaptive management strategies.</i></p> <p><i>(x) Identifying priority areas in its original distribution range which can be cleared of alien fishes, allowing for re-introduction of the species.</i></p>

The following five strategic domains were outlined:

(a) Advocacy and Awareness: To elevate the status of the sandfish to the level of an flagship species for the Doring and Oorlogskloof rivers and promote its conservation through posters, presentations, the media and promotional materials; to liaise with relevant government departments, as well as conservation and municipal authorities to ensure that water resource development in the catchment is guided by the principles of ecological sustainability.

(b) Alien Invasive Fish Management: To establish a management plan that will hopefully ensure that no new translocations of invasive alien fish occur, to clear priority existing water bodies of invasive alien fish populations, to reclaim invaded river reaches and to regularly monitor the distribution of alien fishes through the catchment;

(c) Land and Water Resources Management: To ensure that the principles of ecological sustainability are central to land and water use practices in the Doring and Oorlogskloof River catchments. This includes effective, wetland and riparian zone management to ensure that their ability to provide ecosystem services downstream is not impaired.

(d) Research and Monitoring: To ensure that all recommendations with regard to water and land management are data-driven and scientifically defensible – in particular, an understanding of sandfish biology and ecology and of populations responses to water quality and hydrological regimes.

(e) Re-introduction: To establish at least one additional, secured population of sandfish in a tributary of the Olifants or Doring Rivers in a region where they were likely to have originally occurred.

1.3 Benefits of the BMP-S

The necessity of developing a BMP-S for the Clanwilliam sandfish as well as for addressing broader freshwater ecosystem concerns in the catchment was highlighted in the *Wetland Assessment and Catchment Action Plan* developed for the Bokkeveld Plateau (Job and Schumann 2009). In this plan, the importance of good

governance and stakeholder participation for successfully implementing catchment management strategies was emphasised. In addition to providing guidelines for management interventions that will reduce the likelihood of future alien species invasions, the actions proposed in this management plan are intended to dovetail with the aforementioned assessment and plan and further its objectives to the benefit of endemic fish assemblages downstream. The Clanwilliam sandfish is an ideal flagship species for conserving the threatened freshwater ecosystems in the Nieuwoudtville area (e.g. Cape Vernal Springs) and for the Doring River system as whole. The species will therefore serve to focus attention on conserving freshwater ecosystems throughout its distribution range. In addition to the measures proposed to reduce the chances of extinction, this BMP-S has fostered close collaboration between two nature conservation authorities in the Northern and Western Cape, i.e. DENC and CapeNature.

1.4 Anticipated outcomes

The following outcomes are anticipated:

- A greater awareness among landowners within the catchment, local authorities and government bodies with regards to the plight and conservation status of the Clanwilliam sandfish and of the threats it faces – particularly the risks of illegally moving alien fish species. There needs to be a greater commitment to ecologically sustainable land and water use practices.
- An alien fish management plan that will reduce the likelihood of additional fish introductions occurring in rivers or catchments that have Clanwilliam sandfishes, to reclaim priority invaded habitat and to monitor the distribution of alien fish species through the system, especially in areas where sandfish are still common or have been re-introduced.
- A greater awareness among landowners in key catchments, local authorities and government bodies of the importance of implementing sustainable land and water use practices and a stewardship programme that will ensure these are being implemented.
- A more in-depth knowledge of sandfish biology and ecology, in particular how populations respond to environmental variability.

1.5 Conservation status

1.5.1 Conservation Status

The Clanwilliam sandfish *Labeo seeberi* is listed by the IUCN Red Data List and by the South Africa's Threatened or Protected Species Regulations of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)(NEMBA) as Endangered B2ab(iii,v)(IUCN 2010). This recognizes that species facing an extremely high risk of extinction and is therefore subject to the restrictions imposed by national legislation on its removal from the wild, transport, trade and use. In addition to legislation protecting the species itself, Chapter 5 of NEMBA restricts the translocation and spread of the alien invasive fish (e.g. bass, *Micropterus* spp.) and plant species (e.g. mesquite, *Prosopis glandulosa*) that have directly contributed to the species' decline through predation or indirectly through degrading riparian habitats and reducing runoff.

Responsibility for the conservation and management of the sandfish are shared by the conservation authorities in the two provinces – the Western and Northern Cape – in which it occurs, i.e. CapeNature and Northern Cape Department of Environment and Nature Conservation. Responsibility also extends to municipalities, as well as to private landowners that fall both within and outside its distribution range where land-use practices impact on downstream aquatic habitat. Private landowners, through conservancies and stewardship programmes are expected to manage land and water resources in a manner consistent with national environmental legislation and to adhere to the restrictions imposed on the movement and introduction of alien invasive species.

1.6 Legislative context

1.6.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)

Key principles embedded in the NEMA that are considered relevant to this BMP-S include—

- section 2(4)
- (i) *That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;*
 - (ii) *that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied; and*
 - (viii) *that negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.*
 - (n) *Global and international responsibilities relating to the environment must be discharged in the national interest.*
 - (r) *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.*

In terms of Section 2 and to give effect to the above principles, the Minister of Environmental Affairs is required to—

The Minister, and every MEC with the concurrence of the Minister, may identify- individual or generic existing activities which may have a detrimental effect on the environment and in respect of which an application for an environmental authorization must be made to the competent authority” With respect to these activities, Environmental Impact Assessment Regulations, 2010 of the NEMA relate specifically to the construction of facilities or infrastructure for—

- (m) *(m) any purpose in the one in ten year floodline of a river or stream, or within 32 metres from the bank of a river or stream where the flood line is unknown, excluding purposes associated with existing residential use, but including—*
 - (i) *canals;*
 - (ii) *channels;*
 - (iii) *bridges;*
 - (iv) *dams; and*
 - (v) *weirs*
- (n) *the off-stream storage of water, including dams and reservoirs, with a capacity of 50 000 cubic metres or more.*

1.6.2 National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA)

Section 9(1)(a)(i) of the NEMBA requires that the Minister “*may, by notice in the Gazette issue norms and standards for the achievement of any of the objectives of this Act, including for the management and conservation of South Africa's biological diversity and its components*”. These norms and standards are made explicit in the Norms and Standards for Biodiversity Management Plans for Species (Government Gazette No. R. 214 3 March 2009).

Other relevant provision contained in the NEMBA includes section 56 (1) (b) that defines an endangered species as "*being any indigenous species facing a high risk of extinction in the wild in the near future, although they are not a critically endangered species*". Biodiversity Management Plans can be submitted to the Minister for these species.

In terms of restricted activities involving listed species, section 57 (1) states that "*a person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit*" and 57 (2) (a), that the Minister may prohibit carrying out an activity that may "*negatively impact on the survival of a listed threatened or protected species*".

The following provisions in NEMBA relate specifically to restricted activities with respect to alien invasive species and their control. These are, *inter alia*—

- section 65 (1) *A person may not carry out a restricted activity involving a specimen of an alien species without a permit issued in terms of Chapter 7*
- (2) *A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out*
- section 75 (1) *Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs*

1.6.3 Western Cape Nature Conservation Laws Amendment Act, 2000 (Act No. 3 of 2000)

The Western Cape Nature Conservation Laws make special recommendations with regard to clearing alien invasive species in inland waters. The laws state that any fish or aquatic growth found in any inland waters which is injurious to any other fish or aquatic growth or to the water in such inland waters, the Director may—

- section 19(1) (a) *in writing order the owner of such inland waters to take such measures, including measures inconsistent with the provisions of this ordinance, as [he]it may specify in such order, to catch or kill such fish or to destroy such growth, and*
- (b) *if requested thereto by such owner, render such assistance to such owner as the [Director] Board may deem necessary for the purpose of enabling such owner to comply with such order.*
- (2) *If an owner contemplated by subsection (1) refuses or, within a period of twelve months from the date of an order in terms of subsection (1), fails to comply with such order the Director may cause the fish or growth concerned to be caught, killed or destroyed, as the case may be, and recover the costs incurred in that regard from such owner.*

Chapter V, sections 48, (a) and (b), 49 and 50 are also relevant to the pollution of inland waters, the obstruction of fish passage and introduction of fish into inland waters.

1.6.4 Northern Cape Nature Conservation Act, 2009 (Act No. 9 of 2009)

The Northern Cape Nature Conservation Act makes provision for protected fish species. Chapter V, sections 33 and 34 indicate that no person may—

- section 32 (a) *Angle and not immediately release; (b) catch; (c) import; (d) export; (e) transport; (f) keep; (g) possess; (h) breed; or (i) trade in, a specimen of specially protected fish.*

Sections 33 to 39 relate to licensing, permissions, permits, seasons and gear restrictions. Section 41 pertains to the releasing of fish into aquatic systems, indicating that—

- section 41 *No person may, without a permit, place in or in any manner introduce into or cause or allow to be placed or introduced into an aquatic system a live fish or other animal, but the provisions of*

this section do not apply to a live indigenous fish which is replaced into an aquatic system immediately after it has been caught in such a system.

Sections 44 makes special mention of trade in certain species—

section 44 *No person may, without a permit—*

- (a) Sell or buy a fish which is a specially protected animal or the carcass or spawn of such a fish;*
- (b) Sell or buy any live carp, bluegill sunfish, trout, black bass, banded tilapia or any exotic invertebrate freshwater fauna;*
- (c) Sell or buy any fish which has been caught in contravention of this Act or any other law.*

Sections 46 and 47 of Chapter V relate to the obstruction of free pass of fish in aquatic systems and to the pollution of aquatic systems respectively.

1.6.5 Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA)

The CARA aims to conserve natural agricultural resources by maintaining the production potential of land, preventing soil erosion, conserving water sources and combating weeds and invader plants. Specific clauses for instituting control measures include, *inter alia*—

- section 2 *(e) the utilization and protection of vleis, marshes, water sponges, water courses and water sources*
- (f) the regulating of the flow pattern of run-off water*
 - (l) the control of weeds and invader plants*
 - (m) the restoration or reclamation of eroded land or land which is otherwise disturbed or denuded*
 - (n) the protection of water sources against pollution on account of farming practices*

1.6.6 National Water Act, 1998 (Act No. 36 of 1998) (NWA)

The NWA is directed toward the water resource (as opposed to the supply and sanitation of water), i.e. it relates specifically to streams, rivers, dams and groundwater and how these resources are developed and protected. Section 2 states that the purpose of the Act is to *inter alia*, provide for growing demands for water use in ways that account for—

- section 2 *(g) protecting aquatic and associated ecosystems and their biological diversity and*
- (h) reducing and preventing pollution and degradation of water resources*

These responsibilities extend to the owner occupier of the land on which the water resource is located. The NWA defines a set of measures, known as the “*Resource Directed Measures*” as a strategy to ensure the protection of water resources in the country. These measures include a classification system, *Resource Quality Objectives* (RQOs, relating to water quality and quantity) and water ‘reserved’ to meet basic human needs and ecosystem protection – the Ecological Reserve. The latter is defined by the NWA as “*the water required to protect the aquatic ecosystems of the water resource. The Reserve refers to both the quantity and quality of the water in the resource, and will vary depending on the class of the resource.*”

In terms of section 137 (2) of the NWA, Chapter 14, Part 1, the DWA is also required to establish national monitoring systems on water resources in order to collect appropriate data and information necessary to assess, *inter alia*:

- a) *the quantity of water in the various water resources;*
- b) *the quality of water resources;*
- c) *the use of water resources;*
- d) *the rehabilitation of water resources;*
- e) *compliance with resource quality objectives; and*
- f) *the health of aquatic ecosystems*

1.6.7 *Convention on International Trade in Endangered Species (CITES)*

The Clanwilliam sandfish is not traded and CITES is therefore not relevant to this species.

1.7 Institutional and Administrative Context

1.7.1 *Nature Conservation Authorities: Department of Environment and Nature Conservation, Northern Cape (DENC) and CapeNature*

As the provincial department tasked with conserving and managing natural resources in the Northern Cape, and more specifically, with administering the OKNR, DENC was identified as the lead implementing agent in the Northern Cape. CapeNature will lead the implementation of the BMP in the Western Cape. In terms of their constitutional mandate both DENC and CapeNature are guided by section 24 of the Constitution of South Africa which states that—

Everyone has the right

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

A number of the legislative mandates cited above are relevant to DENC's role as lead implementing agent in the Northern Cape and CapeNature in the Western Cape. These include: National Environment Management Act, 2008 (Act No.62 of 2008), Nature and Environmental Ordinance and Regulations (1974), National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) and National Environmental Management Protected Areas Act, 2003 (Act No. 57 of 2003).

