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Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA

WP 10544

LAKE SIBAYA INTERMEDIATE EWR

VOLUME 1 - ECOCLASSIFICATION REPORT

FINAL

NOVEMBER 2015

Report No. RDM/WMA6/CON/COMP/1613

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DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEMS
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Consultants: Tlou Consulting (Pty) Ltd and Southern Waters

Checked for the Consultants by:

……

Dr C Brown
Internal Reviewer

Approved for the Consultants by:

……..

A Singh
Project Leader

Client: Department of Water and Sanitation

Approved for the DWS:

……..

N Mohapi
Chief Director: Water Ecosystems

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- Karl Reinecke
- Alison Joubert
- Andrew Birkhead
- Steve Weerts
- Jane Turpie
- James Mackenzie
- Ricky Taylor
- Susan Taljaard
- Cate Brown
- Adhishri Singh

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ABBREVIATIONS AND ACRONYMS

AEC	Alternative Ecological Category
BHN	Basic Human Needs
CSIR	Council for Scientific and Industrial Research
DRIFT	Downstream Response to Imposed Flow Transformation
DSF	Desired Future Status
DSS	Decision Support System
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
ERC	Ecological Reserve Category
EWR	Environmental Water Requirements
IFR	Instream Flow Requirement
LWR	Lake Water Requirement Approach
PES	Present Ecological State
REC	Recommended Ecological Condition
WMA	Water Management Area

GLOSSARY OF TERMS

- **Ecological Categories.** A distinction is made between Management Classes, which form part of the National Classification System, and Ecological Categories, which forms part of the Ecological Water Requirement assessment.
- **Ecological Category** (EC) replaces former terms used, namely: Ecological Reserve Category (ERC), Desired Future State (DFS) and Ecological Management Class (EMC).
- **Ecological Water Requirements** (EWR) should be used instead of the term Instream Flow Requirements (IFR) for various reasons, including international acceptance of the former term.
- **Ecosystem Integrity**: refers to the integrated composition of physicochemical, habitat and biotic characteristics on a temporal and spatial scale that are comparable to the characteristics of natural ecosystems of the region.
- **Preliminary Reserve** refers to Reserve signed off by the Minister or her representative in the absence of the Classification Process having been undertaken in the basin.
- **Recommended Ecological Condition** (REC) The target maintenance Ecological Condition for a water resource based solely on ecological criteria.
- **Reserve** refers to the EWR for maintaining a particular ecological condition where operational limitations and stakeholder consultation are taken into account. The Reserve includes both ecological and Basic Human Needs (BHN) requirements.

1 INTRODUCTION

1.1 Background to the study

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS), issued an open tender invitation for the "*Appointment of a Professional Service Provider to undertake Reserve Determinations for selected Surface water, Groundwater, Estuaries and Wetlands in the Usuthu to Mhlatuze Basins*". The focus on this area was a result of the high conservation status and importance of various water resources in the basin and the significant development pressures affecting the availability of water in the area.

Reserve determinations are required to assist the DWS in making informed decisions with respect to the magnitude of the impacts of the proposed developments on the water resources in the Water management Area (WMA), and to provide the input data for Water Resource Classification of the area, and eventual gazetting of the Reserve (DWAF 1999a).

In July 2013, DWS appointed Tlou Consulting to undertake the project.

1.1.1 Study objectives

The objectives of the overall study are to:

- determine the Ecological Reserve (DWAF 1999a) at various levels of detail, for the Nyoni, Matigulu, Mlalazi, Mhlatuze, Mfolozi, Nyalazi, Hluhluwe, Mzinene, Mkuze, Assegaai and Pongola Rivers;
- determine the Ecological Reserve, at an Intermediate level, for the Pongola Floodplain;
- determine the Ecological Reserve, at an Intermediate level, for the St Lucia/Mfolozi, Estuary System;
- determine the Ecological Reserve, at an Rapid level, for the Mlalazi Estuary;
- determine the Ecological Reserve, at a Rapid level, for the Amatikulu Estuary;
- determine the Ecological Reserve, at an Intermediate level, for Lake Sibaya;
- determine the Ecological Reserve, at a Rapid level for Kozi Lake and Estuary;
- classify the causal links between water supply and condition of key wetlands;
- incorporate existing EWR assessments on the Mhlatuze (river and estuary) and Nhlabane (lake and estuary) into study outputs;
- determine the groundwater contribution to the Ecological Reserve, with particular reference to the wetlands;
- determine the Basic Human Needs Reserve for the Usuthu/Mhlatuze WMA;
- outline the socio-economic water use in the Usuthu/Mhlatuze WMA;
- build the capacity of team members and stakeholders with respect to EWR determinations and the ecological Reserve.

1.2 This report

This report is Volume 1 of four volumes of the Lake Sibaya Intermediate EWR Report:
Volume 1: Ecoclassification Report
Volume 2: EWR Assessment – Results
Volume 3: Specialists reports
Volume 4: Ecospecs and Monitoring Programme.

This report covers the activities required for Step 3 of the Reserve determination process as prescribed by the CD: RDM of DWS (DWAF 1999a; Kleynhans *et al.* 2007).

This report serves to document the results of the ecological classification (Step 3 in Figure 1.1) for the EWR zones within Lake Sibaya for which Intermediate EWR determinations were undertaken.

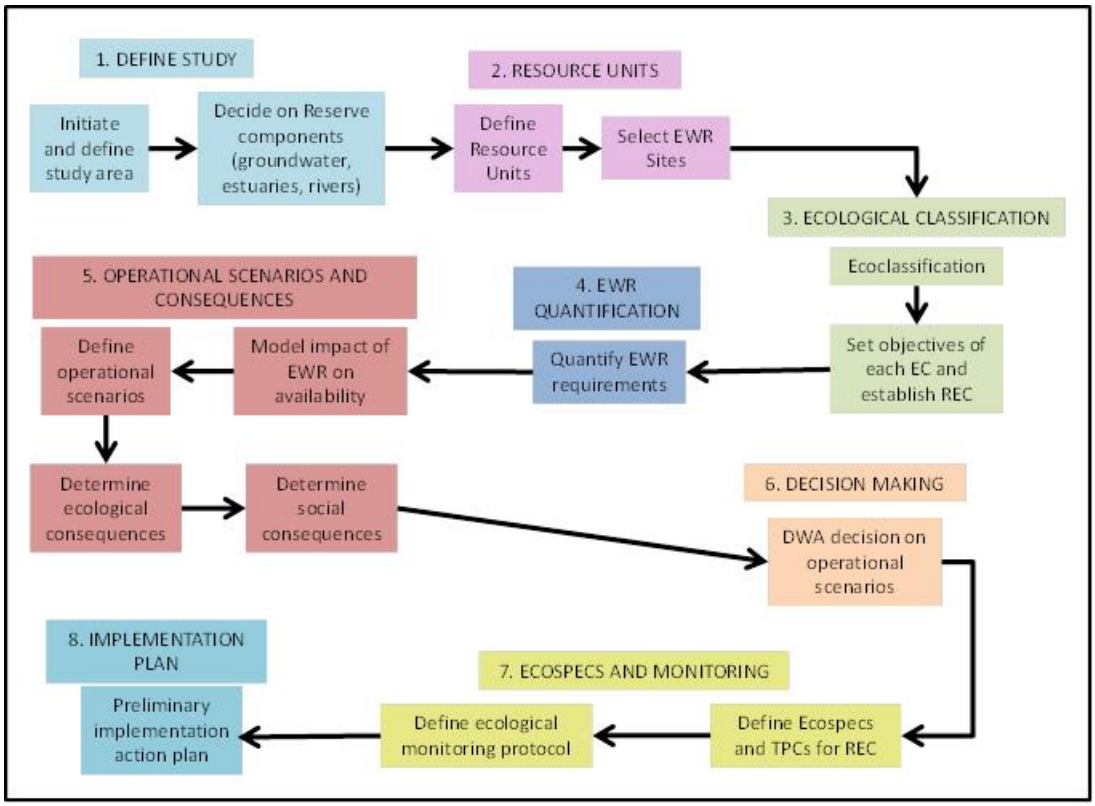

Figure 1.1 Generic procedure for the determination of the Ecological Reserve

The results are provided per EWR zone and include the following:

- Data availability.
- Ecological Importance and Sensitivity (EIS)
- Reference conditions.

- Baseline ecological condition, including:
  - individual component Ecoclassification;
  - cause and sources;
  - trends;
  - Ecostatus.
- Recommended Ecological category (REC) for each specialist component and EcoStatus.
- Alternative Ecological categories (AEC) for each specialist component and EcoStatus.
- Confidence in the results.

1.2.1 Study team

The names and affiliations of the members of the study team are provided in Table 1.1.

Table 1.1 Members of the study team for Lake Sibaya portion of the overall study

Name	Affiliation	Role
Adhishri Singh	Tlou Consulting	Project Manager
Cate Brown	Southern Waters	Internal review
Alison Joubert	Southern Waters	DRIFT DSS manager
Karl Reinecke	Southern Waters	EWR process co-ordinator
Drew Birkhead	Streamflow Solutions	Hydraulics
Susan Taljaard	CSIR	Water quality
James MacKenzie	BioRiver Solutions	Vegetation
Ricky Taylor	Hydrological Training and Research Specialists	Herpetofauna, semi-aquatic mammals, molluscs and macrocrustacea
Steven Weerts	CSIR	Icthyofauna
Jane Turpie	Anchor Environmental	Avifauna
Toriso Tlou	Tlou Consulting	Social

2 ORGANISATION OF THE STUDY AREA

2.1 Delineation of Lake Sibaya

The morphology of Lake Sibaya is a result of sedimentary processes, driven by fluctuating water levels and wind driven currents that dictate Lake Sibaya's morphology through the processes of infilling and shoreline progradation associated with the lake segmentation process (Miller 1998). Importantly, lake morphology is driven by lake water level, with the highest levels of erosion, and hence sediment deposition in the lake, occurring at high water levels (Miller 1998).

