The use of the umbrella and indicator species concept as a tool for conserving aquatic species and processes.

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Title of main WRC project:

"The development of a conservation framework for southern African Fish,using *Opsaridium peringueyi* as a reference species".

The aim of the main project:

To develop a generic conservation framework for southern African freshwater fish by first developing **a framework for a selected fish species based on its habitat requirements and water quality requirements.**

Opsaridium peringueyi (Gilchrist & Thompson, 1913) (Southern barred minnow/Suidelike balkghieliemientjie)

The genus is part of the African bariliins (characterized by vertical bars)
The barillins are generally:
shoaling, streamlined,
active swimming and predatory.

Three species occur in sthrn Africa

O. peringueyi occurs from the Save River system south to the Phongola System.

At the onset of the project it was classified as "vulnerable" (IUCN)
→ changed to of "least concern" during the course of the project

Concepts

- **Umbrella species:** species selected for making conservation related decisions, typically because protecting these species indirectly protects the many other species.

- An **indicator species:** species that defines a trait or characteristic of the environment.

  (environmental condition)

  Indicator species are the most sensitive species

- **Focal species:** suite of species (selected from the total pool of species in a landscape) that defines an extended set of environmental characteristics

The approach followed in the project:

During the study we investigated aspects of *O. peringueyi* (OPER) ecology on different scales:

- **Micro-habitat scale**
- **Broader habitat scale**
- **Landscape scale**

The methods

Micro-habitat scale

- The micro-habitat scale (local) focused on selected sites and the **hydraulic biotopes** within these sites (Paxton, 2005) within the site.

- **Methods:**
  - Physico-chemical aspects (e.g. pH, WQ etc.)
  - Determining and mapping the heterogeneity of sites.
  - ID hydraulic biotopes (substrate, depth, velocity) .
  - Survey fish within each hydraulic biotope

Broader habitat scale

- At the broader scale (regional) focused on the distribution of the species and the accompanying fish assemblage composition within eco-regions and “river types” (based on the geomorphological zonation- Freeman and Rowntree – 2005).

- **Methods:**

  - ID river types and eco-regions where sites occur.

  - Relate this to the fish data collected at micro-habitat scale

Landscape scale

- At the landscape scale focused on the distribution of the species throughout the catchment of all the rivers where the species historically occurred.
- **Methods:**
  - Gathering historic data.
  - Compiling detailed spatial maps of this distribution
  - Survey of the historic sites and establish current distribution
  - ID of threats and impacts within each river system.

Results

Micro-habitat scale

Habitat diversity at the sites where OPER was collected.

(The numbers represent the biotope type as a % of the total number of biotopes sampled, the **red** indicates where OPER occurred [present vs absent])

Site no	River	FS	SS	FD	SD
27	**Mutale**	**20**	20	**50**	**10**
23	**Mukhase**	18	28	9	**45**
28	**Mutshindudi**	**50**	20	0	**21**
62	**Blyde**	60	10	10	**20**
63	**Letaba**	**69**	8	15	8
31	**Mac-mac**	**33**	**33**	22	**12**
32	**Sabane**	**25**	63	0	12
33	**Sabie-conf**	**61**	17	0	**13**
34	**Sabie-hox**	**50**	33	0	17
36	**Marite**	**17**	0	16	67
58	**Thala**	**58**	**36**	7	0

Substrate dominance in the biotopes where OPER was collected.

(Where Br = bedrock, B = boulders etc. The **red** indicates where OPER occurred [present vs. absent])