1.7.2 *Oorlogskloof Nature Reserve (OKNR)*

The OKNR is located in the Northern Cape section of the Oorlogskloof River – including that section of the river supporting the last known viable population of Clanwilliam sandfish – flows through this reserve. In terms of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003), the OKNR is obligated to manage and preserve the ecological integrity of the ecosystems delimited by its boundaries. In terms of this legislation, the OKNR is required to develop and implement a biodiversity management plan that may include subsidiary plans to ensure the '*protection, conservation and management*' of the protected area (NEMA: Protected Areas Act, 41(1)). Annual performance in implementing the management plan is assessed against a set of indicators outlined in the management plan (43 (1), (2) and (3)). As stated above, the OKNR supports the last remaining viable population of Clanwilliam sandfish. However, due to the longitudinal nature of river systems and the mobility of fish within river corridors, protection of Clanwilliam sandfish populations within this reserve cannot be guaranteed unless upstream impacts beyond the boundaries of the reserve are also addressed – hence the need for a management plan that takes account of these factors as well.

1.7.3 Department of Water Affairs, Olifants-Doorn Catchment Management Agency

Responsibility for the management water resources in the Western and Northern Cape falls within the mandate of the Department of Water Affairs (DWA). Key legislations with which the DWA is required to comply include the National Water Act, 1998 (Act No. 36 of 1998) (NWA) and National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

The DWA has devolved responsibility for water resources management from central government to Catchment Management Agencies (CMAs). The CMA for the Olifants and Doring Rivers (Olifants-Doorn CMA) was established in 2006 although organisational structures are still in the process of being set up. This CMA has jurisdiction over delineated Olifants-Doring Water Management Area No. 17 for which they are required to develop Catchment Management Strategies (CMS). These CMSs, as defined in the DWAs guidelines, are a 'set of medium- to long-term action programmes to support the achievement of sustainability, equity and efficiency through integrated water resource management' (Pollard et al. 2007). Achieving these objectives will require ownership of the strategies contained in the CMS by all stakeholders including, *inter alia* CMAs, Water User Associations (WUAs) (former Irrigation Boards), as well as local government, conservation authorities and landowner stewardship programmes.

An Ecological Water Requirements (EWR) study has been completed for the Olifants and Doring Rivers (Brown and Pemberton 2005) and the Reserve is currently in the implementation phase. Based on the best available knowledge at the time, the EWR study includes provision for the delivery of river flows of the correct magnitude, timing, frequency and duration that will ensure that all phases of the indigenous fishes' life history including migration, spawning and growth can be completed. It is the responsibility of the DWA through CMAs and WUAs to ensure these requirements are met and that additional water resource developments won't further compromise the survival of native fish assemblages.

1.7.4 Hantam Municipality

The Oorlogskloof-Koebee Management Unit falls under the authority of the Hantam Municipality, one of six local municipalities in the Namakwa District of the Northern Cape Province. The Hantam Municipality encompasses a geographical area of roughly 30 000 km² which includes the towns of Brandvlei, Loeriesfontein, Middelpoos and Calvinia with the latter being the largest of these and the administrative centre. As an instrument of local government in the region, it derives its mandate from a number of environmental legislative prescripts mentioned above. Principally, however, the Hantam Municipality is guided by the Municipal Systems Act, 2000 (Act No. 32 of 2000), which requires that the provision of 'basic municipal services' does not endanger human health or safety, or the environment, as well as by the Water Services Act, 1997 (Act No. 108 of 1997) which requires that water of waste water of an acceptable standard be released into the environment. The Hantam Municipality manages the Nieuwoudtville Dam and were responsible for introducing banded tilapia into the dam from where they subsequently escaped into the Oorlogskloof River.

1.8 Municipal and Bioregional Plans and management tools

1.8.1 Hantam Municipality Rural Spatial Development Framework/Land Development Plan

The Rural Spatial Development Framework (RSDF) for the Hantam (Hantam Local Municipality 2010) describes the region as being marked by high levels of unemployment (27%) and having limited investment in mining or other industries. Most of the wealth is therefore generated by commercial farming. In addition to the potential threats addressed at the stakeholder meeting, the following development issues raised by the RSDF are considered pertinent to the integrity of aquatic habitats downstream in the Oorlogskloof and Koebee Rivers:

- limited surface water supply in the region;
- a need for the expansion of services – particularly water and housing;

- the need to contain low density sprawl;
- the expansion of Nieuwoudtville beyond the urban edge;
- sandstone mining and the cultivation of rooibos.

Because of the generally limited scope for mining and industry to support growth in the region, the RSDF places a strong emphasis on conservation and tourism. In addition, it suggests that future growth be channelled away from the smaller nodes such as Nieuwoudtville and Brandvlei and toward Calvinia. In order to contain low-density sprawl, increased densification of dwelling units per hectare is also recommended. To address the water deficit, water conservation and demand strategies, with rain water harvesting and the reuse of waste water are recommended. The development of a Land-Use Management System (LUMS) is suggested to guide land-use change applications and effective land management.

Generally low population densities and growth rates in the region suggest that the pace of change is comparatively slow. This combined with the emphasis of the RSDF on sustainability and conservation suggests that future development scenarios pose little threat to the status quo. However, this does not preclude the necessity for vigilance with regards to wetland and riparian corridor degradation, the subdivision of land, the expansion of agricultural activities, or the proliferation of illegal water abstraction infrastructure. Generally low levels of literacy and conservation awareness impede the uptake of conservation initiatives in this region.

1.8.2 The National Water Resource Classification System (NWRCS) and National Freshwater Ecosystem Priority Areas (NFEPA)

The DWA has adopted Integrated Water Resource Management (IWRM) as a guiding precept. The principles of sustainability, equity and participation are therefore central to their philosophy and practice of water resource governance (Department of Water Affairs and Forestry 2003). The NWA stipulates that a proportion of the volume of water in a river (the *Ecological Reserve*) be set aside to protect and maintain the aquatic ecosystem. Together with water to meet basic human needs, the NWA ensures the Reserve is accorded the highest priority for water allocation and is therefore determined before water-license applications are processed or large-scale water resource developments approved. The National Water Resource Classification System (NWRCS) is used to assign a management class to the resource, together with the level of protection that is associated with that class. In order to determine the quantity and quality of water allocated for the Ecological Reserve, water resources are classified into Recommended Ecological Categories (RECs) (A – natural to F – Critically Modified). These RECs specify objectives (Resource Quality Objectives) that define levels of protection into the future and maintains a desired state of ecosystem health and functioning. The Olifants-Doring WMA is one of the first systems in the country to be classified in this way and the process is nearing completion.

Using systematic conservation planning to provide strategic spatial priorities, the National Freshwater Ecosystem Priority Areas (NFEPA) programme identifies a national network of conservation areas deemed to be essential to support freshwater biodiversity in the country. The NFEPA therefore provides input to both conservation planning and to the NWRCS by identifying those systems that require special protection and higher management classes. Three river systems that fall within sandfish distribution ranges were identified as fish sanctuary areas by NFEPA: the Gif, Oorlogskloof-Koebee and Biedouw Rivers (Nel et al. 2006). The responsibility falls on the DWA, through CMAs and WUAs to ensure that these spatial priority areas are incorporated into planning and decision making and that they are maintained in a Class A or B.

2. CLANWILLIAM SANDFISH – SPECIES BACKGROUND INFORMATION

2.1 Biology and ecology of the Clanwilliam sandfish

2.1.1 Taxonomy

The genus *Labeo* is a large genus of cyprinid (carp-like) fishes that occur throughout Africa, India and South East Asia. They have adapted to a wide variety freshwater environments including both lacustrine and high flow riverine conditions. The *Labeos* are considered monophyletic on the basis of several shared characteristics, notably a vomero-palatine organ (fleshy folds in roof of mouth) and papillose lips (Reid 1982, Reid 1985). *L. seeberi* (Gilchrist and Thompson 1911) is one of only two indigenous Labeine cyprinid species to be found in Western Cape freshwater ecosystems; the other being *L. umbratus* which is found in the Gouritz River system. It has spindle-shaped body, small eyes and scales and is adapted for benthic feeding using its sucker-like mouth to scrape algae, diatoms and particulate organic matter from rock surfaces (Plate 2.1a). Its distinctive mouth leaves characteristic scalloped trails where it has fed (Plate 2.1b).



Plate 2.1 (a) An adult Clanwilliam sandfish from the mainstem of the Doring River near Langvlei and (b) characteristic scalloped trails left on rocks by sandfish feeding in the mainstem of the Doring River at Oudrif.

Individual fish measuring as much as 650 mm and weighing just over two kilograms have been recorded in the mainstem Doring River, but modal lengths of fish in the mainstem are more commonly in the region of 500 mm (Paxton et al. 2002). There is evidence to suggest that individuals in most tributary populations are growth-limited and maximum lengths in these reaches do not exceed ~250 mm (Paxton et al. 2002).

2.1.2 Life history and reproduction

As a consequence of their rarity, conservation status and lack of research on the species, little is known regarding the life history of the Clanwilliam sandfish. Early investigations during the 60s and 70s, together with anecdotal evidence, suggests that sexual maturity is reached at approximately 250 mm with large females weighing about 2 kg and carrying up to 80 000 eggs (Jubb 1967, Gaigher 1973b, Impson 1997). The latter character suggests an altricial, r-selected life history strategy best suited for exploiting unpredictable environmental fluctuations (Impson 1997). Potts et al. (2005) found that *Labeo umbratus*, a closely related species occurring in the Orange-Vaal River system of South Africa, has an r-selected reproductive strategy characterised by high fecundity, short incubation time and early larval development and that females are able

to retain eggs for an extended period over the reproductive season in order to exploit optimal conditions. In other studies, labeos were found to migrate upstream and onto floodplains where the adhesive eggs are scattered on submerged vegetation (Jackson and Coetzee 1982) or gravel beds (Mulder 1973), suggesting that this group of labeos are intermediate phyto-lithophils (Balon 1975, Potts et al. 2005). Spawning is polyandrous with several males pursuing a single female (Reid 1985). There is strong evidence to suggest that spawning is rainfall and flow-linked with poor rainfall years resulting in recruitment failure. In some instances, females may resorb their gonads without spawning if conditions aren't favourable (Gaigher 1984, Tómasson et al. 1984, Potts et al. 2005). While it may be assumed that some of these traits are shared by the Clanwilliam sandfish, the absence of floodplains in the Olifants and Doring Rivers, together with the winter rainfall character of the Western Cape climate regime, suggests that sandfish may differ in some respects from better studied species further to the north. Anecdotal evidence from farmers (Mr. M. Hough, Uitspanskraal Farm, *pers. comm.*) as well as early Cape Piscatorial Society records (Harrison 1977) do however, suggest that Clanwilliam sandfish undertake mass migrations in September and October in order to spawn.

2.1.3 *Habitat requirements*

Clanwilliam sandfish are more than likely rheophilic, requiring fast-flowing waters for spawning and deep pools for feeding, over-wintering and over-summering. Water quality from the tributaries that rise on the eastern flanks of the Cederberg and that flow into the Doring via the Groot, Tra-tra and Biedouw Rivers is influenced by the quartzitic sandstones of the Table Mountain and Witteberg Groups. These tend to be clear, low conductivity waters. During summer, convectional activity over the Karoo occasionally sends pulses of turbid, saline waters that drain the highly erodible shales and mudstones of the Dwyka Formation and Ecca Group into the Doring River. Waters flowing from these formations exhibit elevated levels of nutrients, conductivity and pH. Sandfish tend to be more common in these middle and northern reaches of the Doring River (highest abundances have been recorded from the Bos-Doring River confluence) suggesting that they derive some benefit from the Karoo-fed hydrologic and sediment regimes (Paxton et al. 2002).

2.1.4 *Geographical distribution*

Clanwilliam sandfish are endemic to the mainstem and tributaries of the Olifants and Doring Rivers, Western Cape, South Africa. They were formerly distributed throughout the catchment but now only occur in the middle and northern reaches of the mainstem Doring River and some of its tributaries, notably the Koebee River, called the Oorlogskloof in its upper reaches (Figure 2.1). Historical evidence suggests that their current distribution ranges have shrunk considerably from former ranges. In 1938, Harrison (1963) witnessed large shoals of juvenile sandfish in the upper reaches of the Olifants River near Keerom and in the middle reaches of the Olifants River downstream of the Bulshoek and Clanwilliam Dams in September when 'thousands' of sandfish were seen massed below the dam walls during the annual spring spawning run (Harrison 1977: 123). They were last recorded in these reaches in 1958 (SAIAB database).