Lake Sibaya can be subdivided into five regions, the: Main Basin, Northern Arm, Western Arm, Southwestern Basin and Southern Basin (Hill 1979, cited in Miller 1998; Figure 2.1).

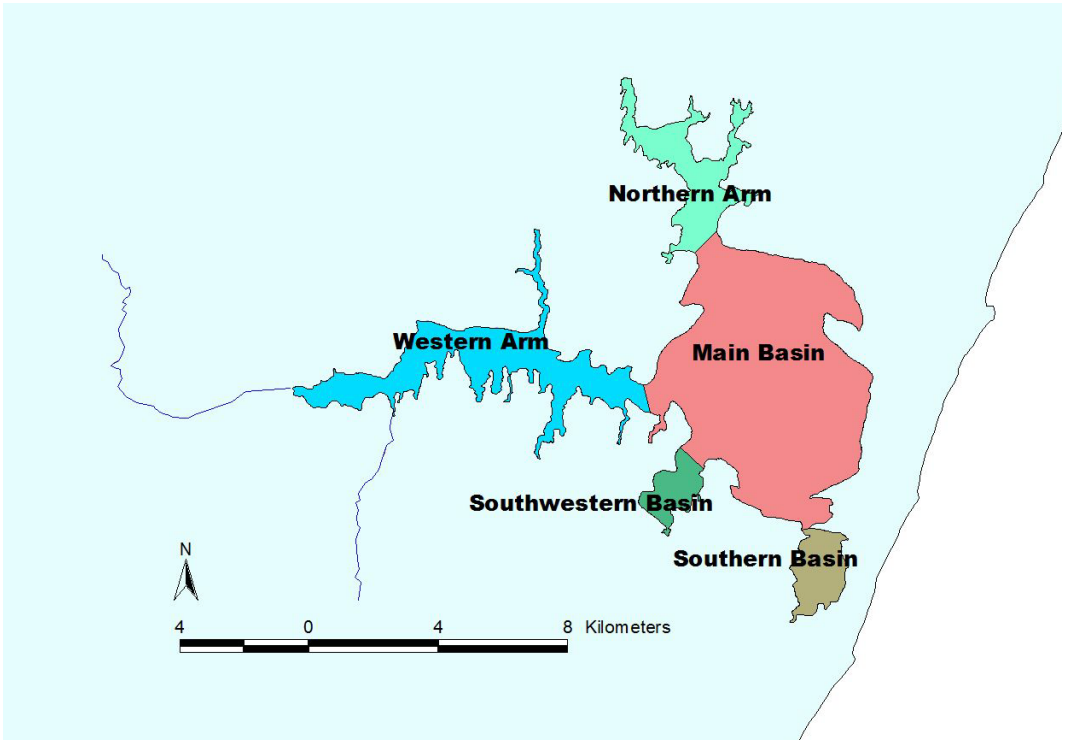

Figure 2.1 The five main regions of the lake

2.2 Study zones

The study zones are the five regions: Main Basin, Northern Arm, Western Arm, Southwestern Basin and Southern Basin (Figure 2.1). Site codes for the five regions are provided in Table 2.1.

Table 2.1 Site codes for the five regions

Zone	Code
Main Basin	MB
Northern Arm	NA
Western Arm	WA
Southwestern Basin	SWB
Southern Basin	SB

3 ECOSTATUS

A summary of the data used to assess the ecological condition of each region is provided for each, along with a description of the Ecostatus. The Ecoclassification results are summarized in Section 4.

3.1 EWR Zone – Main Basin (MB)

Figure 3.1 shows the location of the Main Basin in relation to Lake Sibaya and photographs of some of the areas that were sampled as part of the study.

Figure 3.1 Main Basin

3.1.1 Data availability

The data available at EWR MB are summarised in Table 3.2. Scores for confidence ratings are provided in Table 3.1.

Table 3.1 Description of confidence ratings

Confidence rating	Description
1	Low confidence
2	Low to medium confidence
3	Medium confidence
4	Medium to high confidence
5	High confidence

Table 3.2 Data available at EWR MB

Component	Data availability	References	Confidence
Water quality	Occasional data 1967-1977: pH, DO, Secchi depth, DIN, DIP; Jul 2015: EC, cations/anions, pH, Turbidity, DO, DIN, DIP.	Allanson, 1979; This study	2
Vegetation	Description of coastal dune forests and lake-dependant macrophytes.	Allanson (1979)	4
	Trends in sediment and nutrient accumulation rates.	Humphries & Benitez-Nelson (2013)	4
	Satellite data (7 Oct 2004 to 13 Jan 2015).	Google Earth ©	5
	Lake level data (1980 to 2015).	DWS	2
	DEMs.		2
	General vegetation distribution and description.	Mucina & Rutherford (2006)	5
	Distribution data of plant species.	POSA SANBI (2009)	3
	Species confirmation.	iSpot SANBI	4
	Holocene sequence of vegetation at Sibaya.	Neumann *et al.* (2008)	5
	Bathymetry and sediment distribution.	Miller (1998)	5
	Red list of SA plants.	Raimondo *et al.* (2009)	5
	Geology and geohydrology.	Both & Singh (2012)	5
	Regions of Floristic Endemism in Southern Africa.	Van Wyke & Smith (2001)	5
	Site visit (15 July 2015); collection of species height / depth relative to WL and vegetation assessment.	This report	5
Molluscs	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths. Complementing this is Appleton's work on snails and Miranda's work on Terebia.	Hart (1979 & 80); Appleton (1977 & 1980); Miranda (2012 & 2014)	4
Crustacea	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths.	Hart (1979 & 80)	4
Fish	Good information on biologies of selected species in Lake Sibaya. No site specific data. No quantitative data on abundances.	Bowen SH (1976). Bowen SH (1978). Bruton MN (1979). Bruton MN (1979). Bruton MN (1980). Bruton MN and Allanson BR (1974).	3
Herpetofauna	Count data and nest censuses from EKZNW, and Combrink et al. (2011) which provide census data and the decline of crocodiles in Lake Sibaya.	EKZNW census files; Combrink et al. 2011	5
Birds*	Counts of top 15 species for 1970 and 1976 (Bruton 1979); Bird checklist by Cyrus et al. (1980); Brief description by Bruton (1980); Phil Hockey count Dec 1981 (Ryan et al. 1988); Summer and winter CWAC counts 1992-2014;	See report.	5

Component	Data availability	References	Confidence
	Field notes (R Taylor) Jul 2015.		
Semi-aquatic mammals	Count data and life history parameters from EKZNW, and Taylor (2013) which provide census data and the decline of hippopotamuses in Lake Sibaya.	EKZNW; Taylor 2013	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.1.2 Ecological importance and sensitivity

The EIS of EWR MB, with motivations, is provided in Table 3.3.

Table 3.3 EIS of EWR MB

DETERMINANTS	SCORE	REASONING	CONFIDENCE
BIOTA	(0-4)		
Rare & endangered (range: 4=very high - 0 = none)	3.75	*Wolffellia denticulata* listed as VU D2 (http://redlist.sanbi.org/species.php?species=3873-1); last recorded at Sibaya 1973 by A.A. Mauve (http://sibis.sanbi.org/faces/SearchSpecimen/SpecimenDetails.jsp?1=1); not recorded at site but is possibly present. *Silhouettea sibayi* is listed as Endangered on the IUCN Red List of Threatened Species. Many other species are IUCN listed, albeit in the "Least Concern" category. Hippo and crocodiles are red data species. Presence of 7 bird species that are on the regional red data list (2014), though none in very large numbers except occasionally.	3.75
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.00	*Cyperus natalensis* restricted to area; falls within Maputaland Centre of plant endemism (Van Wyk & Smith, 2001) but mostly applicable to species not associated with the Lake; isolated distribution of swamp forest associated with western arm. Several species are endemic to southern Africa. *Aplocheilichthys myaposae* occurs in KZN only, so is highly localised. This lake is also unique in its fish assemblage having relict remnants of an estuarine assemblage, despite being isolated from the sea since the Pleistocene. Estuarine relic molluscs, crustacea and herptofauna. No, though several bird species at the edge of range in SA.	4.00
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.50	Aquatic and emergent macrophytes highly dependent on lake level High water levels and connectivity with adjacent swamps, pans and wetlands are needed for several species of fishes. This includes facultative use by two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*). Climbing perch (*Ctenopoma multispine*) have a more obligate need for reaching these peripheral habitats for breeding. Shallow, gentle sloping shelves are needed for several other species as well, including those that are numerically dominant. These habitats (and therefore these fauna) are sensitive to lake water level fluctuations. Most of the herpetofauna, crustacea,	3.25