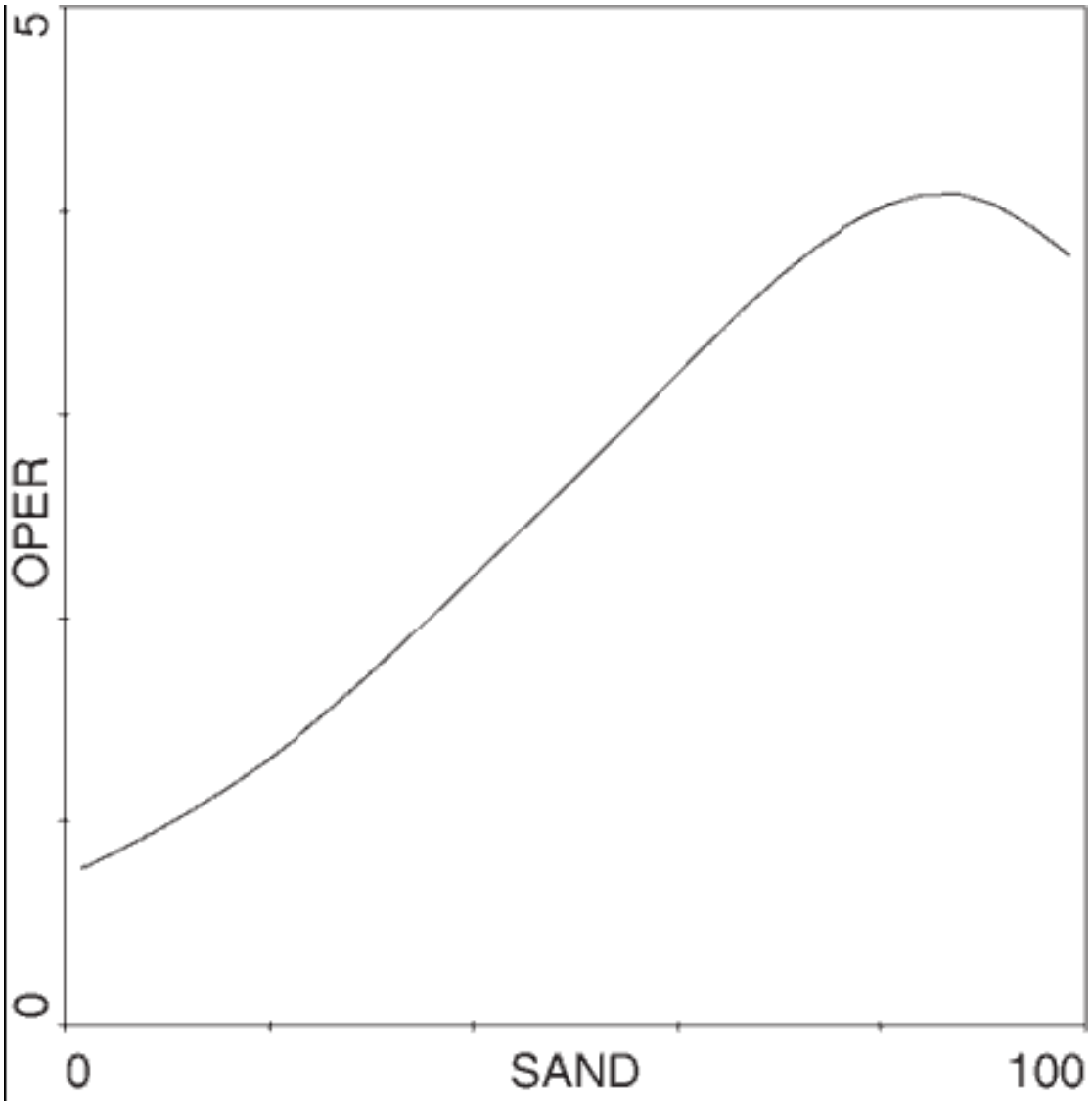
Site no	River	FS	SS	FD	SD
27	**Mutale**	**C**	BC	**BC**	**S**
23	**Mukhase**	Br	BrC	Br	**Ssi**
28	**Mutshindudi**	**B**	C	BC	**BCS**
62	**Blyde**	BrBC	C	Br	**CS**
63	**Letaba**	**C**	C	G	Si
31	**Mac-mac**	**BrCS**	**BrS**	BrC	**S**
32	**Sabane**	**B**	BCS		S
33	**Sabie-conf**	**C**	S		**CS**
34	**Sabie-hox**	**BrC**	C		S
36	**Marite**	**S**		B	BS
58	**Thala**	**BCGS**	**BCS**	B	

If we look a bit closer at the factors affecting distribution of OPER on a local (BIOTOPE) scale.

Local scale environmental variables explain 24.8% of variation in fish assemblage structure. Four environmental variables explain significant amounts of systematic variation and are, in order of importance: sand, maximum velocity, root wads and gravel.