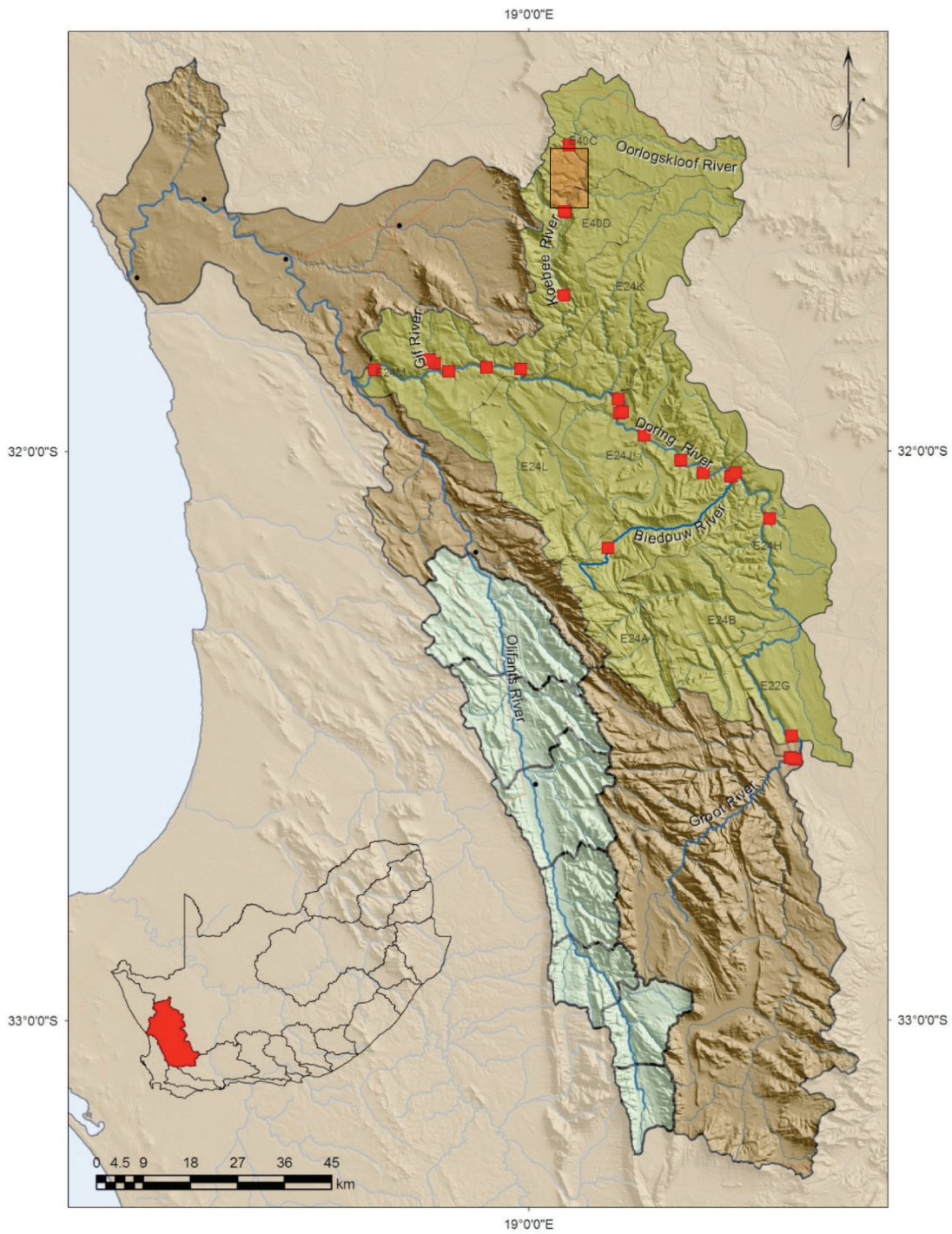


Figure 2.1 Distribution of Clanwilliam sandfish populations in the Olifants and Doring Rivers basin. Red squares indicate sites where sandfish were recorded between 1998 and 2001 in two surveys undertaken by Paxton et al. (2002) and Bills (1999). The location of the only known viable and regularly recruiting population in the Oorlogskloof River is indicated by the red square.

2.1.5 Population status and trends

Clanwilliam sandfish are considered Endangered B2ab(iii,v) and populations declining (Impson and Swartz 2007). Surveys undertaken in 2001 (Paxton et al. 2002) suggested that although adults were present in the

mainstem Doring River and appeared to be reproducing, very few recruits were surviving their first year of life due to alien fish predation (Figure 2.2). The main source of recruits appeared to be non-invaded tributaries, notably the Oorlogskloof-Koebee catchment. Surveys by CapeNature and the Northern Cape Department of Environment and Nature Conservation in 2010 showed that populations of sandfish are successfully recruiting in the Oorlogskloof River above the upstream limit of bass invasion, but that banded tilapia (*Tilapia sparrmanii*) had invaded from the Nieuwoudtville Municipal Dam upstream.

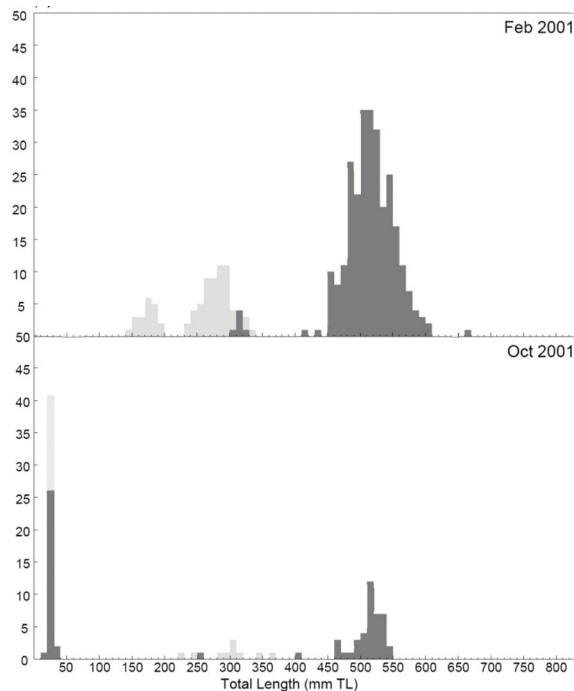


Figure 2.2 Length frequency histograms of Clanwilliam sandfish sampled from the Doring River and its tributaries during February and October 2001 (Paxton et al. 2002). Light grey bars represent fish sampled from tributaries, dark grey bars represent fish sampled from mainstem reaches.

2.2 Threats to Clanwilliam sandfish

Most of the threats to the endemic fish species of the Olifants–Doring River have long been recognised and documented (Impson 1997, Impson et al. 2007, Impson et al. 2000, Nel et al. 2006, Paxton et al. 2002, Gaigher 1973a, Scott 1982, Woodford et al. 2005). Clanwilliam sandfish are threatened by many of the same factors that impact native fish elsewhere in the catchment. This section examines the major threats to Clanwilliam sandfish and provides information for the basis of workshop discussions and exploring management options.

2.2.1 Alien invasive fish species

As with many of the other indigenous fish species in the Doring River, the primary threat to the persistence of the sandfish is predation and competition by alien invasive fish species, notably, smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*) and bluegill sunfish (*Lepomis macrochirus*) which were introduced as sport fish by the then Department of Inland Fisheries during the earlier half of the twentieth century (Harrison 1977, Roth 1952). While the former species present a considerable threat to the endemic species through predation and have completely replaced them where they occur, others such as banded tilapia (*Tilapia sparrmanii*) pose a significant risk through competition and predation upon the young. Undoubtedly, alien invasive fish species introductions present the greatest threat to the Clanwilliam sandfish as in most instances invasions are near impossible or prohibitively expensive to reverse. An additional and much greater

threat is the recent confirmed reports that sharptooth catfish (*Clarias gariepinus*) is present in the system. This species has illegally been introduced to several large river systems throughout the Western Cape and may pose an even greater threat to the indigenous species than bass and bluegill sunfish because of its dispersal ability, predatory habits and large size.

2.2.2 Water quantity

Much of the thinking that has focused attention on the importance of the natural flow regime for river fish populations in South Africa and elsewhere in the world, has been centred around the contribution that river flow makes to fish recruitment (Koehn and Harrington 2006, Humphries et al. 1999, Cambray et al. 1997, King et al. 1998, Poff et al. 1997). Although this process is not well understood in the case of the Clanwilliam sandfish, there is substantive evidence, both anecdotal and from the ecology of closely related species, to support the contention that the species is a synchronous rheophilic spawner requiring optimal flow and temperature conditions for successful reproduction. Natural hydrological variability, together with water regulation and abstraction is therefore likely to play a major role in year-class strength.

Water resources in both the Olifants and Doring Rivers are heavily exploited. This is especially true of the Olifants River where run-of-river abstractions and flow regulation by dams in the Olifants River valley (notably the Clanwilliam Dam and Bulshoek Weir) have had a major effect on the hydrological regime. In recent years the combination of intensive abstraction towards the end of summer compounded by unusually dry winters has reduced the normally perennial main channel of the Olifants River to a series of standing pools. Under these conditions the duration of the no-flow period over the dry season has increased from 5% under natural conditions to 45% presently (Birkhead et al. 2005). These conditions confer an ecological advantage to the invasive fish species which have completely replaced the indigenous fish in these reaches (Paxton et al. 2002).

While agricultural development along the Doring River is not as intensive as it is in the Olifants River, abstraction in the Koue bokkeveld region is believed to be having a significant impact on its MAR (DWA 2005). In addition, a number of large-scale dam options on the Doring River have been proposed (Aspoort, Melkbosrug and Melkboom) to meet the demand for increased agriculture in the region (DWA 2005, PGWC 2007). It is considered highly probable that further water resources development on the Doring River will negatively impact on Clanwilliam sandfish populations persisting in the mainstem. In addition to major water resource developments and utilisation, localised impacts are evident from farming activities (livestock and agricultural return flows) and invasion of riparian zones by mesquite which alters riparian habitats and reduces run off. Reduced water quality due to livestock grazing—particularly goats in the Biedouw Valley area—within the riparian zone may contribute to mortality of mainstem populations over the summer when fish are concentrated in isolated pools.

2.2.3 Water quality

As explained in Section 2.1.3, the quality of the water in the Doring River and its tributaries has a distinctly dual nature: water flowing off the Table Mountain and Witteberg Groups are typically clear and oligotrophic, whereas the waters that drain shales and mudstones of the Dwyka Formation and Ecca Group into the Doring River have higher concentrations of suspended solids and total dissolved salts. As a consequence, salinity levels in the Doring River are unusually high for what is considered a largely unimpacted system (PGWC 2001). The absence of heavy industry in the Olifants and Doring Rivers catchment and the predominantly rural-agricultural nature of the economy in the region means that water quality in both systems is relatively unimpacted. However, salinity levels in the Olifants River downstream of Vredendal are too high for irrigation as a consequence of agricultural return flows (PGWC 2007). There is little or no water quality data available for the tributaries of rivers where significant populations of sandfish occur, and the impact of localised eutrophication on the mainstem of the Doring River is also not clear (Section 2.2.4).

2.2.4 Physical habitat degradation

Erosion of river banks and siltation by bulldozing and modifying riparian corridors for agricultural purposes have been reported as impacting indigenous fish habitat in the Olifants River as early as the 1960s when Harrison (1963: 28) noted that between Citrusdal and Clanwilliam, the 'rocky defiles' and 'large pools' used by Clanwilliam yellowfish for spawning – and that had previously been rich in indigenous fish species – had become blanketed by white sand (Harrison: comments in Jubb (1961)). In 2005, the Olifants-Doring Rivers Ecological Water Requirements study identified bulldozing the river channel, cultivation on alluvial floodplains and encroachment by alien riparian vegetation species as continuing to compromise the geomorphological integrity of the riparian corridor on the Olifants River (Brown et al. 2007).

Although opportunities for cultivation along the banks of the Doring River are limited by the nature of the topography; localised impacts are apparent at Uitspankraal and Elandsvlei where overgrazing, trampling and eutrophication by livestock are sufficient to warrant concern. On the Bokkeveld plateau in the vicinity of Nieuwoudtville, invasion by mesquite, together with clearing, ploughing, overgrazing and trampling are causing wetland degradation and loss (Job and Schumann 2009). These impacts are compromising the natural ability of the wetlands to attenuate floods and store water and sediment, resulting in more flash flooding, higher silt loads and turbidity in critical sandfish habitats downstream. Similar impacts are apparent further to the south on the Koue bokveld plateau that forms the upstream catchment of the Groot River.

2.2.5 Instream barriers

The free movement of fish in a river system is important for the dispersal of young and moving to and from feeding, breeding and overwintering areas. Harrison's (1977) reporting of large aggregations of indigenous fish downstream of the Bulshoek Weir early in the twentieth century provides evidence that annual spawning migrations were being thwarted by the barrage. The endemic species have all but disappeared from the middle and lower reaches of the Olifants River where large scale water resource infrastructure and water abstraction has interrupted spawning migrations and degraded aquatic habitat. In contrast, for the most part, the Doring River is still free-flowing. However, a large privately-owned dam on the mainstem at Brakfontein and DWA gauging weir at Aspoort are considered to be substantial obstacles to fish movement during critical times of the year. It should be noted, however, that in some instances artificial instream barriers can be used as a management tool to reduce the risks of fish invasion from downstream reaches. Careful consideration should therefore be given to the removal of barriers in instances where it may promote invasion. This is particularly noteworthy in the light of potential invasions by sharptooth catfish.