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		molluscs and mammal species are 'generalists'. Several species have relatively narrow habitat requirements.	
Species/taxon richness (range: 4=very high - 1=low/marginal)	3.00	Falls within the Maputaland-Pondoland region of plant endemism with app. 7000 taxa (Van Wyk & Smith, 2001) Species richness of KZN freshwater fishes is naturally low (south of the Pongola). This lake has elevated species richness because of the relict estuarine component in its fish fauna. There is a tropical richness, but reduced a bit by the isolation causing an 'island' effect.	4.00
HABITATS	(0-4)		
Diversity of types (4=Very high - 1=marginal/low)	3.00	Aquatic, littoral, pan adjacent and off-lake wetland, open sandy beach areas, protected coves, stream inflow areas, coastal dune, swamp forest. This is one of very few coastal lakes in the country. It is the only system that has lost its estuarine connection, but which retains a relict estuarine fauna. The high diversity of submerged, emergent and floating plants, together with connect pans, swamps and wetlands, provides a very high diversity of freshwater habitats not found anywhere else at one locality. High diversity of habitats, reduced by the even morphology of the basin, few rocks and consistent sized sand grains.	4.00
Refugia (4=Very high - 1=marginal/low)	2.75	Refugia for smaller similar systems during extended drought. This is one of the few (and possibly only) permanent deep freshwater bodies on the Maputaland flats. It becomes a refuge during drought and centre of distribution for fishes that inhabit pans, swamps and wetlands on the wider coastal plain. The embayments are very important to the mammals, herpetofauna, crustacea and molluscs.	4.00
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.75	Large ground water dependant system more resilient to change. The main habitat types, gentle banks and shallow water with submerged vegetation, are susceptible to lake water level drop. Because of the systems morphology these habitats are lost very rapidly below critical water levels. Herptofauna, molluscs, crustacea and mammals are affected by water level changes.	3.75
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.40	Large ground water dependant system more resilient to change. At very low levels saltwater intrusion might occur, which will result in the loss of (vegetated) habitat as well as primary freshwater elements of the fish assemblage. Most species would be affected. Lake water levels would need to drop below sea level for this to occur. At levels above this water quality should remain suitable for all fishes in the lake. Flow translates into Water level in these lakes. WQ parameter influenced by lake level is EC The dystrophic water is easily enriched with nutrients.	3.80
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1.50	Occurs within a string of such systems along the coastline but not likely to be important for plant species migration. The lake itself is not used as a migration route, but high water levels do facilitate migration to adjacent swamps, pans and wetlands for several species of fishes. These include two species	3.25

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*) as well as climbing perch (*Ctenopoma multispine*). This is an endorheic system - but hippopotami, crocodiles and birds do move between waterbodies.	
Importance of conservation & natural areas (range, 4=very high - 0=very low)	4.00	Within iSimangaliso and largest freshwater lake in southern Africa, RAMSAR site. This is a unique lake in that its biota retains a relict fauna of a geological past. It remains in good condition and its catchment can still be managed to protect its ecological integrity as a relatively pristine freshwater lake adjacent to a World Natural heritage site. This is a Ramsar and World Heritage Site - the highest conservation rating that can be given.	4.25
MEDIAN OF DETERMINANTS	3		
EISC	HIGH		

3.1.3 Reference conditions

The expected reference condition at EWR MB is described in Table 3.4.

Table 3.4 Reference condition at EWR MB

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
Water quality	DO, Turbidity and Conductivity as Present. DIN ~0.07 mg/l (deeper waters) and 0.1 mg/l (shallower waters, reflecting some input from peripheral vegetation under natural); DIP ~0.02 mg/l.	2	Expert judgement based on available data; De Villiers & Thiart, 2007
Vegetation	The Main Basin is characterised by more exposed, straighter shorelines than the other areas of the lake and as such submerged aquatic vegetation is expected to be less well represented and more generally dominated by species are resilient to wind and wave action, such as Fennel-leaved Pondweed (*Stuckenia pectinatus*) and Saw Weed (*Najas marina subsp. armata*). Spiked Water-milfoil (*Myriophyllum spicatum*), native to Europe, Asia and North Africa, is expected to be absent. Similarly, emergent macrophytes in the littoral zone are expected to be less well developed as a result of exposure to prevailing wind and wave action. Along most shores the dominant plant form is likely to be sedges and grasses (notably *Schoenoplectus scirpoides, Juncus oxycarpus, Cyperus natalensis*) with coverage being lower with more exposure. Alien and woody species would be absent from this zone. Shoreline macrophytes are those species that occur between the emergent macrophytes and	4	Mucina & Rutherford, 2006; Allanson, 1979; Ricky Taylor, per com

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
	the tree line and along open exposed beach areas where those occur. This zone should be dominated by a mixture of grasses and sedges (*notably C. natalensis, Juncus oxycarpus, Dactyloctenium geminatum* and *Imperata cylindrica*) and should be free of alien or woody species. The tree line is where woody vegetation starts and should characteristically be in keeping with the surrounding vegetation type. This is some Maputaland Coastal Belt but mostly Northern Coastal Forest (specifically Dune Forest). The beginning of this zone should remain clearly defined and usually indicates a level beyond which inundation is rare. Some encroachment of the shoreline zone by woody species is natural (especially by *A. karoo*) but should be transient and reduced by lake level fluctuations. High woody aerial cover, notably *A. karoo, S. cordatum* and Dune Forest elements, should dominate this zone.		
Molluscs	Same condition but with no *Tarebia*.	5	Miranda (2012)
Crustacea	Before habitat alteration by *Myriophyllum* - no info available of this condition,	3	
Fish	Part of an oligo-mesotrophic, endorheic lake with seasonally connected swamps and shallow pans. Large, deep basin with naturally fluctuating water level. Good water quality characterised by well oxygenated, clear waters with naturally elevated chloride and calcium concentrations. At high levels large areas of shallow shelf areas are used and fish gain access to flooded marginal habitats and allocthonous carbon inputs. Shallow areas become increasingly wave washed with decreasing water level and during drought are poor fish habitat because aquatic vegetation has died back and been impacted by waves, summer day time water temperatures are too high for adults of several species, and detritus and microphytobenthic beds (diatoms) are churned up.	H	Allanson BR (1979).
Herpetofauna	There were more crocodiles than present.	5	EKZNW census data
Birds*	The avifauna was dominated by Reed & Whitebreasted Cormorants. Other common species included three species of kingfishers, African Fish Eagles (7prs), several large herons, African Darter and Greyheaded Gull. The area was an important breeding area for Whitefronted Plover, and supported few other waders. The sheltered bays had a distinctive fauna characterised by African Jacana, Black	3	Bruton (1979)

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
	Crake, African Purple Gallinule and Common Moorhen; Little Grebe (=Dabchick) was the most common species found in open water areas.		
Semi-aquatic mammals	More hippopotami were found.	5	EKZNW census data

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.1.4 Baseline ecological condition

This section summarises the outcome of the discipline specific Ecoclassification assessments that are provided in Volume 3: Specialist reports.

3.1.4.1 Causes and sources

Causes and sources for the Present Ecological State are summarised in Table 3.5.

Table 3.5 Causes and sources of PES at EWR MB

COMPONENT	CAUSES	SOURCES	FLOW OR NON-FLOW RELATED	CONFIDENCE
Water quality	Assuming limited DDT contamination.	Spraying of DDT for malaria.	Non-flow	2
Vegetation	Altered species composition in the aquatic zone.	Prevalence of *M. spicatum* in aquatic zone.	Non-flow	5
	Reduced cover and abundance of emergent macrophytes.	Receding lake levels combined with exposure to prevailing winds.	Flow	5
	Altered species composition in the shoreline vegetation.	Encroachment of zone by woody species (*A. karoo* and *S. cordatum*).	Flow	5
Molluscs	Invasion of an alien species *(Tarebia).*		Non-flow	5
Crustacea	Habitat altered by the invasion of an alien species *(Myriophyllum).*		Non-flow	3
Fish	Lake water level reductions.	Surface water and groundwater abstraction.	Flow	5
Herpetofauna	Severe poaching (of crocodiles and nests) has decimated numbers.		Non-flow	5
Birds*	Water level, emergent vegetation, shallow backwater areas, exposed shoreline etc	Various.	Largely flow related	4
Semi-aquatic mammals	Severe poaching of hippopotamuses has decimated numbers.		Non-flow	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.1.4.2 Trends

Trends in the Present Ecological Status for all components of EWR MB are summarised below in Table 3.6.

Table 3.6 Trends in PES for EWR MB

COMPONENT	ABSENT/POSITIVE/NEGATIVE	CONFIDENCE
Water quality	Absent.	2
Vegetation	Stable for alien species; negative for receding lake levels.	4
Molluscs	Negative - the *Tarebia* are still having and increasing impact.	3
Crustacea	Absent - system has now stabilised since the introduction of *Myriophyllum* (>50 years ago) which altered habitat.	3
Fish	Negative.	5
Herpetofauna	Negative - Crocodile numbers declining rapidly.	5
Birds*	Negative for Cormorants, darters, kingsfishers and birds of prey which have decreased; positive for other species as they have increased with recent drying.	4
Semi-aquatic mammals	Negative - Hippo numbers still declining rapidly.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.1.5 Ecostatus

The Present Ecological Status and the Recommended Ecological Category of each component at EWR MB is summarised below in Table 3.7.

Table 3.7 Present Ecological Status of all components at EWR MB

COMPONENT	% EC	EC	REC	OF SIGNIFICANCE/REASON FOR REC
Water quality	97	A	A	Water quality resetting mechanisms (e.g. flushing) in lakes are very weak, thus maintain high WQ.
Vegetation	70.7	C	B	The EIS of the area is HIGH and within a protected area, so the system should be managed towards a B.
Molluscs	70	C	C	*Tarebia* cannot be controlled.
Crustacea	85	B	B	*Myriophyllum* stable.
Fish	85	B	A	Prolonged WL drop has reduced habitat for key elements of the fish assemblage. This habitat loss in most pronounced in the Main Basin. These species remaining in the system and will recover should WL recover. The lake borders a World Heritage Site and is unique in the fish fauna assemblage it supports. This includes relict estuarine species, species of conservation significance, and species which are rare and threatened in KZN and SA.
Herpetofauna	65	C	A	Poaching can be stopped.
Semi-aquatic mammals	65	C	A	Poaching can be stopped.
Birds*	80	B	A	Protected area; unique habitat; refuge function.