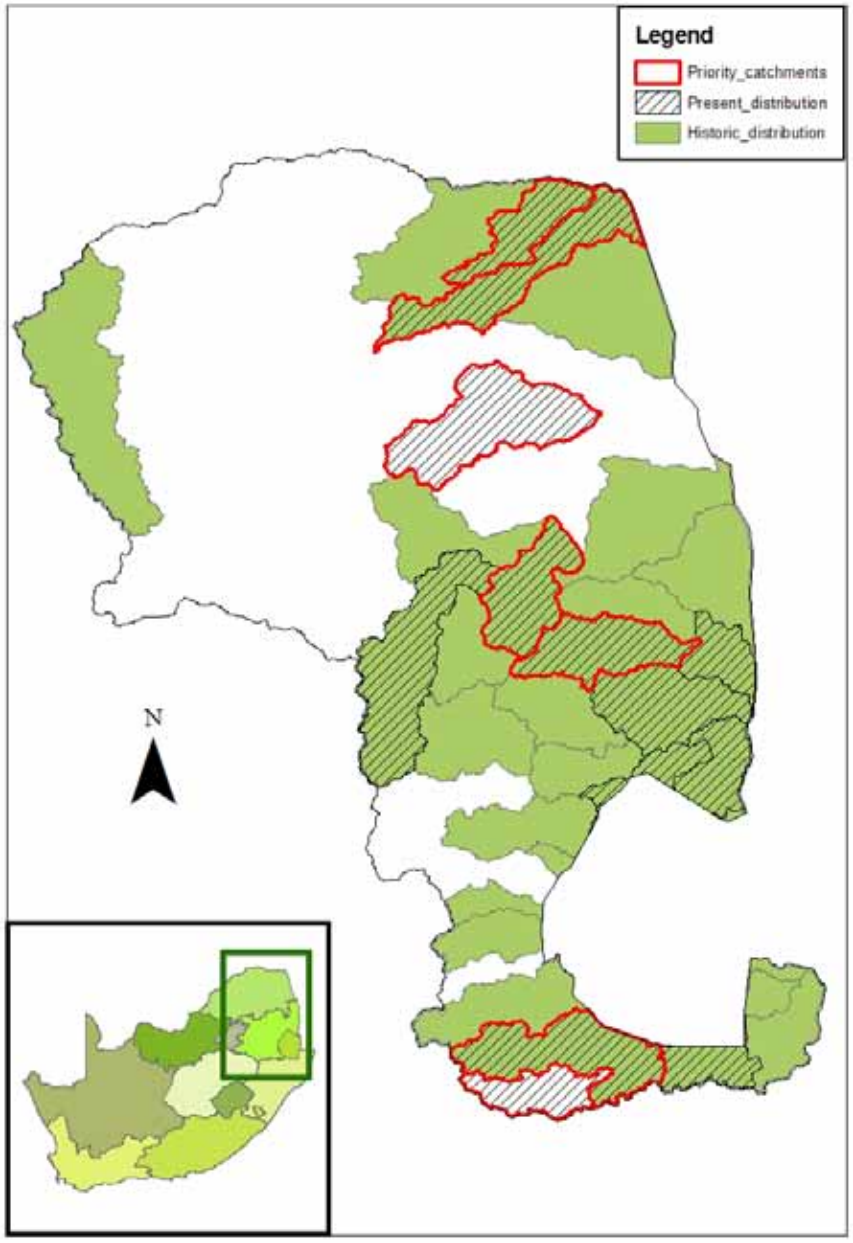
Sand as a predictive variable is the only environmental factor that produces a significant response model based on the generalized additive model for OPER that has a uni-modal response to percentage sand cover with an optimum at 80%.

Response of OPER to sand.



Broader habitat scale

The distribution of the species



Species assemblages at the Luvuvhu River sites where OPER occur.

	Luvuvhu River	Sabie Rive r
AMOS		
AURA	X	X
BAFR		
BANN		
BEUT	X	X
BLIN		
BNEE	X	
BPAU		
BTOP		
BTRI		
BUNI		
BVIV	X	
CANO		X
CGAR	X	
CPRE	X	X
CENG		
GGUI		
LCYL	X	X
LMAR	X	
LMOL	X	X
MACU	X	X
MBRE		
MMAC		
OMOS	X	
OPER	X	X
PWES		
PPHI		
TREN		
VNEL		X
	12	**9**

“River types” and eco-regions

- **“Rivers types”**

  OPER collected mostly mountain streams, transitional and upper foothill streams.