2.3 Socio-economic issues

History of utilisation: The extent to which the indigenous fish were harvested for consumption by people living in the Olifants and Doring Rivers basin in the past is not clear. Parkington (1977) suggested that early hunter-gatherers migrated from the coast and harvested them over the spawning season. Reports from farmers in the catchment suggest that in the earlier half of the 20th century, when fish were more abundant, both farmers and farm labourers would club fish in the shallows when they spawned (Kobus Hough, Elandsvlei, *pers. comm.*). In some instances, deep pools where fish were known to congregate were dynamited, the fish loaded onto ox wagons and taken to the Klawer market to be sold (Koos Greef, Melkboom, *pers. comm.*). Numbers are too low to harvest now and since there is very little chance of recovery of mainstem populations, it is unlikely that they will be harvested in the future. Although the Clanwilliam yellowfish is highly priced as an angling species, the Clanwilliam sandfish is difficult to catch on either bait or a fly and has therefore never been a targeted angling species.

2.4 Past conservation measures

No conservation measures have been directed specifically towards conserving the Clanwilliam sandfish in the past. However, the only known viable breeding population occurs in the Oorlogskloof Nature Reserve where surveys have been conducted by the reserve staff since 2000.

3. CONSERVATION PLANNING METHODOLOGY FOR THE BMP-S

3.1 Background to the Clanwilliam sandfish BMP-S development

The need for a BMP-S for the Clanwilliam sandfish was identified by DENC and CapeNature following the 2010 survey of the Oorlogskloof River when it was discovered that banded tilapia had invaded the Oorlogskloof River. The high conservation priority of the sandfish and the threat posed by further possible invasions (e.g. carp, sharptooth catfish) and habitat degradation alerted these two organisations to the importance of urgently addressing the conservation and management issues related to its survival. With support from the Table Mountain Fund, this BMP-S was developed as a collaborative project between an external service-provider (the Freshwater Consulting Group) and two provincial conservation organisations: CapeNature (Western Cape) and DENC (Northern Cape). Prior to the identification of stakeholders, an inception meeting was held at the SANBI on the 25th March 2011, Kirstenbosch, Golden Mole Room. At this meeting it was agreed that CapeNature and DENC would collaborate as joint lead implementing agencies. A rough outline of the BMP-S process and a timeline was agreed to at this meeting.

3.2 Spatial context and identification of Management Units

At the inception meeting it was decided to divide the Extent of Occurrence (EOO)¹ of the Clanwilliam sandfish into three Management Units (MUs): 1) the Lower-Middle Doring River; 2) the Oorlogskloof-Koebee and 3) the Biedouw Valley (Figure 3.1). These MUs provided the spatial context for management actions, with specific challenges being associated with each unit. In particular, the Lower-Middle Doring River MU challenges require large-scale water resource management interventions. Although adult sandfish occur in this MU, population abundances are very low and subject to recruitment failure due to the high numbers of alien fish species. The success of recruitment in this MU depends on the availability of the appropriate water quality and quantity delivered at the right time of the year.

The Oorlogskloof-Koebee MU is perhaps the highest priority unit, since this is where the last known viable populations of sandfish occur. Management issues in this unit relates specifically to avoiding intentional or unintentional introductions of ALIEN fish species in the upper catchment, especially in farm dams (Nieuwoudtville area) and encouraging sustainable land and water use practices in this region.

A risk assessment of water bodies that could potentially supply alien fish species into the Oorlogskloof-Koebee MU was undertaken. A hydrological drainage network for the Olifants-Doring Basin was created using SRTM 90 m²Digital Elevation Models (USGS Shuttle Radar Topography Mission, 3 Arc Second, SRTM 3) in the ESRI © ArcMapTM 9.3 software package. Sub-quaternary catchment boundaries were delineated as the source area upstream of selected pour points, i.e. the lowest point in the basin of interest, or the junction between two rivers for the Gif, Koebee/Oorlogskloof and Biedouw Rivers (Figure 3.2). The presence of artificial water bodies (farm dams) within each of these three catchments were identified using 1: 50 000 base maps, satellite imagery. This assessment was followed up by surveys of the selected dams and landowner interviews.

The Biedouw River is one of the few places where larval and early-juveniles sandfish have been found to occur other than in the Oorlogskloof River. This river is therefore still believed to be used by mainstem sandfish populations for breeding under favourable hydrological conditions.

¹The minimum convex polygon encompassing all known normal occurrences of the species

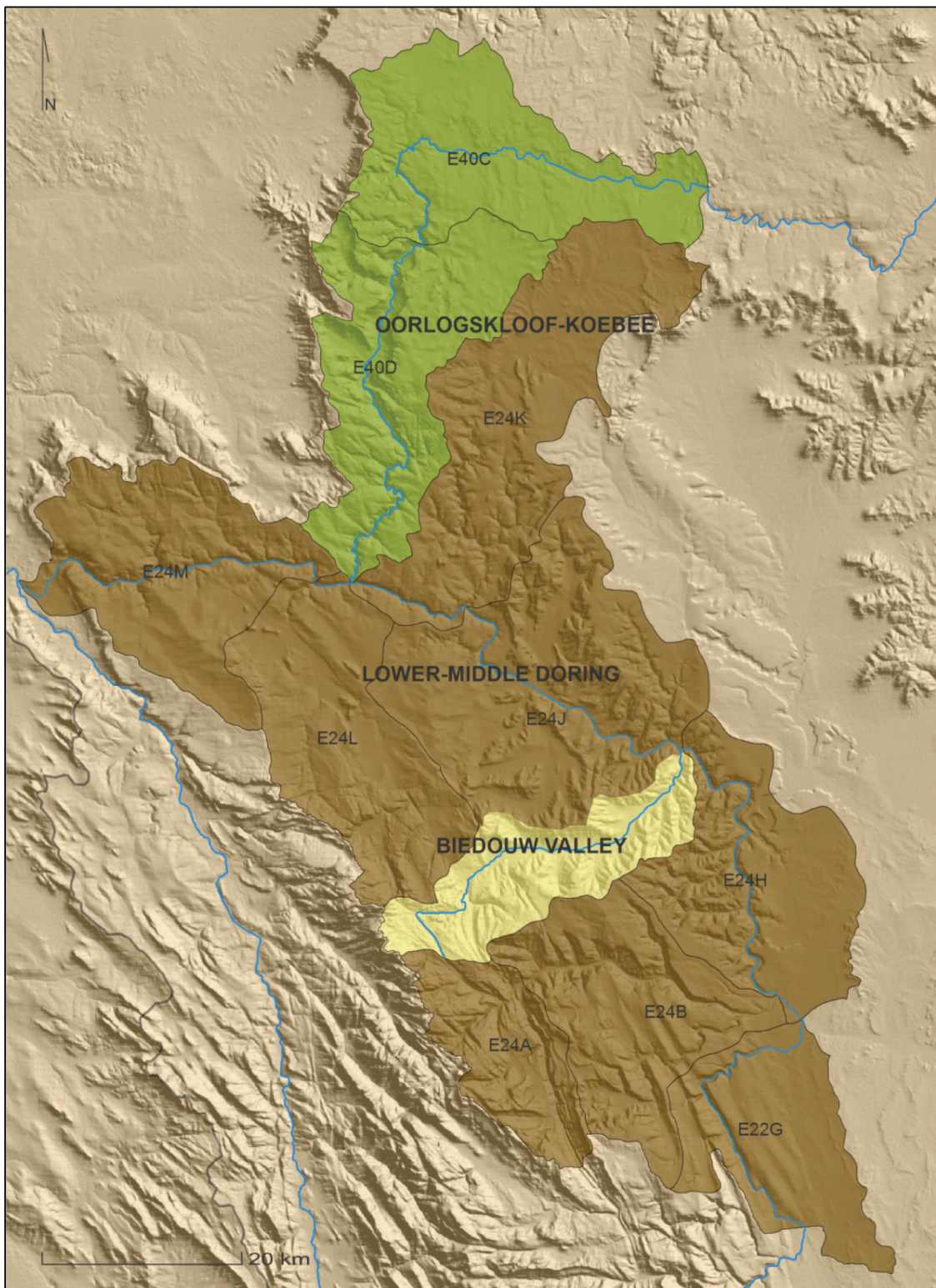


Figure 3.1 Management units encompassing the EOO of the Clanwilliam sandfish: the Lower-Middle Doring MU, the Oorlogskloof-Koebee MU and the Biedouw MU.

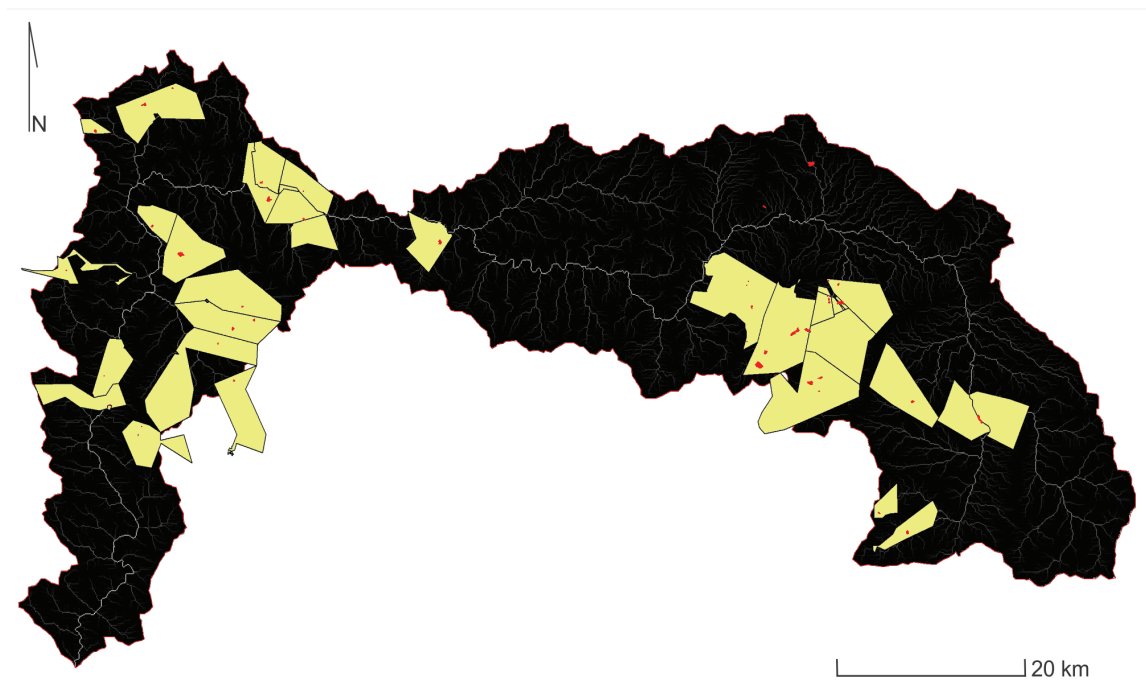


Figure 3.2 Invasion risk assessment of the Koebee-Oorlogskloof Rivers catchment showing the location of water bodies that may support alien fish species (red polygons).

The remoteness of the Biedouw Valley together with staff and capacity issues of the two conservation organisations limit realistic management interventions here, but awareness and monitoring of sandfish breeding in this unit is considered important and feasible.

3.3 Identification of stakeholders

Stakeholders were identified on account of (a) the stakeholder group to which they belong and (b) their interests and mission. All organisations or individuals in any way involved in managing land or water resources that directly impact on Clanwilliam sandfish habitats were considered eligible for participation. The following stakeholder groups were identified: conservation, government, landowners, anglers and the interested public (teachers, student's etc.). A stakeholder list was compiled using distribution lists from DENC and CapeNature (Appendix A). During the development of the BMP-S, partnerships were established with the Department of Water Affairs, the Olifants-Doring CMA, the Hantam Municipality, NGOs and conservancies including Indigo Development and Change and the Rietvlei Trust. SAIAB provided technical support

3.4 Stakeholder participation process

Once the stakeholder groups and individuals had been identified, an invitation to participate in the development to the BMP-S was sent out (Appendix B). This invitation included a brief outline of the background, context and aims of the BMP-S and was translated into English and Afrikaans. Since conservation and management threats and actions differed with respect to each MU, it was decided that a separate stakeholder meeting would be held for each MU. The venue and dates for each of the stakeholder meetings were as follows:

- (1) **Lower-Middle Doring River MU:** 16 Sep 2011, DWA Head Office Bellville, Western Cape, Sigma Building Conference Room
- (2) **Oorlogskloof-Koebee MU:** 26 Aug 2011, Indigo Development and Change Offices, 1 NeethlingStr, Nieuwoudtville

(3) **Biedouw Valley MU**: these actions were addressed by stakeholders at the Lower-Middle Doring MU meeting.