* Birds were assessed for the overall Lake and not individual Basins/ Arms

In order to calculate PES the scores for Molluscs/ Crustacea and also Semi-aquatic mammals/ herpetofauna were first combined before averaging the scores across the disciplines (Table 3.8).

Table 3.8 Overall Present Ecological Status for EWR MB

COMPONENT	INDIVIDUAL SCORE	OVERALL SCORE	OVERALL PES
Water quality	97	79.04	B/C
Vegetation	70.7		
Molluscs/Crustacea	77.5		
Fish	85		
Herpetofauna/Semi-aquatic mammals	65		
Birds*	80		

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.2 EWR Zone – Northern Arm (NA)

Figure 3.2 shows the location of the Northern Arm in relation to Lake Sibaya and photographs of some of the areas that were sampled for the study.

Downstream view of the Northern Arm

Upstream view of the Northern Arm

Figure 3.2 Northern Arm

3.2.1 Data availability

The data available at EWR NA are summarised in Table 3.9.

Table 3.9 Data available at EWR NA

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
Water quality	2010: Sediment accumulation (TC, TN, TP) & DDT.	Humphries and Benitez-Nelson, 2013; Humphries, 2013.	1
Vegetation	Site visit (14 July 2015); collection of species height / depth relative to WL and vegetation assessment.	This report.	5
Molluscs	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths. Complementing this is Appleton's work on snails and Miranda's work on *Tarebia*.	Hart (1979 & 80); Appleton (1977 & 1980); Miranda (2012 & 2014).	4
Crustacea	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths.	Hart (1979 & 80).	4

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
Fish	Good information on biology of selected species in Lake Sibaya. No site specific data. No quantitative data on abundances.	Bowen SH (1976). Bowen SH (1978). Bruton MN (1979). Bruton MN (1979). Bruton MN (1980).. Bruton MN and Allanson BR (1974).	3
Herpetofauna	Count data and nest censuses from EKZNW, and Combrink et al. (2011) which provide census data and the decline of crocodiles in Lake Sibaya	EKZNW census files; Combrink et al. 2011	5
Birds*	Counts of top 15 species for 1970 and 1976 (Bruton 1979); Bird checklist by Cyrus et al. (1980); Brief description by Bruton (1980); Phil Hockey count Dec 1981 (Ryan et al. 1988); Summer and winter CWAC counts 1992-2014; Field notes (R Taylor) Jul 2015.	See report	5
Semi-aquatic mammals	Count data and life history parameters from EKZNW, and Taylor (2013) which provide census data and the decline of hippopotamuses in Lake Sibaya	EKZNW; Taylor 2013	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.2.2 Ecological importance and sensitivity

The EIS of EWR NA, with motivations, is provided in Table 3.10.

Table 3.10 EIS of EWR NA

DETERMINANTS	SCORE	REASONING	CONFIDENCE
BIOTA	(0-4)		
Rare & endangered (range: 4=very high - 0 = none)	3.75	*Wolffellia denticulata* listed as VU D2 (http://redlist.sanbi.org/species.php?species=3873-1); last recorded at Sibaya 1973 by A.A. Mauve (http://sibis.sanbi.org/faces/SearchSpecimen/SpecimenDetails.jsp?1=1); not recorded at site but is possibly present. *Silhouettea sibayi* is listed as Endangered on the IUCN Red List of Threatened Species. Many other species are IUCN listed, albeit in the "Least Concern" category. Hippo and crocodiles are red data species. Presence of 7 bird species that are on the regional red data list (2014), though none in very large numbers except occasionally.	4.33
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.00	*Cyperus natalensis* restricted to area; falls within Maputaland Centre of plant endemism (Van Wyk & Smith, 2001) but mostly applicable to species not associated with the Lake; isolated distribution of swamp forest associated with western arm. Several species are endemic to southern Africa. *Aplocheilichthys myaposae* occurs in KZN only, so is highly localised. This lake is also unique in its fish assemblage having relict remnants of an estuarine assemblage, despite being isolated from the sea since	4.33

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		the Pleistocene. Estuarine relic molluscs, crustacea and herpetofauna. No, though several bird species at the edge of range in SA.	
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.50	Aquatic and emergent macrophytes highly dependent on lake level High water levels and connectivity with adjacent swamps, pans and wetlands are needed for several species of fishes. This includes facultative use by two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*). Climbing perch (*Ctenopoma multispine*) have a more obligative need for reaching these peripheral habitats for breeding. Shallow, gentle sloping shelves are needed for several other species as well, including those that are numerically dominant. These habitats (and therefore these fauna) are sensitive to lake water level fluctuations. Most of the herpetofauna, crustacea, molluscs and mammal species are 'generalists'. Several species have relatively narrow habitat requirements.	3.33
Species/taxon richness (range: 4=very high - 1=low/marginal)	3.00	Falls within the Maputaland-Pondoland region of plant endemism with app. 7000 taxa (Van Wyk & Smith, 2001). Species richness of KZN freshwater fishes is naturally low (south of the Pongola). This lake has elevated species richness because of the relict estuarine component in its fish fauna. There is a tropical richness, but reduced a bit by the isolation causing an 'island' effect.	4.00
HABITATS	(0-4)		
Diversity of types (4=Very high - 1=marginal/low)	3.00	Aquatic, littoral, pan adjacent and off-lake wetland, open sandy beach areas, protected coves, stream inflow areas, coastal dune, swamp forest. This is one of very few coastal lakes in the country. It is the only system that has lost its estuarine connection, but which retains a relict estuarine fauna. The high diversity of submerged, emergent and floating plants, together with connect pans, swamps and wetlands, provides a very high diversity of freshwater habitats not found anywhere else at one locality. High diversity of habitats, reduced by the even morphology of the basin, few rocks and consistent sized sand grains.	4.00
Refugia (4=Very high - 1=marginal/low)	2.75	Refugia for smaller similar systems during extended drought. This is one of the few (and possibly only) permanent deep freshwater bodies on the Maputaland flats. It becomes a refuge during drought and centre of distribution for fishes that inhabit pans, swamps and wetlands on the wider coastal plain. The embayments are very important to the mammals, herpetofauna, crustacea and molluscs.	4.00
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.75	Large ground water dependant system more resilient to change. The main habitat types, gentle banks and shallow water with submerged vegetation, are susceptible to lake water level drop. Because of the systems morphology these habitats are lost very rapidly below critical water levels. Affected by water level changes	3.67
Sensitivity to flow related water quality changes	2.40	Large ground water dependant system more resilient to change. At very low levels saltwater intrusion might occur, which will result in the loss of (vegetated)	3.75

DETERMINANTS	SCORE	REASONING	CONFIDENCE
(4=Very high - 1=marginal/low)		habitat as well as primary freshwater elements of the fish assemblage. Most species would be affected. Lake water levels would need to drop below sea level for this to occur. At levels above this water quality should remain suitable for all fishes in the lake. Flow translates into Water level in these lakes. WQ parameter influenced by lake level is EC The dystrophic water is easily enriched with nutrients.	
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	2.00	Occurs within a string of such systems along the coastline but not likely to be important for plant species migration. The lake itself is not used as a migration route, but high water levels do facilitate migration to adjacent swamps, pans and wetlands for several species of fishes. Lake arms and smaller basins have greater proximity to a higher area of such peripheral wetlands and are therefore more important than the Main Basin in this regard. These include two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*) as well as climbing perch (*Ctenopoma multispine*). This is an endorheic system - but hippopotami, crocodiles and birds do move between waterbodies.	3.33
Importance of conservation & natural areas (range, 4=very high - 0=very low)	4.00	Within iSimangaliso and largest freshwater lake in southern Africa, RAMSAR site. This is a unique lake in that its biota retains a relict fauna of a geological past. It remains in good condition and its catchment can still be managed to protect its ecological integrity as a relatively pristine freshwater lake adjacent to a World Natural heritage site. This is a Ramsar and World Heritage Site - the highest conservation rating that can be given.	4.33
MEDIAN OF DETERMINANTS	3		
EISC	HIGH		

3.2.3 Reference conditions

The expected reference condition at EWR NA is described in Table 3.11.

Table 3.11 Reference condition at EWR NA

Component	Reference condition	Confidence	References
Water quality	DO, Turbidity and Conductivity as Present. DIN ~0.07 mg/l (deeper waters) and 0.1 mg/l (shallower waters, reflecting some input from peripheral vegetation under natural); DIP ~0.02 mg/l.	2	Expert judgement based on available data; De Villiers & Thiart, 2007.
Vegetation	The aquatic zone is expected to be well developed, in keeping with lacustrine environments, with species distribution varying according to water clarity (which affects light penetration) and the degree of wind and wave disturbance. In shallow, more secluded areas Water Lilies (*Nymphaea nouchali var. caerulea*) and Broad-leaved	4	Mucina & Rutherford, 2006; Allanson, 1979; Ricky Taylor, per com.