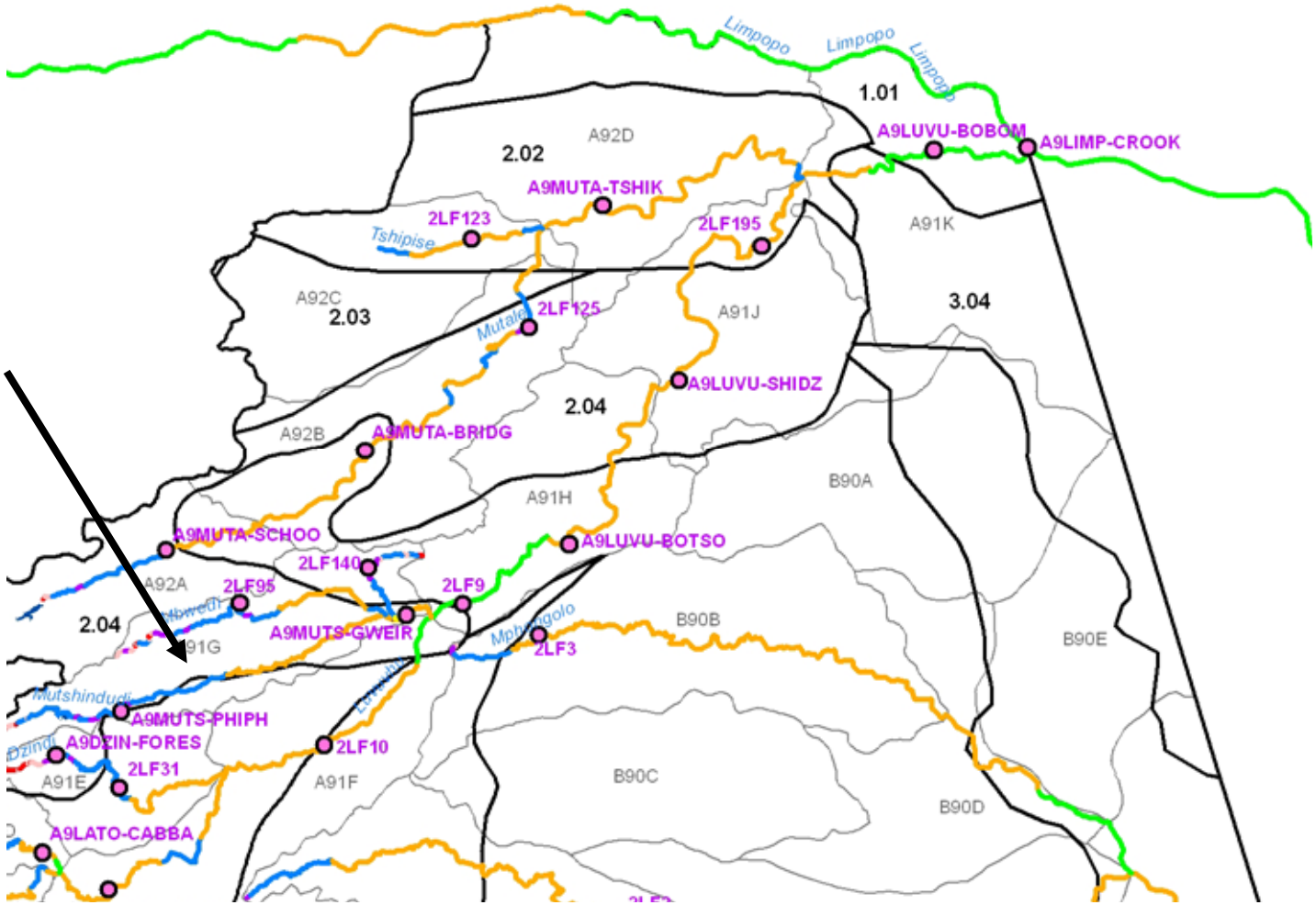
  (steep to moderately steep gradients, boulders and cobbles, sand in pools and at the “foot” of cascades and riffles)

- **Eco-regions**

  Eco-regions where OPER was collected varied but relates well to “river type”.