Once dates and times of the meetings had been agreed on, invitations were sent out via email and key participants were contacted telephonically. Landowners that did not have email were also contacted telephonically. A Species Background document was prepared and sent out to all stakeholders. This document contained information on the purpose of the BMP, the current status of the Clanwilliam sandfish and principle threats. The background document was also presented in hardcopy form at the meetings.

An example of the agenda for the Nieuwoudtville meeting is shown in Appendix C. At each meeting the following procedure was followed. The meetings commenced with a background and introduction to the species and an explanation of the BMP-S process. Following this, major threats were identified, grouped and prioritised by the participants. A vision statement and intended outcomes were work-shopped and a list of management actions decided upon.

Following each meeting, the project team met to evaluate the outcomes of the meeting and streamline the management actions. When deciding on management actions, consideration had to be given to the staffing, financial and capacity constraints among the lead and implementing agencies. The BMP-S presented in this document therefore represents the aspirations and deliberations of participants at the workshops and evaluation by the project team following consultations with the relevant implementing agents.

4. CLANWILLIAM SANDFISH BMP-S ACTION PLAN

4.1 Oorlogskloof-Koebee Management Unit (Northern Cape)

4.1.1 Identification, description, prioritisation and grouping of threats

The following section lists and describes the threats that were identified at a workshop held in Nieuwoudtville on 26 August 2011. They appear here in the order they were considered a priority. Note that consideration of these threats was restricted to the Oorlogskloof-Koebee Management Unit. There was a marked absence of landowner participation in the development of this BMP-S. This was attributed to the distance many had to travel to get to the meetings and the fact that where properties adjoin the Oorlogskloof River gorge and sandfish habitat, the river is not accessible. Consequently there are low levels of awareness around aquatic conservation issues in the catchment.

i. Threat 1: Alien Invasive fish species

The intentional or unintentional introduction of alien fish species is considered to be the single greatest threat to the continued survival of Clanwilliam sandfish populations in the Oorlogskloof River. Species that are highest risk include: largemouth and smallmouth bass and bluegill sunfish. Sharptooth catfish are considered to be a potential high-risk future threat. The following categories of threats are identified:

- (i) *Invasion from upstream water bodies*—The intentional introduction of bass and bluegill sunfish for fishing purposes into water bodies on the Koue bokkeveld escarpment that could feed these species into the Oorlogskloof River is considered the highest potential threat – as was demonstrated by the introduction of banded tilapia into the Oorlogskloof River from the Nieuwoudtville Municipal Dam after the 2007 floods. There are several farm dams adjacent the rim of the Oorlogskloof gorge that currently have mirror carp (*Cyprinus carpio* var. *specularis*). However, these water bodies feeding into the Oorlogskloof River have a number of steepdrop-offs that may cause mortality to adults and propagules before they reached the Oorlogskloof River. However, the potential for invasion from these water bodies is considered serious enough to warrant the eradication of carp.
- (ii) *Invasion from downstream water bodies*—A large instream natural barrier at the downstream end of the Oorlogskloof Nature Reserve has thus far prevented invasions from the Koebee River. However, sharptooth catfish have a higher invasion potential due to their swimming abilities and if these are already present the lower Olifants River as some reports suggest, then some artificial reinforcement of the barrier may be considered necessary.

ii. Threat 2: Increasing water demand and climate change

Increasing water demand with the concomitant effects of climate change is considered to be the second highest threat to Clanwilliam sandfish populations in the Oorlogskloof River. Currently, Nieuwoudtville draws its domestic water from five boreholes to the west of the town whereas Calvinia draws its water from the Karee Dam which is supplemented by borehole water when the dam is dry. There is therefore limited utilisation of surface water resources for domestic use. However, water for agricultural purposes in the region is obtained from surface water which is stored in farm dams. Attenuated flows in the Oorlogskloof River may curtail recruitment if insufficient water was available to trigger spawning and/or incubate eggs. Deteriorating water quality conditions in pools with little or no freshwater input over the dry season may also result in declining juvenile and adult health and condition, reduced fecundity and, in extreme cases, mortality. The following threats were considered at the Nieuwoudtville stakeholder workshop with regards to surface water resources:

- (i) *Human population growth*—It was a perception among the participants that population growth and the subdivision of land in the Oorlogskloof catchment is likely to increase the demand for water in the future.
- (ii) *Ecological Reserve compliance*—The Reserve for the Olifants and Doring Rivers has been signed-off by the Department of Water Affairs (DWA) and a Desktop Reserve Determination has been conducted for the Oorlogskloof and Koebee Rivers. However, the absence of gauging facilities on these rivers means that degrees of compliance with the Reserve cannot be assessed.
- (iii) *Climate change*—It was considered likely that water availability would be reduced in future by changing temperature and rainfall patterns brought on by climate change. Reduced runoff from the catchment as a result of increasing water demand together with climate change would increase the duration and severity of the dry season. Climate change may also increase the frequency and severity of floods that would increase the risk of introductions of fish from upstream.

iii. *Threat 3: Deteriorating water quality in the Oorlogskloof River*

Concern was expressed at the Nieuwoudtville stakeholder workshop that the Nieuwoudtville sewage works contributed nutrient enrichment to receiving water bodies, notably the Groen River. However, an absence of monitoring and associated data meant that the severity of the threat could not be ascertained.

iv. *Threat 4: Alien Invasive Plants*

Poplars (*Populus* sp.), mesquite (*Prosopis glandulosa*), black wattle (*Acacia mearnsii*), Port Jackson willow (*Acacia saligna*), blue gum (*Eucalyptus* spp.) and oleander (*Nerium oleander*) are all considered a threat to Clanwilliam sandfish populations in the Oorlogskloof River, as well as to water flow from the wetlands of the Bokkeveld Plateau. Impacts of alien plant invasions on fish populations related mainly to a reduced water table, damage to the riparian zone as they replace indigenous vegetation and the implications this has for runoff in the Oorlogskloof River. Invasion of the river channel in the Oorlogskloof River by oleander would, with attenuated flows, lead to degradation and terrestrialisation of aquatic habitats, particularly spawning riffles. The difficulty of clearing alien invasive vegetation is compounded by the inaccessibility of the terrain and the fact that Working for Water (WfW) does not have teams capable of camping overnight in the Northern Cape. WfW prioritisation of areas targeted for clearing was done in the absence of data on critical freshwater systems and the Oorlogskloof and Koebee Rivers weren't therefore included in their five year plan. It is suggested that WfW needs to have a contingency plan for instances where priority areas were overlooked.

v. *Threat 5: Lack of environmental awareness*

The general lack of environmental awareness among landowners and local communities in the region – particularly with regard to freshwater related issues – is considered a significant problem. Fish aren't considered a food source, they aren't seen as a source of income and most landowners are located away from major water courses. The poor attendance of the meeting by landowners and members of the local communities reinforced this perception. However, a concern was raised at the Nieuwoudtville stakeholder workshop that increased awareness may be counterproductive to conservation efforts since people may want to catch the fish and translocate them to dams and aquariums.

vi. *Threat 6: Unsustainable land-use patterns*

Loss of wetlands and river corridors on the Bokkeveld plateau is regarded as a threat to Clanwilliam sandfish populations. Job and Schumann (2009) list the following land-use patterns which are believed to be compromising wetland integrity and functioning on the Bokkeveld plateau: absence of buffers, ploughing and cultivating wetlands and riparian zones, overgrazing and trampling and sand mining of sandy valley bottom wetlands. This latter issue isn't currently being monitored and therefore needs attention.

These practices impact on the delivery of water downstream and increase sediment supply in the catchment which degrades aquatic habitats. The ability of wetlands to attenuate floods is compromised and their ability to store water and release it over the dry season is reduced. This is particularly important on the Bokkeveld plateau where water would otherwise flow rapidly over exposed sandstone.

vii. Threat 7: Lack of governance and lack of capacity and resources in conservation and environmental departments

Lack of governance in the catchment means that sustainable land and water resource management practices are not clearly understood or endorsed. Conservation and environmental departments lack the capacity and resources to follow up on these issues. This has contributed to a lack of extension and awareness amongst landowners. DENC has one aquatic scientist based in Kimberley for the whole province. Lack of capacity and vigilance is one of the primary reasons banded tilapia were introduced into the Nieuwoudtville Municipal Dam.

- (i) *Water or land management forums*—there are no forums to discuss water and land management issues (e.g. Water User Associations or Conservancies) and little contact with regional DWA staff which reflects a lack of capacity.
- (ii) *Illegal water abstraction and impoundments*—illegal water abstraction, the construction of farm dams and the raising of existing farm dam walls to increase storage capacity were on-going issues and enforcement (related to lack of capacity and governance) is problematic.

viii. Threat 8: Lack of biological information and monitoring

Lack of biological information on the Clanwilliam sandfish and monitoring of extant populations hinders the ability to develop effective conservation and management interventions. In particular, more detailed information on the responses of sandfish populations to environmental change – water quality, river discharge and temperature – are needed to predict responses to water abstraction and future climate change.

ix. Threat 9: Epizootic Ulcerative Syndrome (EUS)

Epizootic Ulcerative Syndrome (EUS) has been recognized worldwide as a major threat to brackish and freshwater fish populations, causing large fish kills even in relatively pristine systems. The most likely agent of EUS is considered to be a fungus, *Aphanomyces invaderis*, which causes liquefactive necrosis of muscle tissue in infected fishes. EUS has recently been reported in the Western Cape in the Palmiet and Eerste River catchments. Infection in the Oorlogskloof River may severely compromise the viability of sandfish populations and may provide the banded tilapia with a competitive advantage since this species is considered less susceptible to infection. It should be noted that the control of the disease in natural waters is not possible, but vigilance with regard to its outbreak in the Oorlogskloof River should be maintained through periodic monitoring. The disease is commonly introduced through infected fish – hence the need for greater awareness amongst landowners and aquaculture organisations. While infection is not caused by poor water quality, this may increase the vulnerability of fishes to infection (Threat 3).

4.2 Oorlogskloof-Koebee Management Unit Actions

4.2.1 Threat 1: Alien Invasive fish species

ACTION 1(a)	Memoranda of Agreement (MOA) to be signed by Hantam Local Municipality and selected landowners
Agencies:	<i>Lead agency:</i> DENC: Aquatic Scientist, OKNR manager <i>Implementing agency:</i> EWT, DENC, OKNR manager and staff
Objective:	To reduce the probability of the intentional or unintentional introduction of high risk invasive alien fish species into the catchment of the Oorlogskloof River upstream of the OKNR, i.e. bass (<i>Micropterus dolomieu</i> , <i>M. salmoides</i> , <i>M. punctulatus</i>), bluegill sunfish (<i>Lepomis macrochirus</i>), banded tilapia (<i>Tilapia sparrmanii</i>) and sharptooth catfish (<i>Clarias gariepinus</i>)
Description:	(i) Draw up a Memoranda of Agreement (MOA) requesting that no alien invasive fish species be introduced into municipal or farm dams; (ii) Request signatures from selected landowners together with the Hantam Local Municipality;
Resources:	MOAs to be drafted and agreed by BMP-S Project Team, EWT, CapeNature and DENC. Coordination and distribution of MOAs by DENC and the OKNR staff.
Timeframe:	Initiation: July 2014 Duration: 3months Completion: December 2014
Indicators:	Key landowners and municipality in possession of signed copies of the MOA.
Monitoring:	DENC to maintain a database of landowners with dams considered to be high risk and follow up with them that they are complying with the terms of the MOA.

ACTION 1(b)	Interpretive signage at the Nieuwoudtville Municipal Dam, Papkuilsfontein farm and OKNR (Brakwater and at the entrance to the reserve)
Agencies:	<i>Lead agency:</i> DENC: Aquatic Scientist, OKNR manager <i>Implementing agency:</i> DENC, EWT, OKNR manager and staff
Objective:	To increase awareness among the local community around the ecological risks of introducing alien invasive fish species into water bodies on the Bokkeveld plateau.
Description:	(i) Design and manufacture outdoor interpretive signage highlighting the uniqueness of the Oorlogskloof River fish fauna, its conservation importance and risks posed by unsustainable land-use practices and biological invasions; (ii) Install signs at Nieuwoudtville Municipal Dam, Papkuilsfontein farm and OKNR (Brakwater and at the entrance to the reserve).
Resources:	Interpretive text, maps, drawings, signage, labour.
Timeframe:	Initiation: July 2014 Duration: 3 months Completion: December 2014

ACTION 1(b)	Interpretive signage at the Nieuwoudtville Municipal Dam, Papkuilsfontein farm and OKNR (Brakwater and at the entrance to the reserve)
Indicators:	Interpretive signage at the Nieuwoudtville Dam, increased awareness among the local community on indigenous fish conservation issues.
Monitoring:	Monitor signage for vandalism and/or wear and tear.