Component	Reference condition	Confidence	References
	Pondweed (*Potamogeton schweinfurthii*) are expected to be highly abundant, with Water Hornwort (*Ceratophyllum demersum var. demersum*) in quiet deeper waters. In more exposed areas where wind and wave action is more frequent and vigorous, the aquatic zone is more likely to be dominated by Fennel-leaved Pondweed (*Stuckenia pectinatus*) and Saw Weed (*Najas marina subsp. armata*). Spiked Water-milfoil (*Myriophyllum spicatum*), native to Europe, Asia and North Africa, is expected to be absent. Emergent macrophytes in the littoral zone are expected to be well developed in most areas not exposed to prevailing winds. Along most shores the dominant plant form is likely to be sedges and reeds, (notably *Schoenoplectus scirpoides, Phragmites australis* and *Eleocharis acutangula*) which should variously span the transition area from shoreline to the aquatic environment, growing well into the water and mixing with aquatic zone species. In sheltered areas, species more sensitive to wind and wave action (including *Typha capensis, Cyperus papyrus, C. prolifer, Ludwigia octovalvis* and *Hydrocotyle bonariensis*) should be abundant with 100% (or near 100%) aerial coverage. Alien and woody species would be absent from this zone. Shoreline macrophytes are those species that occur between the emergent macrophytes and the tree line and along open exposed beach areas where those occur. This zone should be dominated by a mixture of grasses and sedges (notably *C. natalensis, Juncus oxycarpus, Dactyloctenium geminatum* and *Imperata cylindrica*) and should be free of alien or woody species. The tree line is where woody vegetation starts and should characteristically be in keeping with the surrounding vegetation type. This is mostly Maputaland Coastal Belt (with some distict patches of Northern Coastal Forest). The beginning of this zone should remain clearly defined and usually indicates a level beyond which inudation is rare. Some encroachment of the shoreline zone by woody species is natural but should be transient and reduced by lake level fluctuations. High woody aerial cover, notably S. cordatum, should dominate this zone.		
Molluscs	Same condition with no *Tarebia*.	5	Miranda (2012)
Crustacea	Before habitat alteration by *Myriophyllum* - no info available of this condition.	3	
Fish	Part of an oligo-mesotrophic, endorheic lake with seasonally connected swamps and shallow pans. Large, deep basin with naturally fluctuating water level. Good water	H	Allanson BR (1979).

Component	Reference condition	Confidence	References
	quality characterised by well oxygenated, clear waters with naturally elevated chloride and calcium concentrations. At high levels large areas of shallow shelf areas are used and fish gain access to flooded marginal habitats and allocthonous carbon inputs. Shallow areas become increasingly wave washed with decreasing water level and during drought are poor fish habitat because aquatic vegetation has died back and been impacted by waves, summer day time water temperatures are too high for adults of several species, and detritus and microphytobenthic beds (diatoms) are churned up.		
Herpetofauna	There were more crocodiles present.	5	EKZNW census data
Birds*	The avifauna was dominated by Reed & Whitebreasted Cormorants. Other common species included three species of kingfishers, African Fish Eagles (7prs), several large herons, African Darter and Greyheaded Gull. The area was an important breeding area for Whitefronted Plover, and supported few other waders. ;The sheltered bays had a distinctive fauna characterised by African Jacana, Black Crake, African Purple Gallinule and Common Moorhen ; Little Grebe (=Dabchick) was the most common species found in open water areas.	3	Bruton (1979)
Semi-aquatic mammals	There were many more hippopotami present.	5	EKZNW census data

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.2.4 Baseline ecological condition

This section summarises the outcome of the discipline specific Ecoclassification assessments, which are provided in Volume 3: specialist reports.

3.2.4.1 Causes and sources

Causes and sources for the Present Ecological State at EWR NA are summarised in Table 3.12.

Table 3.12 Causes and sources of PES at EWR NA

COMPONENT	CAUSES	SOURCES	FLOW OR NON-FLOW RELATED	CONFIDENCE
Water quality	DDT contamination in muddy extremities.	Spraying of DDT for malaria.	Non-flow	2
Vegetation	Altered species composition in the aquatic zone.	Dominance of aquatic zone by M. spicatum.	Non-flow	5

COMPONENT	CAUSES	SOURCES	FLOW OR NON-FLOW RELATED	CONFIDENCE
	Altered species composition in the shoreline vegetation.	Encroachment of zone by woody species (*S. cordatum*).	Flow	5
	Reduced non-woody cover in shoreline vegetation.	Grazing and trampling pressure of livestock coupled with increasing water stress due to receding lake levels.	Both	3
Molluscs	Invasion of an alien species *(Tarebia).*		Non-flow	5
Crustacea	Habitat altered by the invasion of an alien species *(Myriophyllum).*		Non-flow	3
Fish	Lake water level reductions.	Surface water and groundwater abstraction.	Flow	5
Herpetofauna	Severe poaching (of crocodiles and nests) has decimated numbers.		Non-flow	5
Birds*	Water level, emergent vegetation, shallow backwater areas, exposed shoreline etc.	Various.	Largely flow related	4
Semi-aquatic mammals	Severe poaching of hippopotami has decimated numbers.		Non-flow	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.2.4.2 Trends

Trends in the Present Ecological Status for all components of EWR NA are summarised below in Table 3.13.

Table 3.13 Trends in PES for EWR NA

COMPONENT	ABSENT/POSITIVE/NEGATIVE	CONFIDENCE
Water quality	Absent/Negative.	2
Vegetation	Stable for alien species; negative for receding lake levels.	4
Molluscs	Negative - the *Tarebia* are having an increasing impact.	3
Crustacea	Absent - system has now stabilised since the introduction of *Myriophyllum* (>50 years ago) that altered habitat.	3
Fish	Negative.	5
Herpetofauna	Negative - Crocodile numbers declining rapidly.	5
Birds*	Negative for Cormorants, darters, king fishers and birds of prey which have decreased; positive for other species as they have increased with recent drying.	4
Semi-aquatic mammals	Negative - Hippopotamus numbers declining rapidly.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.2.5 Ecostatus

The Present Ecological Status and the Recommended Ecological Category of each component at EWR NA is summarised below in Table 3.14.

Table 3.14 Present Ecological Status of all components at EWR NA

COMPONENT	% EC	EC	REC	OF SIGNIFICANCE/REASON FOR REC
Water quality	94	A	A	Water quality resetting mechanisms (e.g. flushing) in lakes are very weak, thus maintain high WQ.
Vegetation	80.2	B/C	B	The EIS of the area is HIGH so the system should be managed towards a B.
Molluscs	70	C	C	*Tarebia* cannot be controlled.
Crustacea	85	B	B	*Myriophyllum* stable.
Fish	90	A	A	Prolonged WL drop has reduced habitat for key elements of the fish assemblage. This habitat loss in less pronounced in the Northern Arm compared to the lake's basins. Of importance in the Northern Arm is its connectivity to swamps and wetlands which are important as breeding areas which climbing perch migrate to during the wet season. Fish species remaining in the system and will recover should WL recover. The lake is borders a World Heritage Site amd is unique in the fish fauna assemblage it supports. This includes relict estuarine species, species of conservation significance, and species which are rare and threatened in KZN and SA.
Herpetofauna	65	C	A	Poaching can be stopped.
Birds*	80	B	A	Protected area; unique habitat; refuge function.
Semi-aquatic mammals	65	C	A	Poaching can be stopped.

* Birds were assessed for the overall Lake and not individual Basins/ Arms

In order to calculate PES the scores for Molluscs/ Crustacea and also Semi-aquatic mammals/ herpetofauna were first combined before averaging the scores across the disciplines (Table 3.8).

Table 3.15 Overall Present Ecological Status for EWR NA

COMPONENT	INDIVIDUAL SCORE	OVERALL SCORE	OVERALL PES
Water quality	94	81.34	B/C
Vegetation	80.2		
Molluscs/Crustacea	77.5		
Fish	90		
Herpetofauna/Semi-aquatic mammals	65		
Birds*	80		

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.3 EWR Zone – Western Arm (WA)

Figure 3.3 shows the location of the Western Arm in relation to Lake Sibaya. The photographs indicate the exposure of rich organic material that has become exposed as a result of receding water levels.

Low water levels exposing organic deposits

Figure 3.3 Western Arm

3.3.1 Data availability

The data available at EWR WA are summarised in Table 3.16.

Table 3.16 Data available at EWR WA

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
Water quality	2010: Sediment accumulation (TC, TN, TP) & DDT; Jul 2015: EC, cations/anions, pH, Turbidity, DO, DIN, DIP.	Humphries and Benitez-Nelson, 2013; Humphries, 2013; This study.	2
Vegetation	Site visit (15 July 2015); collection of species height / depth relative to WL and vegetation assessment.	This report	5
Molluscs	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths. Complementing this is Appleton's work on snails and Miranda's work on *Terebia*.	Hart (1979 & 80); Appleton (1977 & 1980); Miranda (2012 & 2014)	4
Crustacea	Detailed studies by Boltt and	Hart (1979 & 80)	4

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
	other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths.		
Fish	Good information on biologies of selected species in Lake Sibaya. No site specific data. No quantitative data on abundances.	Bowen SH (1976). Bowen SH (1978). Bruton MN (1979). Bruton MN (1979). Bruton MN (1980). Bruton MN and Allanson BR (1974).	3
Herpetofauna	Count data and nest censuses from EKZNW, and Combrink et al. (2011) which provide census data and the decline of crocodiles in Lake Sibaya.	EKZNW census files; Combrink et al. 2011.	5
Birds*	Counts of top 15 species for 1970 and 1976 (Bruton 1979); Bird checklist by Cyrus et al. (1980); Brief description by Bruton (1980); Phil Hockey count Dec 1981 (Ryan et al. 1988); Summer and winter CWAC counts 1992-2014; Field notes (R Taylor) Jul 2015.	See report.	5
Semi-aquatic mammals	Count data and life history parameters from EKZNW, and Taylor (2013) which provide census data and the decline of hippopotami in Lake Sibaya	EKZNW; Taylor 2013.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.3.2 Ecological importance and sensitivity

The EIS of EWR WA, with motivations, is provided in Table 3.17.