Eg Luvuvhu River:

Eco-regions (Luvuvhu River)



Factors affecting distribution of OPER on a regional scale.

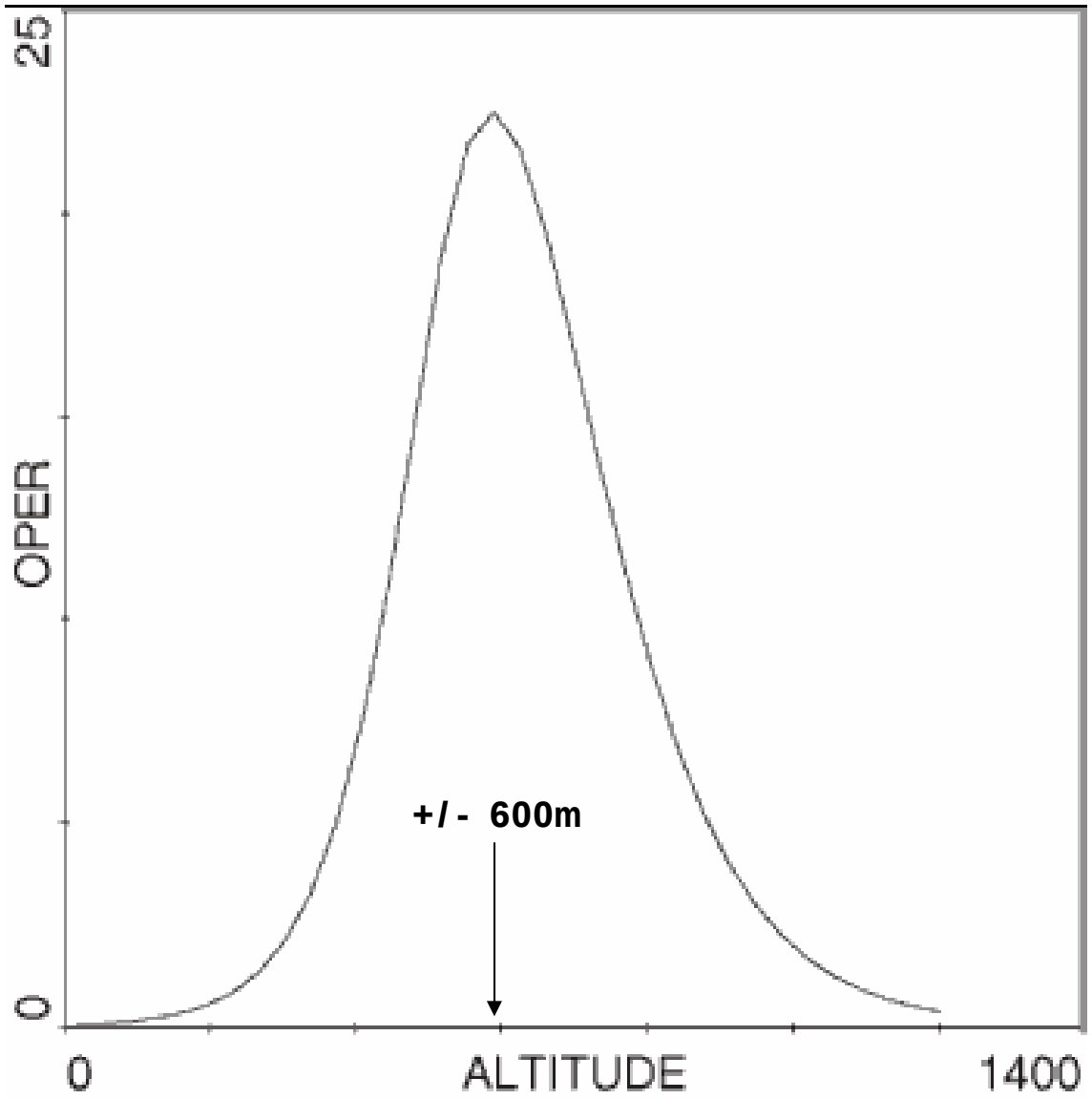
Regional environmental variables explain 21.9% of variation in fish assemblage structure.