ACTION 1(c)	Eliminate populations of banded tilapia (<i>Tilapia sparrmanii</i>) from the Nieuwoudtville Municipal Dam
Agencies:	<i>Lead agency:</i> DENC: OKNR <i>Implementing agency:</i> DENC, OKNR manager and reserve staff, Hantam Local Municipality
Objective:	To eliminate the threat of repeated introductions of banded tilapia into the Oorlogskloof River from the Nieuwoudtville Municipal Dam using seine nets and electrofishing
Description:	(i) DENC to request that the Hantam Local Municipality inform them when they intend to drain the dam for maintenance; (ii) Use this opportunity to clear the dam of banded tilapia using a combination of seine nets (>30 m), hand nets and electrofishing; (iii) Pending the outcome of current trials using rotenone to clear water bodies of alien fish species, to investigate its feasibility for clearing the municipal dam and Groen River using this method.
Resources:	DENC Aquatic scientist, OKNR manager and staff, seine nets, electroshocker
Timeframe:	<i>Initiation:</i> N/A <i>Duration:</i> 1 week <i>Completion:</i> N/A
Indicators:	Elimination of banded tilapia from the Nieuwoudtville Municipal Dam
Monitoring:	Annual monitoring of the Nieuwoudtville Municipal Dam by OKNR to check for the presence of introduced fish.

ACTION 1(d)	Eliminate populations of mirror carp (<i>Cyprinus carpio var. specularis</i>) from the Kranskloof and Driefontein Dams
Agencies:	<i>Lead agency:</i> DENC <i>Implementing agency:</i> OKNR manager and staff, EWT, landowner Kranskloof farm and landowner Driefontein farm
Objective:	Eliminate the threat of the Kranskloof and Driefontein Dams as a potential source of new invasions into the Oorlogskloof River by mirror carp
Description:	Using a combination of seine nets (>30 m) and rotenone, eliminate populations of mirror carp from the Kranskloof and Driefontein Dams. Note: the operation will need

ACTION 1(d)	Eliminate populations of mirror carp (<i>Cyprinus carpio</i> var. <i>specularis</i>) from the Kranskloof and Driefontein Dams
	to be conducted when dam levels are low enough to facilitate the task of clearing. Landowner to report to DENC when conditions are suitable.
Resources:	DENC, OKNR staff, EWT, seine nets, electroshocker
Timeframe:	Initiation: N/A Duration: 1 week Completion: N/A
Indicators:	Elimination of mirror carp from the Kranskloof and Driefontein Dams
Monitoring:	Annual monitoring of the Kranskloof and Driefontein dams by OKNR staff to monitor presence and abundance of IA fish populations

4.2.2 Threat 2: Increasing water demand and climate change

ACTION 2(a)	Source funding to install a stage logger and gauging plate on the Oorlogskloof River
Agencies:	<i>Lead agency:</i> CapeNature, DENC OKNR staff <i>Implementing agency:</i> DENC, EWT
Objective:	Jointly source funding for installation of a stage logger and gauging plate on the Oorlogskloof River.
Description:	Install gauging station on the Oorlogskloof or Koebee Rivers to monitor discharge and temperature continuously. This data will be used to assess compliance with the Ecological Reserve as well as provide input to an understanding of the response of sandfish populations to environmental variability (Section 4.2.8, Action 8 (a)). OKNR staff to download the data on a quarterly basis.
Resources:	DENC personnel, stage logger, stilling well, gauge plate, rating
Timeframe:	Initiation: March 2014 Duration: 1 month Completion: Apr 2014
Indicators:	Daily flow records for the Oorlogskloof River
Monitoring:	Annual review of flow records to assess compliance with Ecological Reserve

4.2.3 Threat 3: Deteriorating water quality in the Oorlogskloof River

ACTION 3(a)	Water quality monitoring in the Groen and Oorlogskloof Rivers
Agencies:	<i>Lead agency:</i> DWA, OKNR staff <i>Implementing agency:</i> DWA, EWT, OKNR staff
Objective:	Implement a water quality monitoring in the Groen and Oorlogskloof Rivers to ensure compliance with water quality standards and monitor the potential impacts to sandfish populations.
Description:	Monitor the quality of the water in the Groen River as it leaves Nieuwoudtville and the Oorlogskloof River where it enters the OKNR (bridge on the Suid Bokkeveld Road) as

ACTION 3(a)	Water quality monitoring in the Groen and Oorlogskloof Rivers
	well as at Brakwater especially with regards to nutrient enrichment (N and P). OKNR staff to collect water quality samples and submit to DWA for analysis
Resources:	DENC, OKNR staff, conductivity, turbidity and pH meters, budget for water quality samples (nitrates, phosphates, <i>E. coli</i>).
Timeframe:	Initiation: March 2014 Duration: Quarterly Completion: ongoing
Indicators:	Quarterly records of water quality from the Oorlogskloof and Groen Rivers
Monitoring:	Annual assessment of quarterly water quality records by OKNR staff and DWA staff to assess trends. Copy of reports to be sent to Department of Agriculture, Forestry and Fisheries

4.2.4 Threat 4: Alien Invasive Plants

ACTION 4(a)	Clear AIP from the Oorlogskloof River and Bokkeveld Plateau wetlands
Agencies:	<i>Lead agency:</i> WfW <i>Implementing agency:</i> WfW, DENC, OKNR
Objective:	Clear AIP from the Oorlogskloof River notably: poplars (<i>Populus sp.</i>), mesquite (<i>Prosopis glandulosa</i>), black wattle (<i>Acacia mearnsii</i>), Port Jackson willow (<i>Acacia saligna</i>), blue gum (<i>Eucalyptus spp.</i>) and oleander (<i>Nerium oleander</i>).
Description:	Motivate for a small mobile Working for Water (WfW) team to clear alien vegetation from the Oorlogskloof River and Bokkeveld Plateau wetlands in conjunction with OKNR staff. DENC and OKNR personnel to develop proposals to submit to WfW
Resources:	WfW clearing team, DENC, OKNR staff
Timeframe:	Initiation: Feb 2015 Duration: 4 weeks Completion: Mar 2016
Indicators:	Reduced invasion of the riparian corridor of the Oorlogskloof River and Bokkeveld Plateau wetlands.
Monitoring:	Annual monitoring and follow up operations by WfW

4.2.5 Threat 5: Lack of environmental awareness

ACTION 5(a)	Engage actively in outreach and advocacy
Agencies:	<i>Lead agency:</i> DENC <i>Implementing agency:</i> DENC, OKNR manager, EWT
Objective:	Raise awareness in the local community regarding the conservation importance of the Clanwilliam sandfish and its habitat in the Oorlogskloof River. Reduce the risk of new invasions by invasive alien fish species.

ACTION 5(a)	Engage actively in outreach and advocacy
Description:	(i) Maintain contact with Farmer Associations, schools and interest groups. Distribute promotional materials (t-shirts, brochures etc.); (ii) Articles submitted to local newspapers and newsletters and via websites
Resources:	DENC, OKNR staff, EWT, brochures, t-shirts (produced as part of the BMP-S project)
Timeframe:	Initiation: Feb 2014 Duration: ongoing Completion: N/A
Indicators:	Increased awareness among the local community on sandfish conservation issues.
Monitoring:	Assessment of outreach and advocacy activities at the end of the outreach period

4.2.6 Threat 6: Unsustainable land-use patterns

ACTION 6(a)	Sustainable land-use practices encouraged through stewardship programmes
Agencies:	<i>Lead agency:</i> Department of Agriculture <i>Implementing agency:</i> Department of Agriculture
Objective:	Encourage sustainable land-use practices, prevent loss of additional wetlands and riparian corridors and rehabilitate degraded corridors.
Description:	Set up stewardship programmes with local landowners
Resources:	DENC personnel, Agricultural extension staff, documentation detailing best practices with regards to sustainable land-use practices (e.g. Job and Schumann 2009) and product certification required by the market which include biodiversity friendly production techniques.
Timeframe:	Initiation: Feb 2014 Duration: ongoing Completion: N/A
Indicators:	No new loss of wetlands and riparian corridors, rehabilitation of degraded wetlands and riparian corridors
Monitoring:	Annual monitoring of land-use practices, especially along riparian belt

4.2.7 Threat 7: Lack of governance and lack of capacity and resources in conservation and environmental departments

ACTION 7(a)	Conservation authorities to become more involved in strategic development planning by ensuring Bioregional Plans are given due consideration
Agencies:	<i>Lead agency:</i> DENC <i>Implementing agency:</i> DENC, Hantam Local Municipality, Department of Agriculture
Objective:	Provide early input to strategic development planning and executive decision-making at local government level
Description:	(i) Conservation authorities to become actively involved in strategic development planning and decision-making that is likely to affect aquatic ecosystems in the Bokkeveld plateau region.

ACTION 7(a)	Conservation authorities to become more involved in strategic development planning by ensuring Bioregional Plans are given due consideration
	(ii) Input should be provided to: water conservation and demand strategies, the Land-Use Management System (LUMS) and the implementation of the Namakwa Biodiversity Sector Plan.
Resources:	Department of Agriculture, DENC personnel
Timeframe:	Initiation: N/A Duration: Ongoing Completion: N/A
Indicators:	Informed decision making, biodiversity considerations incorporated into development planning
Monitoring:	Annual review of development planning in the region in consultation with the Hantam Local Municipality.

4.2.8 Threat 8: Lack of biological information and monitoring

ACTION 8(a)	Annual monitoring of sandfish populations in the Oorlogskloof Reserve
Agencies:	<i>Lead agency:</i> DENC: OKNR <i>Implementing agency:</i> DENC, OKNR manager and staff, EWT and CapeNature
Objective:	Monitor sandfish populations in the Oorlogskloof Reserve to obtain information on relative fish abundances, the spread of invasive alien fish species and fish health and condition.
Description:	(i) Annual monitoring of fish populations in the Oorlogskloof River from Brakwater to Rietkuil. (ii) Data should include relative abundance, population structure and recruitment and individual fish health and condition. (iii) This monitoring programme should be supported by data on environmental variables including flow, water quality and temperature regimes (Section 4.2.2, Action 2 (a)). River health indicators should be assessed as well.
Resources:	OKNR personnel
Timeframe:	Initiation: March 2014 Duration: ongoing Completion: N/A
Indicators:	Annual abundance estimates, population structure, indicators of fish health and condition
Monitoring:	Annual review of trends in fish abundances linked flow variation by OKNR staff

4.2.9 Threat 9: Epizootic Ulcerative Syndrome (EUS)

There are currently no known means of controlling EUS in wild fish populations, however vigilance with regards to its outbreak in the Oorlogskloof Nature Reserve needs to be exercised and landowners need to be informed about the risks of translocation. This is addressed in Action 8(a) above (Point 4.2.8).

4.3 Lower-Middle Doring and Biedouw River Management Units

A regional stakeholder meeting was conducted during September 2011 focussing on the Lower-Middle Doring MU. The aim of the meeting was to focus on sandfish conservation issues related to the mainstem of the Doring River which require centralised water resources management and planning.

4.3.1 Identification, description, prioritisation and grouping of threats

i. Alien fish species invasions

Invasive alien fish species were identified as the primary threat to the survival of Clanwilliam sandfish populations. Species that were considered the highest risk currently were largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*) and bluegill sunfish *Lepomis macrochirus*). However, sharp-toothed catfish (*Clarias gariepinus*) have been reported in the lower Olifants River and an invasion of the Doring River, and thence into Oorlogskloof-Koebee Rivers catchment by this species was considered a potential future threat and would present the greatest risk to the survival of the species. It was agreed that the risks of future invasions were exacerbated by:

- “Backyard” fish farming: small scale aquaculture operations that may become a potential source of alien fish introductions;
- Farm dams: many farmers want fish for their dams – they need to be provided with low risk alternatives to the highest risk invasive species;
- Bait and lure anglers: considered a high risk group for introducing catfish into new water bodies
- Climate change and extreme events: increased flooding events may serve as trigger for spreading alien fish that are present in high risk areas such as dams within the 1/100 flood line.