Table 3.17 EIS of EWR WA

DETERMINANTS	SCORE	REASONING	CONFIDENCE
BIOTA	(0-4)		
Rare & endangered (range: 4=very high - 0 = none)	3.75	*Wolffellia denticulata* listed as VU D2 (http://redlist.sanbi.org/species.php?species=3873-1); last recorded at Sibaya 1973 by A.A. Mauve (http://sibis.sanbi.org/faces/SearchSpecimen/SpecimenDetails.jsp?1=1); not recorded at site but is possibly present. *Silhouettea sibayi* is listed as Endangered on the IUCN Red List of Threatened Species. Many other species are IUCN listed, albeit in the "Least Concern" category. Hippopotami and crocodiles are red data species. Presence of 7 bird species that are on the regional red data list (2014), though none in very large numbers except occasionally.	4.33

DETERMINANTS	SCORE	REASONING	CONFIDENCE
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.00	*Cyperus natalensis* restricted to area; falls within Maputaland Centre of plant endemism (Van Wyk & Smith, 2001) but mostly applicable to species not associated with the Lake; isolated distribution of swamp forest associated with western arm. Several species are endemic to southern Africa. *Aplocheilichthys myaposae* occurs in KZN only, so is highly localised. This lake is also unique in its fish assemblage having relict remnants of an estuarine assemblage, despite being isolated from the sea since the Pleistocene. Estuarine relic molluscs, crustacea and herptofauna. No, though several bird species at the edge of range in SA.	4.33
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.50	Aquatic and emergent macrophytes highly dependent on lake level High water levels and connectivity with adjacent swamps, pans and wetlands are needed for several species of fishes. This includes facultative use by two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*). Climbing perch (*Ctenopoma multispine*) have a more obligative need for reaching these peripheral habitats for breeding. Shallow, gentle sloping shelves are needed for several other species as well, including those that are numerically dominant. These habitats (and therefore these fauna) are sensitive to lake water level fluctuations. Most of the herpetofauna, crustacea, molluscs and mammal species are 'generalists'. Several species have relatively narrow habitat requirements.	3.33
Species/taxon richness (range: 4=very high - 1=low/marginal)	3.00	Falls within the Maputaland-Pondoland region of plant endemism with app. 7000 taxa (Van Wyk & Smith, 2001). Species richness of KZN freshwater fishes is naturally low (south of the Pongola). This lake has elevated species richness because of the relict estuarine component in its fish fauna. There is a tropical richness, but reduced a bit by the isolation causing an 'island' effect.	4.00
HABITATS	(0-4)		
Diversity of types (4=Very high - 1=marginal/low)	3.00	Aquatic, littoral, pan adjacent and off-lake wetland, open sandy beach areas, protected coves, stream inflow areas, coastal dune, swamp forest This is one of very few coastal lakes in the country. It is the only system that has lost its estuarine connection, but which retains a relict estuarine fauna. The high diversity of submerged, emergent and floating plants, together with connect pans, swamps and wetlands, provides a very high diversity of freshwater habitats not found anywhere else at one locality. High diversity of habitats, reduced by the even morphology of the basin, few rocks and consistent sized sand grains.	4.00
Refugia (4=Very high - 1=marginal/low)	2.75	Refugia for smaller similar systems during extended drought. This is one of the few (and possibly only) permanent deep freshwater bodies on the Maputaland flats. It becomes a refuge during drought and centre of distribution for fishes that inhabit pans, swamps and wetlands on the wider coastal plain. The embayments are very important to the	4.00

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		mammals, herpetofauna, crustacea and molluscs.	
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.75	Large ground water dependant system more resilient to change. The main habitat types, gentle banks and shallow water with submerged vegetation, are susceptible to lake water level drop. Because of the systems morphology these habitats are lost very rapidly below critical water levels. Affected by water level changes.	3.67
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.20	Large ground water dependant system more resilient to change. At very low levels saltwater intrusion might occur, which will result in the loss of (vegetated) habitat as well as primary freshwater elements of the fish assemblage. Most species would be affected. Lake water levels would need to drop below sea level for this to occur. At levels above this water quality should remain suitable for all fishes in the lake. Flow translates into Water level in these lakes. WQ parameter influenced by lake level is EC The dystrophic water is easily enriched with nutrients. Especially the case for Mseleni enrichment.	3.75
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	2.00	Occurs within a string of such systems along the coastline but not likely to be important for plant species migration. The lake itself is not used as a migration route, but high water levels do facilitate migration to adjacent swamps, pans and wetlands for several species of fishes. Lake arms and smaller basins have greater proximity to a higher area of such peripheral wetlands and are therefore more important than the Main Basin in this regard. These include two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*) as well as climbing perch (*Ctenopoma multispine*). This is an endorheic system - but hippopotami, crocodiles and birds do move between waterbodies.	3.33
Importance of conservation & natural areas (range, 4=very high - 0=very low)	4.00	Within iSimangaliso and largest freshwater lake in southern Africa, a RAMSAR site. This is a unique lake in that its biota retains a relict fauna of a geological past. It remains in good condition and its catchment can still be managed to protect its ecological integrity as a relatively pristine freshwater lake adjacent to a World Natural heritage site. This is a Ramsar and World Heritage Site - the highest conservation rating that can be given.	4.33
MEDIAN OF DETERMINANTS	3		
EISC	HIGH		

3.3.3 Reference conditions

The expected reference condition at EWR WA is described in Table 3.18.

Table 3.18 Reference condition at EWR WA

Component	Reference condition	Confidence	References
Water quality	DO, Turbidity and Conductivity as Present. DIN ~0.07 mg/l (deeper waters) and 0.1 mg/l (shallower waters, reflecting some input from peripheral vegetation under natural); DIP ~0.02 mg/.	2	Expert judgement based on available data; De Villiers & Thiart, 2007.
Vegetation	The aquatic zone is expected to be well developed, in keeping with lacustrine environments, with species distribution varying according to water clarity (which affects light penetration) and the degree of wind and wave disturbance. In shallow, more secluded areas Water Lilies (*Nymphaea nouchali var. caerulea*) and Broad-leaved Pondweed (*Potamogeton schweinfurthii*) are expected to be highly abundant, with Water Hornwort (*Ceratophyllum demersum var. demersum*) in quiet deeper waters. In more exposed areas where wind and wave action is more frequent and vigorous, the aquatic zone is more likely to be dominated by Fennel-leaved Pondweed (*Stuckenia pectinatus*) and Saw Weed (*Najas marina subsp. armata*). Spiked Water-milfoil (*Myriophyllum spicatum*), native to Europe, Asia and North Africa, is expected to be absent. Emergent macrophytes in the littoral zone are expected to be well developed in most areas not exposed to prevailing winds. Along most shores the dominant plant form is likely to be sedges and reeds, (notably *Schoenoplectus scirpoides, Phragmites australis* and *Eleocharis acutangula*) which should variously span the transition area from shoreline to the aquatic environment, growing well into the water and mixing with aquatic zone species. In sheltered areas, species more sensitive to wind and wave action (including *Typha capensis, Cyperus papyrus, C. prolifer, Ludwigia octovalvis* and *Hydrocotyle bonariensis*) should be abundant with 100% (or near 100%) aerial coverage. Alien and woody species would be absent from this zone. Shoreline macrophytes are those species that occur between the emergent macrophytes and the tree line and along open exposed beach areas where those occur. This zone should be dominated by a mixture of grasses and sedges (notably *C. natalensis, Juncus oxycarpus, Dactyloctenium geminatum* and *Imperata cylindrica*) and should be free of alien or woody species. The tree line is where woody vegetation starts and should characteristically be in keeping with the surrounding vegetation type. This is mostly Maputaland Coastal Belt (with some distinct patches of Northern	4	Mucina & Rutherford, 2006; Allanson, 1979; Ricky Taylor, per com.

Component	Reference condition	Confidence	References
	Coastal Forest). The beginning of this zone should remain clearly defined and usually indicates a level beyond which inundation is rare. Some encroachment of the shoreline zone by woody species is natural but should be transient and reduced by lake level fluctuations. This zone should be dominated by high woody aerial cover, notably *S. cordatum.*		
Molluscs	Same condition with no *Tarebia*.	5	Miranda (2012)
Crustacea	Before habitat alteration by *Myriophyllum* - no information available of this condition.	3	
Fish	Part of an oligo-mesotrophic, endorheic lake with seasonally connected swamps and shallow pans. Large, deep basin with naturally fluctuating water level. Good water quality characterised by well oxygenated, clear waters with naturally elevated chloride and calcium concentrations. At high levels large areas of shallow shelf areas are used and fish gain access to flooded marginal habitats and allocthonous carbon inputs. Shallow areas become increasingly wave washed with decreasing water level and during drought are poor fish habitat because aquatic vegetation has died back and been impacted by waves, summer day time water temperatures are too high for adults of several species, and detritus and microphytobenthic beds (diatoms) are churned up.	H	Allanson BR (ed) (1979). Lake Sibaya. Monographiae Biologicae 36: 1-394. Dr W. Junk Publishers, The Hague
Herpetofauna	A greater abundance of crocodiles.	5	EKZNW census data
Birds*	The avifauna was dominated by Reed & Whitebreasted Cormorants. Other common species included three species of kingfishers, African Fish Eagles (7prs), several large herons, African Darter and Greyheaded Gull. The area was an important breeding area for Whitefronted Plover, and supported few other waders. The sheltered bays had a distinctive fauna characterised by African Jacana, Black Crake, African Purple Gallinule and Common Moorhen; Little Grebe (=Dabchick) was the most common species found in open water areas.	3	Bruton (1979)
Semi-aquatic mammals	A greater abundance of hippopotami.	5	EKZNW census data

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.3.4 Baseline ecological condition

This section summarises the outcome of the discipline specific Ecoclassification assessments, which are provided in Volume 3: specialist reports.

3.3.4.1 Causes and sources

Causes and sources for the Present Ecological State at EWR WA are summarised in Table 3.19.