Four environmental variables explain significant amounts of systematic variation:

altitude, TDS, width of stream and pH (in order of importance)

Altitude as a predictive variable is the only environmental factor that produces a significant response model for OPER.

Response of *OPER* to altitude.



Landscape scale

From the results at this level:

- The apparent **source-sink** migration of OPER was the most important result as it illustrates the necessity of ensuring connectivity within a river system.

Also noted that:

- Protection of catchment is needed in order to ensure water quality and quantity downstream.

- Water quality maintenance from catchment to lower reaches.

OPER as an indicator species

Tolerance rating of OPER (and other "related" species in the assemblage) on a scale of 1 → 5 with 1 = tolerant and 5 = intolerant

Species	Fast deep	Fast shallow	Slow deep	Slow shallow	Flow/ velocity	Substrate	Water Qual
OPER		3.2	3.3		4.9		4.4
LCYL	3.4	4.8			3.1	4.9	3.1
VNEL	5	5			3.6	5	3.4
LMAT	4	4.4	4.4	3.5	3.2	4.5	2.1
BEUT	4.3	4.7			4.6	4.1	4.9
CANO/CPRE	4.3	4.3			4.8	4.9	4.7

Points of caution for the umbrella species concept

- Single-species umbrellas, in many cases, cannot ensure the conservation of all co-occurring species because some species are inevitably limited by ecological factors that are not relevant to the umbrella species.

- Umbrella species from a given higher taxon may not necessarily confer protection to assemblages from other taxa.

- Many studies criticizing the umbrella species concept focused on terrestrial species.

However with regard to OPER as an umbrella species:

- Although the species might have a localized occurrence its distribution spans over several river systems.
- Its local and regional representation represents “vulnerable” habitat in a system.

  Local = flow dependent biotopes.

  Regional = upper catchment reaches
- Its reliance on connectivity (source-sink)
- Its sensitivity and intolerance rating.
- OPER represents a diverse assemblage (which also contains other sensitive species)

Developing a Biodiversity Management Plan for Species

- NEMBA provides the opportunity and legislative support for the development biodiversity management plans for indigenous species (BMP-S).

- OPER was used as a test case for fish

- Throughout the development of the plan it became clear that the plan has the potential, not only to ensure the long term survival of the species, but also several other aquatic species as well as ecological processes, river types and goods and services.

The BMP-S process

- From the collected data a background report was compiled.
- A stakeholder (experts & implementer) workshop was held
  - Background document discussed
  - The IUCN rating of OPER revised
  - The draft BMP-S was drawn up
- BMP-S has been submitted for approval

The results of the IUCN re-assessment of the species

During the BMP-S process the conservation status of *O. peringueyi* was re-assessed (as a population within South Africa's borders).

Some of the specialists involved in the initial assessment for the current IUCN Red data list were involved in this process.

O. peringueyi was again classified as "vulnerable" but within a regional context

Example of the framework of the draft BMP-S: Vision and Key Result Areas:

Vision

To ensure the protection of Opsaridium *peringueyi* as an umbrella species to maintain or improve the diverse population patterns and ecological integrity of associated species assemblages and processes and secure ecological goods and services in the five catchments to benefit of humankind.

Key result areas:

KRA1: CONSERVATION MEASURES FOR THE CONSERVATION OF *OPSARIDIUM PERINGUEYI*

Goal: To ensure the implementation of conservation measures for *O. peringuyei* in its distribution range in order to secure the long term survival of the species.

KRA2: MAINTANANCE OF ECOLOGICAL PATTERNS AND PROCESSES

Goal: To maintain or improve the diverse population patterns and ecological integrity of species assemblages and processes associated with the umbrella species, *O. peringueyi.*

KRA3: SUSTAINABLE ECOLOGICAL GOODS AND SERVICES

Goal: To ensure that through the conservation of the species associated goods and services are protected for the benefit of humankind

KRA4: EFFECTIVE COMMUNICATION

Goal: To ensure effective stakeholder engagement and communication throughout the implementation of the project.

Organizational implementation structure for BMP-S