The risks of new invasions were increased by lack of championing and awareness and an absence of ‘feet on the ground’

ii. Lack of biological information and monitoring of the species

Lack of biological information and monitoring was identified as the second highest threat since this information fed directly into management strategies. In this regard, understanding the breeding requirements of the species and the factors that promoted survival and recruitment were considered imperative. In addition, radio telemetry studies to understand fish movements and migratory behaviour between and within the tributaries and mainstem, and the monitoring of Doring River mainstem populations were also considered high priorities. Vigilance needs to be exercised with respect to catfish invasions. In the Oorlogskloof and Koebee Rivers a lack of suitable monitoring devices, (flow gauging weirs, temperature loggers, conductivity meters etc.) was hampering effective environmental monitoring.

iii. Reduced river flows in the Doring River and Climate Change

The impacts of altered flow regimes due to increased water requirements for agricultural and domestic use, exacerbated by climate change were considered major threats. Reduced river flows in the Doring River, particularly over the reproduction period in early spring and summer (August – December), are likely to impair triggers for migration and spawning, degrade aquatic habitat conditions for developing young and result in poor year-class strength.

iv. Lack of capacity in governance

There was a general feeling that a lack of capacity in governance was responsible for a failure to monitor water resource use and abstraction, to enforce the Ecological Water Reserve and to promote and implement water

demand management strategies – especially in the agricultural sector. This extended to lack of partnerships between the Western Cape and Northern Cape Departments of Agriculture and Water Affairs as well as local conservation authorities.

v. *Habitat degradation*

Habitat degradation in key catchments such as the Oorlogskloof, Koebee and Biedouw Rivers and a lack of the enforcement of riparian buffer zones was considered to be a threat to the survival of the species by silting reproductive habitat. The ability to manage these problems is hindered by a lack of information and monitoring.

vi. *Pollution and disease*

Pollution in the Oorlogskloof River was likely increase the vulnerability of fish populations to parasites and infections such as Epizootic Ulcerative Syndrome (EUS) which has recently been identified in the Palmiet River as a threat to local fish populations. The risk of infection increases when fish are being moved or introduced into new water bodies.

vii. *Alien vegetation*

Invasion by alien vegetation – particularly by oleander (*Nerium oleander*) that has spread throughout the Doring River may constitute a threat to sandfish populations by clogging riffles and degrading reproductive habitat. Significant invasions of both oleander and mesquite are present in the Biedouw River, considered one of the priority breeding areas for mainstem Doring River sandfish populations.

4.4 Lower-Middle Doring and Biedouw River Management Units Actions

4.4.1 Awareness and Advocacy

ACTION 9(a)	Awareness and advocacy activities among conservancies, angling and interest groups
<p>Agencies:</p> <p>Objective:</p> <p>Description:</p> <p>Resources:</p> <p>Timeframe:</p> <p>Indicators:</p> <p>Monitoring:</p>	<p><i>Lead agency:</i> CapeNature</p> <p><i>Implementing agency:</i> CapeNature</p> <p>Promote sandfish conservation and reduce the probability of intentional introductions of alien fish species into new water bodies</p> <p>(i) Strengthen stakeholder engagement with the organised angling sector (especially bait anglers), as well as landowners in critical catchments (e.g. Biedouw River);</p> <p>(ii) Promote sandfish conservation by giving presentations at local angler meetings and forums including CapeNature’s Freshwater Angling Forum, angling boat shows, clubs and conservancies in the Cederberg/Clanwilliam region;</p> <p>CapeNature personnel, information brochures, posters, t-shirts</p> <p>Initiation: June 2014 Duration: Ongoing Completion: N/A</p> <p>Greater awareness levels among key stakeholder groups</p> <p>Annual assessment of awareness and advocacy activities by conservation organisations.</p>

4.4.2 Ecological research and monitoring

ACTION 10(a)	Initiate monitoring and research programmes on the Clanwilliam sandfish
<p>Agencies:</p> <p>Objective:</p> <p>Description:</p> <p>Resources:</p>	<p><i>Lead agency:</i> CapeNature</p> <p><i>Implementing agency:</i> EWT and CapeNature</p> <p>To provide data-driven and scientifically defensible information on the biology and ecology of the Clanwilliam sandfish for input to adaptive management strategies</p> <p>(i) Develop a proposal and source funding for research into Clanwilliam sandfish populations;</p> <p>(ii) Initiate studies into reproduction, recruitment and movement of Clanwilliam sandfish particularly related to environmental (flow and temperature) variability;</p> <p>(iii) Assess the effectiveness of proposed management actions and predict future population trends with respect to proposed water resource development and climate change scenarios.</p> <p>Research personnel, students, potential funders (e.g. Water Research Commission,</p>

ACTION 10(a)	Initiate monitoring and research programmes on the Clanwilliam sandfish
Timeframe:	Endangered Wildlife Trust) Initiation: May 2014 Duration: Ongoing Completion: Annually
Indicators:	Developed research proposal
Monitoring:	Not applicable

ACTION 10(b)	Annual monitoring of populations in the mainstem Doring and Biedouw Rivers
Agencies:	<i>Lead agency:</i> CapeNature <i>Implementing agency:</i> EWT and CapeNature
Objective:	Ascertain the status of mainstem populations
Description:	Continue surveys of the mainstem of the Doring – suggested every third year. Sampling equipment issues with CapeNature and DENC must be resolved and a joint monitoring team must be set up. Potential involvement from DWA through the RHP program must be investigated. A survey of the Loeriesfontein River should be conducted. A detailed survey of the Olifants gorge and Tankwa River is needed to determine whether sandfish are present. Establish and maintain communication with landowners in the Biedouw River valley and request they report sandfish migratory activity to CapeNature.
Resources:	BMP-S Task Team, vehicles, fyke nets
Timeframe:	Initiation: March 2014 Duration: ongoing Completion: N/A
Indicators:	Updated information on the status of mainstem sandfish populations
Monitoring:	Annual

4.4.3 Translocation and re-introduction of Clanwilliam sandfish

ACTION 11(a)	Translocate Clanwilliam sandfish populations to un-invaded or restored and secured river reaches
Agencies:	<i>Lead agency:</i> CapeNature <i>Implementing agency:</i> CapeNature and EWT
Objective:	Re-introduce Clanwilliam sandfish into suitable waters, especially rivers, within its historical distribution range.
Description:	Identify rivers and/or large dams secure from alien fish invasions where sandfish may have occurred in the past. Once these have been identified, agreements with landowners need to be set up and signed off on. Translocations must be in agreement with the principles of the CapeNature Freshwater Utilization Policy and other relevant policies and guidelines (e.g. IUCN).

ACTION 11(a)	Translocate Clanwilliam sandfish populations to un-invaded or restored and secured river reaches
Resources:	Assessment of potential river reaches, fish transport trailers
Timeframe:	Initiation: March 2014 Duration: 2 years Completion: March 2016
Indicators:	Sandfish introduced into at least one of the abovementioned tributaries
Monitoring:	Annual monitoring of introduced populations to determine if populations have established themselves and are recruiting.

4.4.4 Ecological Water Requirements in the Doring River

ACTION 12(a)	Ecological Water Releases from the Upper Doring tributaries (Groot and Leeu)
Agencies:	<i>Lead agency:</i> CapeNature <i>Implementing agency:</i> CapeNature, DWA and EWT
Objective:	Ensure adequate flows in the Doring River (Aug-Nov) that will promote Clanwilliam sandfish spawning and recruitment
Description:	Increase awareness among landowners in the upper Doring River catchment (Koue bokkeveld region, Groot and Leeu Rivers catchment) and sensitise them to the downstream impacts of water abstracting, particularly during spring (Aug-Nov). DWA to provide annual reports on flows in the Doring River and levels of compliance with the Ecological Reserve to CapeNature.
Resources:	Allocation of DWA personnel to annual reporting
Timeframe:	Initiation: March 2014 Duration: 5 years Completion: March 2015
Indicators:	Annual reports to CapeNature
Monitoring:	DWA monitoring of water abstractions in the region

4.4.5 Re-evaluate conservation status

ACTION 13(a)	Re-evaluate conservation status of the Clanwilliam sandfish
Agencies:	<i>Lead agency:</i> CapeNature <i>Implementing agency:</i> CapeNature and EWT
Objective:	Re-evaluate the conservation status of the Clanwilliam sandfish
Description:	During the course of surveys for this BMP-S it was concluded that there are fewer viable (i.e. reproducing) Clanwilliam sandfish populations than initially thought. Their status may need to be upgraded to Critically Endangered
Resources:	CapeNature and EWT personnel
Timeframe:	Initiation: June 2014 Duration: 3 months Completion: August 2014
Indicators:	Upgrading the Clanwilliam sandfish to Critically Endangered

ACTION 13(a)	Re-evaluate conservation status of the Clanwilliam sandfish
<i>Monitoring:</i>	Not applicable

5. LITERATURE CITED

- Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. *Journal of the Fisheries Research Board of Canada*, 32: 821-864.
- Bills, R. 1999. Biology and conservation status of the Clanwilliam rock catfish and spotted rock catfish. *WWF Investigational Report No. 60*. World Wildlife Fund. 54 pp.
- Birkhead, A.L.; Boucher, C.; Brown, C.; Dollar, E.; Harding, W.; Kamish, W.; Paxton, B.R.; Pemberton, C. and Ratcliffe, S. 2005. Olifants Doring Catchment Ecological Water Requirements Study. Riverine RDM Report. Volume 1: Specialist Reference Report. *Project No. 2002-376*. Southern Waters Ecological Research and Consulting for the Department of Water Affairs and Forestry: RDM Directorate. 309 pp.
- Brown, C.; Pemberton, C.; Birkhead, A.; Bok, A.; Boucher, C.; Dollar, E.; Harding, W.; Kamish, W.; King, J.M. and Paxton, B.R. 2007. In support of water-resource planning—highlighting key management issues using DRIFT: A case study. *Water Sa*, 32: 181.
- Brown, C.A. and Pemberton, C. 2005. *Olifants Doring Catchment Ecological Water Requirements Study. Riverine RDM Report. Volume 2: Environmental Water Requirements*. Southern Waters' Consultancy Report to DWAF: RDM Directorate. Project No. 2002-376. 85 pp.
- Cambray, J.A.; King, J.M. and Bruwer, C. 1997. Spawning behaviour and early development of the Clanwilliam yellowfish (*Barbus capensis*; Cyprinidae), linked to experimental dam releases in the Olifants River, South Africa. *Regulated Rivers: Research & Management*, 13: 579-602.
- DWAF. 2005. Olifants/Doorn Water Management Area: Internal Strategic Perspective. *DWAF Report No. P WMA 17/000/00/0305*. Ninham Shand (Pty) Ltd in association with Jakoet and Associates, Umvoto Africa, FST and Tlou and Matji for the Department of Water Affairs and Forestry National Water Resource Planning, Pretoria.
- Gaigher, C.M. 1973a. The Clanwilliam River: It is not yet too late? *Piscator*, 88: 75-78.
- Gaigher, C.M. 1973b. Die status van inheemse vis in die Olifants Rivier. *Cape Nature Conservation Internal Report* Cape Town. 37 pp.
- Gaigher, I.G. 1984. Reproduction of *Labeo umbratus* (Pisces, Cyprinidae) in Wuras Dam, a shallow, turbid impoundment. *South African Journal of Zoology*, 19: 105-108.
- Hantam Local Municipality. 2010. Rural Spatial Development Framework/Land Development Plan. *Report prepared by Umsebe Development Planners* Department of Rural Development and Land Reform, South Africa. 221 pp.
- Harrison, A.C. 1963. The Olifants/Doorn River system and its fishes. *Piscator*, 57: 25-57.
- Harrison, A.C. 1977. The early transactions of the Cape Piscatorial Society. *Piscator*, 98: 118-123.
- Humphries, P.; King, A.J. and Koehn, J.D. 1999. Fish, flows and flood plains: links between freshwater fishes and their environment in the Murray-Darling River system, Australia. *Environmental Biology of Fishes*, 56: 129-151.
- Impson, D. 1997. Threatened fishes of the world: *Labeo seeberi* Gilchrist & Thompson, 1911 (Cyprinidae). *Environmental Biology of Fishes*, 49: 480-480-480.
- Impson, D. and Swartz, E. 2007. *Labeo seeberi* In: *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4* [Online]. Available: www.iucnredlist.org [Accessed 24 March 2011].
- Impson, N.D.; Bills, I.R. and Skelton, P.H. 2007. Conservation biology and management of a critically endangered cyprinid, the Twee River redbfin, *Barbus erubescens* (Teleostei: Cyprinidae), of the Cape Floristic Region, South Africa. *African Journal of Aquatic Science*, 32: 27-33.
- Impson, N.D.; Bills, R.I. and Cambray, J.A. 2000. State of Biodiversity: Western Cape Province, South Africa: freshwater fishes.
- IUCN. 2010. *2010 IUCN Red List of Threatened Species. Version 2010.4*. www.iucnredlist.org[Online]. [Accessed 7 June 2011 2011].
- Jackson, P.B.N. and Coetzee, P.W. 1982. The spawning behaviour of *Labeo umbratus* (Smith) (Pisces: Cyprinidae). *South African Journal of Science*, 78: 293-295.