Table 3.19 Causes and sources of PES at EWR WA

Component	Causes	Sources	Flow or non-flow related	Confidence
Water quality	DIN/DIP enrichment in shallow waters; DDT contamination in muddy extremities.	Increased rural/forestry development; Spraying of DDT for malaria.	Non-flow	2
Vegetation	Altered species composition in the aquatic zone.	Dominance of aquatic zone by M. spicatum	Non-flow	5
	Altered species composition in the shoreline vegetation.	Encroachment of zone by woody species (*S. cordatum*).	Flow	5
	Reduced non-woody cover in shoreline vegetation and woody vegetation beyond tree line.	Agricultural activities and human pressure.	Non-flow	3
Molluscs	Invasion of an alien species *(Tarebia).*		Non-flow	5
Crustacea	Habitat altered by the invasion of an alien species *(Myriophyllum).*		Non-flow	3
Fish	Lake water level reductions	Surface water and groundwater abstraction.	Flow	5
Herpetofauna	Severe poaching (of crocodiles and nests) has decimated numbers.		Non-flow	5
Birds*	Water level, emergent vegetation, shallow backwater areas, exposed shoreline, etc.	Various.	Largely flow related	4
Semi-aquatic mammals	Severe poaching of hippopotamuses has decimated numbers.		Non-flow	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.3.4.2 Trends

Trends in the Present Ecological Status for all components of EWR WA are summarised below in Table 3.20.

Table 3.20 Trends in PES for EWR WA

COMPONENT	ABSENT/POSITIVE/NEGATIVE	CONFIDENCE
Water quality	Negative	2
Vegetation	Stable for alien species; negative for receding lake levels	4
Molluscs	Negative - the *Tarebia* are having and increasing impact.	3
Crustacea	Absent - system has now stabilised since the introduction of *Myriophyllum* (>50 years ago) which altered habitat.	3
Fish	Negative.	5
Herpetofauna	Negative - Crocodile numbers declining rapidly.	5
Birds*	Negative for Cormorants, darters, kingfishers and birds of prey which have decreased; Positive for other species as they have increased with recent drying.	4
Semi-aquatic mammals	Negative - Hippo numbers still declining rapidly.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.3.5 Ecostatus

The Present Ecological Status and the Recommended Ecological Category of each component at EWR WA is summarised below in Table 3.21.

Table 3.21 Present Ecological Status of all components at EWR WA

COMPONENT	% EC	EC	REC	OF SIGNIFICANCE/REASON FOR REC
Water quality	94	A	A	Water quality resetting mechanisms (e.g. flushing) in lakes are very weak, thus maintain high WQ.
Vegetation	77.2	C	B	The EIS of the area is HIGH so the system should be managed towards a B.
Molluscs	70	C	C	*Tarebia* cannot be controlled.
Crustacea	85	B	B	*Myriophyllum* stable.
Fish	95	A	A	Prolonged WL drop has reduced habitat for key elements of the fish assemblage. This habitat loss in less pronounced in the Western Arm compared to the lake's basins. Of importance in the Northern Arm is its connectivity to swamps and wetlands which are important as breeding areas which climbing perch migrate to during the wet season. Fish species remain in the system and will recover should WL recover. The lake is borders a World Heritage Site and is unique in the fish fauna assemblage it supports. This includes relict estuarine species, species of conservation significance, and species which are rare and threatened in KZN and SA.
Herpetofauna	65	C	A	Poaching can be stopped.
Birds*	80	B	A	Protected area; unique habitat; refuge function.
Semi-aquatic mammals	65	C	A	Poaching can be stopped.

* Birds were assessed for the overall Lake and not individual Basins/ Arms

In order to calculate PES the scores for Molluscs/ Crustacea and also Semi-aquatic mammals/ herpetofauna were first combined before averaging the scores across the disciplines (Table 3.22).

Table 3.22 Overall Present Ecological Status for EWR WA

COMPONENT	INDIVIDUAL SCORE	OVERALL SCORE	OVERALL PES
Water quality	94	81.74	B/C
Vegetation	77.2		
Molluscs/Crustacea	77.5		
Fish	95		
Herpetofauna/Semi-aquatic mammals	65		
Birds*	80		

3.4 EWR Zone - SWB

Figure 3.4 shows the location of the Southwestern Arm in relation to Lake Sibaya. The photographs indicate the exposure of rich organic material that has become exposed as a result of receding water levels.

Figure 3.4 South Western basin

3.4.1 Data availability

The data available at EWR SWB are summarised in Table 3.23.

Table 3.23 Data available at EWR SWB

Component	Data availability	References	Confidence
Water quality	Jul 2015: EC, cations/anions, pH, Turbidity, DO, DIN, DIP.	This study.	1
Vegetation	Site visit (15 July 2015); collection of species height / depth relative to WL and vegetation assessment.	This report.	5
Molluscs	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths. Complementing this is Appleton's work on snails and Miranda's work on *Terebia.*	Hart (1979 & 80); Appleton (1977 & 1980); Miranda (2012 & 2014).	4
Crustacea	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths.	Hart (1979 & 80).	4
Fish	Good information on biologies of	Bowen SH (1976).	3

Component	Data availability	References	Confidence
	selected species in Lake Sibaya. No site specific data. No quantitative data on abundances.	Bowen SH (1978). Bruton MN (1979). Bruton MN (1979). Bruton MN (1980). Bruton MN and Allanson BR (1974).	
Herpetofauna	Count data and nest censuses from EKZNW, and Combrink et al. (2011) which provide census data and the decline of crocodiles in Lake Sibaya.	EKZNW census files; Combrink et al. 2011.	5
Birds*	Counts of top 15 species for 1970 and 1976 (Bruton 1979); Bird checklist by Cyrus et al. (1980); Brief description by Bruton (1980); Phil Hockey count Dec 1981 (Ryan et al. 1988); Summer and winter CWAC counts 1992-2014; Field notes (R Taylor) Jul 2015.	See report.	5
Semi-aquatic mammals	Count data and life history parameters from EKZNW, and Taylor (2013) which provide census data and the decline of hippopotami in Lake Sibaya.	EKZNW; Taylor 2013.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.4.2 Ecological importance and sensitivity

The EIS of EWR SWB, with motivations, is provided in Table 3.24.

Table 3.24 EIS of EWR SWB

DETERMINANTS	SCORE	REASONING	CONFIDENCE
BIOTA	(0-4)		
Rare & endangered (range: 4=very high - 0 = none)	3.75	*Wolffellia denticulata* listed as VU D2 (http://redlist.sanbi.org/species.php?species=3873-1); last recorded at Sibaya 1973 by A.A. Mauve (http://sibis.sanbi.org/faces/SearchSpecimen/SpecimenDetails.jsp?1=1); not recorded at site but is possibly present. *Silhouettea sibayi* is listed as Endangered on the IUCN Red List of Threatened Species. Many other species are IUCN listed, albeit in the "Least Concern" category. Hippo and crocodiles are red data species. Presence of 7 bird species that are on the regional red data list (2014), though none in very large numbers except occasionally.	4.33
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.00	*Cyperus natalensis* restricted to area; falls within Maputaland Centre of plant endemism (Van Wyk & Smith, 2001) but mostly applicable to species not associated with the Lake; isolated distribution of swamp forest associated with western arm. Several species are endemic to southern Africa. *Aplocheilichthys myaposae* occurs in KZN only, so is highly localised. This lake is also unique in its fish assemblage having relict remnants of an estuarine assemblage, despite being isolated from the sea	4.33

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		since the Pleistocene. Estuarine relic molluscs, crustacea and herptofauna. No, though several bird species at the edge of range in SA.	
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.50	Aquatic and emergent macrophytes highly dependent on lake level. High water levels and connectivity with adjacent swamps, pans and wetlands are needed for several species of fishes. This includes facultative use by two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*). Climbing perch (*Ctenopoma multispine*) have a more obligative need for reaching these peripheral habitats for breeding. Shallow, gentle sloping shelves are needed for several other species as well, including those that are numerically dominant. These habitats (and therefore these fauna) are sensitive to lake water level fluctuations. Most of the herpetofauna, crustacea, molluscs and mammal species are 'generalists'. Several species have relatively narrow habitat requirements.	3.33
Species/taxon richness (range: 4=very high - 1=low/marginal)	3.00	Falls within the Maputaland-Pondoland region of plant endemism with app. 7000 taxa (Van Wyk & Smith, 2001). Species richness of KZN freshwater fishes is naturally low (south of the Pongola). This lake has elevated species richness because of the relict estuarine component in its fish fauna. There is a tropical richness, but reduced a bit by the isolation causing an 'island' effect.	4.00
HABITATS	(0-4)		
Diversity of types (4=Very high - 1=marginal/low)	3.00	Aquatic, littoral, pan adjacent and off-lake wetland, open sandy beach areas, protected coves, stream inflow areas, coastal dune, swamp forest. This is one of very few coastal lakes in the country. It is the only system that has lost its estuarine connection, but which retains a relict estuarine fauna. The high diversity of submerged, emergent and floating plants, together with connect pans, swamps and wetlands, provides a very high diversity of freshwater habitats not found anywhere else at one locality. High diversity of habitats, reduced by the even morphology of the basin, few rocks and consistent sized sand grains.	4.00
Refugia (4=Very high - 1=marginal/low)	2.75	Refugia for smaller similar systems during extended drought. This is one of the few (and possibly only) permanent deep freshwater bodies on the Maputaland flats. It becomes a refuge during drought and centre of distribution for fishes that inhabit pans, swamps and wetlands on the wider coastal plain. The embayments are very important to the mammals, herpetofauna, crustacea and molluscs.	4.00
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.75	Large ground water dependant system more resilient to change. The main habitat types, gentle banks and shallow water with submerged vegetation, are susceptible to lake water level drop. Because of the systems morphology these habitats are lost very rapidly below critical water levels. Affected by water level changes.	3.67