- Job, N. and Schumann, M. 2009. Bokkeveld Plateau Wetland Assessment and Catchment Action Plan. Report prepared for the NC Department of Environment, Nature and Conservation, the Nieuwoudtville Farmer's Association and the Botanical Society of South Africa. 67 pp.
- Jubb, R.A. 1961. The cyprinids of the south-western Cape. *Piscator*.
- Jubb, R.A. 1967. *Freshwater fishes of southern Africa*, Cape Town, Balkema.
- King, J.M.; Cambay, J.A. and Impson, N.D. 1998. Linked effects of dam-released floods and water temperature on spawning of the Clanwilliam yellowfish *Barbus capensis*. *Hydrobiologia*, 384: 245-265.
- Koehn, J.D. and Harrington, D.J. 2006. Environmental conditions and timing for the spawning of Murray cod (*Maccullochella peelii peelii*) and the endangered trout cod (*M. macquariensis*) in southeastern Australian rivers. *River Research and Applications*, 22: 327-342.
- Mulder, P.F.S. 1973. Aspects of the ecology of *Barbus kimberleyensis* and *Barbus holubi* in the Vaal River. *Zoological Africana*, 8: 1-14.
- Nel, J.L.; Belcher, A.; Impson, N.D.; Kotze, I.M.; Paxton, B.R.; L.Y, S. and Smith-Adao, L.B. 2006. Conservation assessment of freshwater biodiversity in the Olifants/Doorn Water Management Area: Final Report. CSIR/NRE/ECO/ER/2006/0182/C. Centre for Industrial and Scientific Research (CSIR), Stellenbosch. 128 pp.
- Parkington, J. 1977. Soaqua: hunter-fisher-gatherers of the Olifants River valley Western Cape. *The South African Archaeological Bulletin*, 32: 150-157.
- Paxton, B.R.; Clark, B.M. and Brown, C.A. 2002. An assessment of the effects of habitat degradation and exotic fish species invasions on the distribution of three endemic cyprinids: *Barbus capensis*, *Barbus serra* and *Labeo seeberi* in the Olifants and Doring Rivers, Western Cape. *DWAF Report No. PB E000-00-1302*. Prepared for the Department of Water Affairs and Forestry and Department of Agriculture by Southern Waters Ecological Research and Consulting cc. 53 pp.
- PGWC. 2001. Riverine Ecosystems Report. Prepared by Southern Waters Ecological Research and Consulting cc as part of Contract No. 259 – 2000/2001: Western Cape Olifants/Doring River Irrigation Study.
- PGWC. 2007. Western Cape Olifants/Doring River irrigation study. Summary Report for the Provincial Government of the Western Cape: Department of Agriculture. Prepared by ARCUS GIBB (Pty) Ltd as part of Contract No. 259-2000/2001: Western Cape Olifants Doring River Irrigation Study. PGWC Report No. 259/2004/01.
- Poff, N.L.R.; Allan, J.D.; Bain, M.B.; Karr, J.R.; Presteggaard, K.L.; Richter, B.D.; Sparks, R.E. and Stromberg, J.C. 1997. The natural flow regime. *Bioscience*, 47: 769-784.
- Pollard, S.R.; du Toit, D.; Reddy, J. and Tlou, T. 2007. Guidelines for the development of Catchment Management Strategies: towards equity, efficiency and sustainability in water resources management (1st Ed.). Department of Water Affairs and Forestry, South Africa. www.dwaf.gov.za/documents/other: catchment management.
- Potts, W.M.; Booth, A.J.; Hecht, T. and Andrew, T.G. 2005. Reproductive biology of a riverine cyprinid, *Labeo umbratus* (Teleostei: Cyprinidae), in small South African reservoirs. *African Journal of Aquatic Science*, 30: 147-155.
- Reid, G.M. 1982. The form, function and phylogenetic significance of the vomero-palatine organ in cyprinid fishes. *Journal of Natural History*, 16: 497-510.
- Reid, G.M. 1985. *A revision of African species of Labeo (Pisces : Cyprinidae) and re-definition of the genus. Thesis Zoologicae Vol. 6*, Braunschweig, J. Cramer Verlag.
- Roth, D. 1952. A remarkable bag of smallmouth bass from the Olifants River, Clanwilliam. *Piscator*, 6: 68.
- Scott, H.A. 1982. The Olifants System - unique habitat for rare Cape fishes. *Cape Conservation Series 2*. 14 pp.
- Tómasson, T.; Cambay, J.A. and Jackson, P.B.N. 1984. Reproductive biology of four large riverine fishes (Cyprinidae) in a man-made lake, Orange River, South Africa. *Hydrobiologia*, 112: 179-195.
- Woodford, D.J.; Impson, N.D.; Day, J.A. and Bills, I.R. 2005. The predatory impact of invasive alien smallmouth bass, *Micropterus dolomieu* (Teleostei: Centrarchidae), on indigenous fishes in a Cape Floristic Region mountain stream. *African Journal of Aquatic Science*, 30: 167-173.

Appendix A: Participating organisations and stakeholders

Stakeholders present at the Inception Meeting (Golden Mole Room, SANBI, 25 March 2011), the Northern Cape Stakeholder Meeting (Indigo Development and Change Offices, Nieuwoudtville, 26 Aug 2011) and the Western Cape Stakeholder Meeting (Department of Water Affairs, Bellville, 16 September 2011).

Inception Meeting (Golden Mole Room, SANBI, 25 March 2011)

Stakeholder Group	Name	Organisation
Project Team	Bruce Paxton	Freshwater Consulting Group
	Dean Impson	CapeNature
Conservation	Mandy Schuman	Department of Environment and Nature Conservation
	Martine Jordaan	CapeNature
	Onno Hyser	Table Mountain Fund
	Pierre De Villiers	CapeNature
	Riaan van der Walt	Cape Nature
Consultant	Geordie Ractliffe	Freshwater Consulting Group
Government	Thembela Bushula	Department of Water Affairs
Landowner	JC van der Walt	Koebee Trust
	NGO	Heidi Nieuwoudt
Private	Ross Copin	University of Cape Town
Research	Ernst Swartz	South African Institute of Aquatic Biodiversity

Northern Cape Stakeholder Meeting (Nieuwoudtville, 26 Aug 2011)

Present

Conservation	Eugene Marinus	Hantam National Botanical Garden
	Johannes Afrika	DENC
	Nathan Kotze	DENC
	Riaan van der Walt	Winterhoek Corridor
	Wessel Pretorius	DENC
Government	Noel Viljoen	Hantam Municipality
	Bettina Koelle	Indigo Development & Change
	Donna Kotze	Indigo Development & Change
	Isabelle Rieboww	Indigo Development & Change
	Simon Todd	Independent
Project team	Bruce Paxton	Freshwater Consulting Group
	Mandy Schumann	DENC
	Martine Jordaan	CapeNature
	Peter Ramollo	DENC
Student	Student	Protea Primary School
	Student	Protea Primary School
Teacher	Alida Baard	Protea Primary School

Apologies

Government	Gert Steenkamp	NC Department of Agriculture
	John Crous	Working for Water
Landowner	JC van der Walt	Rietkuil Trust
	Koenas van der Westhuizen	Nieuwoudtville Farmer's Association
	Willem van Wyk	Papkuilsfontein
NGO	Christy Bragg	Green Connection
	Nancy Job	Consultant
Project team	Dean Impson	CapeNature
	Tourism	Margie Baker

Absent

Government	Chris Koopman	Hantam Municipality
	Elsabe Swart	DENC
Landowner	Ian and Hettie McGregor	Hotbergfontein
	Jaco & Alrie van Wyk	Papkuilsfontein
	Jannie de Waal	Driefontein Dam
	John van der Berg	Kranskloof Dam
	Koos Koopman	Landskloof
	Tinus le Roux	Rietkuil Trust
	Willem & Marina v Wyk	Rooiwal Dam
	Willie & Elmiën Lock	Lockenberg Dam

	Willouw Nel	Driefontein Dam
NGO	Derek Malan	Working for Water
	Noel Oettle	Environmental Monitoring Group
	Ruhvene Miles	Working for Wetlands
	Shannon Parring	Indigo Development & Change
Teacher	Petrus Boks	Protea High School

Western Cape Stakeholder Meeting (Bellville, 16 Sep 2011)

Present

Anglers	Max Hafen	Western Cape Bass Anglers Association
	Aminah Shabodien	Western Cape Bass Anglers Association
	Garnet Prince	Cape Piscatorial Society
Conservation	Mandy Schumann	DENC
	Martine Jordaan	CapeNature
	Andrew Turner	CapeNature
Consultant	Nancy Job	Consultant
Government	Bentley Engelbrecht	DWA Western Cape
	Francois van Heerden	DWA Western Cape
	Mashudu Murohvi	DWA Olifants-Doring CMA
	Thembela Bushula	DWA Western Cape
	Francois van Heerden	DWA Western Cape
Landowner	JC van der Walt	Rietkuil Trust
Project team	Bruce Paxton	Freshwater Consulting Group
	Dean Impson	CapeNature
	Heidi Nieuwoudt	SANBI

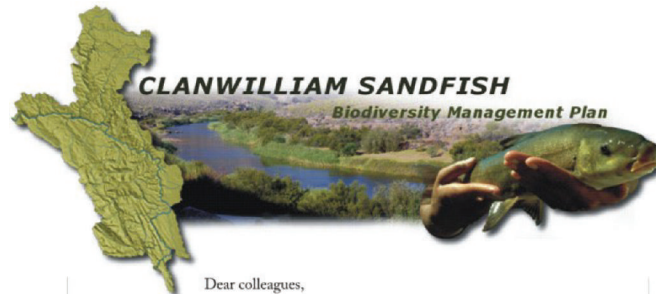
Apologies

Anglers	Graig Fraser	Western Cape Bass Anglers Association
	MC Coetser	Cape Piscatorial Society
Conservation	John Dini	SANBI
	Pierre de Villiers	CapeNature
	Guy Palmer	CapeNature
	Kevin Shaw	CapeNature
Consultant	Geordie Ractliffe	Freshwater Consulting Group
Government	Wilna Kloppers	DWA Western Cape
Landowner	Laurence Dworkin	Keurfontein, Keuromberg
	Tinus le Roux	Rietkuil Trust
Project team	Peter Ramollo	DENC
Research	Jeanne Nel	CSIR
	Ernst Swartz	SAIAB
	Roger Bills	SAIAB

Absent

Anglers	Siggy Kulenkamff	Western Cape Bass Anglers Association
	Hans Gates	Bait Anglers
Conservation	Jenifer Gouza	GCBC
	Johan Burger	GCBC
	Jeanne Gouws	CapeNature
	Derek Malan	WfW
Government	Rudolph Roscher	Landcare
	Ferdie Endemann	Dept. Agriculture, Forestry, Fisheries
Independent	Henk Vivier	Private
Landowner	Mark Stodel	Koebee

Appendix B: Invitation to participate in the BMP-S



Dear colleagues,

CapeNature and the Northern Cape Department of Environmental Affairs and Nature Conservation (DENC), with the Freshwater Consulting Group will be developing a Biodiversity Management Plan – Species (BMP-S) for the Clanwilliam sandfish in the Olifants-Doring Rivers (Western Cape and Northern Cape) over the course of 2011. The aim of this project is to outline a 5 to 10 year programme that will secure refuge and breeding habitats for this critically endangered species by minimising the impacts arising from water resource utilisation and invasive alien fish species in critical catchments.

What is a Biodiversity Management Plan – Species?

A BMP-S as stipulated in the National Environmental Management: Biodiversity Act, is a programme of action aimed at ensuring the long-term (30 year +) survival of a species in nature to which the plan relates.

It is submitted to the Minister of Environmental Affairs who appoints a lead implementing agency (a government department or conservation authority) which may also be responsible for monitoring and reporting on progress.

What is the role of your organisation?

The reason you are receiving this correspondence is because you or your organisation are in some way involved in managing land or water resources that directly impact on Clanwilliam sandfish habitat. While DENC and CapeNature are likely to be the lead implementing agencies and share responsibilities between conservation initiatives in the Northern and Western Cape, you may be invited to contribute in some way during the implementation and monitoring phases.

The Clanwilliam sandfish is one of the most threatened fishes in the Cape Floristic Region and its habitat also supports other threatened species including the Clanwilliam sawfin and Clanwilliam yellowfish. A targeted plan aimed at securing populations of sandfish will be a test of our willingness to conserve freshwater ecosystems, not only within the distribution range of the sandfish, but throughout the Groot Winterhoek, Oorlogskloof-Koebee, Greater Cederberg and Tankwa regions.

We will notify you with regards to developments and meetings in the future and look forward to your participation and support of this important conservation initiative.

Kind regards from the Project Team

Bruce Paxton (FCG); Peter Ramollo (DENC); Mandy Schumann (DENC); Dean Impson (CapeNature); Martine Jordaan (CapeNature)



Appendix C: BMP-S Meeting Agenda



NIEUWOUDTVILLE STAKEHOLDER WORKSHOP MEETING AGENDA

1 Neethlingstraat, Nieuwoudtville

26th August 2011, 09h30 – 13h00

09:30	Verwelkoming en Bekendstelling (Voorsitter)
09:45	Situasie Ontleding en Agtergrond (Bruce Paxton)
10:15	Bedreigings: Omskrywing, Prioritiserings en Groepering (almal)
10:45	Tee
11:00	Visie en Gewenste Uitkoms (almal)
11:30	Bestuursdoelwitte, Aksies en Implementerings Agente (almal)
12:45	Algemene bespreking en Pad Vorentoe (Voorsitter)
13:00	Afsluiting