DETERMINANTS	SCORE	REASONING	CONFIDENCE
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.40	Large ground water dependant system more resilient to change. At very low levels saltwater intrusion might occur, which will result in the loss of (vegetated) habitat as well as primary freshwater elements of the fish assemblage. Most species would be affected. Lake water levels would need to drop below sea level for this to occur. At levels above this water quality should remain suitable for all fishes in the lake. Flow translates into Water level in these lakes. WQ parameter influenced by lake level is EC. The dystrophic water is easily enriched with nutrients.	3.75
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	2.00	Occurs within a string of such systems along the coastline but not likely to be important for plant species migration. The lake itself is not used as a migration route, but high water levels do facilitate migration to adjacent swamps, pans and wetlands for several species of fishes. Lake arms and smaller basins have greater proximity to a higher area of such peripheral wetlands and are therefore more important than the Main Basin in this regard. These include two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*) as well as climbing perch (*Ctenopoma multispine*). This is an endorheic system - but hippopotami, crocodiles and birds do move between waterbodies.	3.33
Importance of conservation & natural areas (range, 4=very high - 0=very low)	4.00	Within iSmangaliso and largest freshwater lake in southern Africa, RAMSAR site. This is a unique lake in that its biota retains a relict fauna of a geological past. It remains in good condition and its catchment can still be managed to protect its ecological integrity as a relatively pristine freshwater lake adjacent to a World Natural heritage site. This is a Ramsar and World Heritage Site - the highest conservation rating that can be given.	4.33
MEDIAN OF DETERMINANTS	3		
EISC	HIGH		

3.4.3 Reference conditions

The expected reference condition at EWR SWB is described in Table 3.25.

Table 3.25 Reference condition at EWR SWB

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
Water quality	DO, Turbidity and Conductivity as Present. DIN ~0.07 mg/l (deeper waters) and 0.1 mg/l (shallower waters, reflecting some input from peripheral vegetation under natural); DIP ~0.02 mg/l.	2	Expert judgement based on available data; De Villiers & Thiart, 2007.
Vegetation	The aquatic zone is expected to be well developed, in keeping with lacustrine environments, with species distribution	4	Mucina & Rutherford, 2006; Allanson, 1979;

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
	varying according to water clarity (which affects light penetration) and the degree of wind and wave disturbance. In shallow, more secluded areas Water Lilies (*Nymphaea nouchali var. caerulea*) and Broad-leaved Pondweed (*Potamogeton schweinfurthii*) are expected to be highly abundant, with Water Hornwort (*Ceratophyllum demersum var. demersum*) in quiet deeper waters. In more exposed areas where wind and wave action is more frequent and vigorous, the aquatic zone is more likely to be dominated by Fennel-leaved Pondweed (*Stuckenia pectinatus*) and Saw Weed (*Najas marina subsp. armata*). Spiked Water-milfoil (*Myriophyllum spicatum*), native to Europe, Asia and North Africa, is expected to be absent. Emergent macrophytes in the littoral zone are expected to be well developed in most areas not exposed to prevailing winds. Along most shores the dominant plant form is likely to be sedges and reeds, (notably *Schoenoplectus scirpoides, Phragmites australis* and *Eleocharis acutangula*) which should variously span the transition area from shoreline to the aquatic environment, growing well into the water and mixing with aquatic zone species. In sheltered areas, species more sensitive to wind and wave action (including *Typha capensis, Cyperus papyrus, C. prolifer, Ludwigia octovalvis* and *Hydrocotyle bonariensis*) should be abundant with 100% (or near 100%) aerial coverage. Alien and woody species would be absent from this zone. Shoreline macrophytes are those species that occur between the emergent macrophytes and the tree line and along open exposed beach areas where those occur. This zone should be dominated by a mixture of grasses and sedges (notably *C. natalensis, Juncus oxycarpus, Dactyloctenium geminatum* and *Imperata cylindrica*) and should be free of alien or woody species. The tree line is where woody vegetation starts and should characteristically be in keeping with the surrounding vegetation type. This is mostly Maputaland Coastal Belt (with some distinct patches of Northern Coastal Forest). The beginning of this zone should remain clearly defined and usually indicates a level beyond which inundation is rare. Some encroachment of the shoreline zone by woody species is natural but should be transient and reduced by lake level fluctuations. High woody aerial cover, notably *S. cordatum*, should dominate this zone.		Ricky Taylor, per com.

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
Molluscs	Condition with no *Tarebia*.	5	Miranda (2012)
Crustacea	Before habitat alteration by *Myriophyllum* - no info available of this condition.	3	
Fish	Part of an oligo-mesotrophic, endorheic lake with seasonally connected swamps and shallow pans. Large, deep basin with naturally fluctuating water level. Good water quality characterised by well oxygenated, clear waters with naturally elevated chloride and calcium concentrations. At high levels large areas of shallow shelf areas are used and fish gain access to flooded marginal habitats and allocthonous carbon inputs. Shallow areas become increasingly wave washed with decreasing water level and during drought are poor fish habitat because aquatic vegetation has died back and been impacted by waves, summer day time water temperatures are too high for adults of several species, and detritus and microphytobenthic beds (diatoms) are churned up.	H	Allanson BR (1979).
Herpetofauna	There were more crocodiles present.	5	EKZNW census data
Birds*	Reed & Whitebreasted Cormorants dominated the avifauna. Other common species included three species of kingfishers, African Fish Eagles (7prs), several large herons, African Darter and Greyheaded Gull. The area was an important breeding area for Whitefronted Plover, and supported few other waders. The sheltered bays had a distinctive fauna characterised by African Jacana, Black Crake, African Purple Gallinule and Common Moorhen; Little Grebe (=Dabchick) was the most common species found in open water areas.	3	Bruton (1979)
Semi-aquatic mammals	More hippopotami were present.	5	EKZNW census data

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.4.4 Baseline ecological condition

This section summarises the outcome of the discipline specific Ecoclassification assessments, which are provided in Volume 3: specialist reports.

3.4.4.1 Causes and sources

Causes and sources for the Present Ecological State at EWR SWB are summarised in Table 3.26.

Table 3.26 Causes and sources of PES at EWR SWB

Component	Causes	Sources	Flow or non-flow related	Confidence
Water quality	DDT contamination in muddy extremities.	Spraying of DDT for malaria.	Non-flow	2
Vegetation	Altered species composition in the aquatic zone.	Dominance of aquatic zone by *M. spicatum*.	Non-flow	5
	Altered species composition in the shoreline vegetation.	Encroachment of zone by woody species (*S. cordatum*).	Flow	5
	Reduced non-woody cover in shoreline vegetation.	Likely thinning due to water stress from receding lake levels.	Flow	3
Molluscs	Invasion of an alien species *(Tarebia).*		Non-flow	5
Crustacea	Habitat altered by the invasion of an alien species *(Myriophyllum).*		Non-flow	3
Fish	Lake water level reductions.	Surface water and groundwater abstraction.	Flow	5
Herpetofauna	Severe poaching (of crocodiles and nests) has decimated numbers.		Non-flow	5
Birds*	Water level, emergent vegetation, shallow backwater areas, exposed shoreline etc.	Various	Largely flow related	4
Semi-aquatic mammals	Severe poaching of hippopotamuses has decimated numbers.		Non-flow	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.4.4.2 Trends

Trends in the Present Ecological Status for all components of EWR SWB are summarised below in Table 3.27.

Table 3.27 Trends in PES for EWR SWB

COMPONENT	ABSENT/POSITIVE/NEGATIVE	CONFIDENCE
Water quality	Absent/Negative.	2
Vegetation	Stable for alien species; negative for receding lake levels.	4
Molluscs	Negative - the *Tarebia* arestill having and increasing impact.	3
Crustacea	Absent - system has now stabilised since the introduction of *Myriophyllum* (>50 years ago) which altered habitat.	3
Fish	Negative.	5
Herpetofauna	Negative - Crocodile numbers declining rapidly.	5
Birds*	Negative for Cormorants, darters, kingfishers and birds of prey which have decreased; Positive for other species as they have increased with recent drying.	4
Semi-aquatic mammals	Negative - Hippo numbers still declining rapidly.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.4.5 Ecostatus

The Present Ecological Status and the Recommended Ecological Category of each component at EWR SWB is summarised below in Table 3.28.

Table 3.28 Present Ecological Status of all components at EWR SWB

COMPONENT	% EC	EC	REC	OF SIGNIFICANCE/REASON FOR REC
Water quality	94	A	A	Water quality resetting mechanisms (e.g. flushing) in lakes are very weak, thus maintain high WQ.
Vegetation	80,1	B/C	B	The EIS of the area is HIGH so the system should be managed towards a B.
Molluscs	70	C	C	*Tarebia* cannot be controlled.
Crustacea	85	B	B	*Myriophyllum* stable.
Fish	90	A	A	Prolonged WL drop has reduced habitat for key elements of the fish assemblage. This habitat loss in less pronounced in this basin compared to the lake's other basins. Of importance in the South West Basin is its connectivity to wetlands which are important as breeding areas which climbing perch migrate to during the wet season. Fish species remaining in the system and will recover should WL recover. The lake is borders a World Heritage Site and is unique in the fish fauna assemblage it supports. This includes relict estuarine species, species of conservation significance, and species which are rare and threatened in KZN and SA.
Herpetofauna	65	C	A	Poaching can be stopped.
Birds*	80	B	A	Protected area; unique habitat; refuge function.
Semi-aquatic mammals	65	C	A	Poaching can be stopped.

* Birds were assessed for the overall Lake and not individual Basins/ Arms

In order to calculate PES the scores for Molluscs/ Crustacea and also Semi-aquatic mammals/ herpetofauna were first combined before averaging the scores across the disciplines (Table 3.29).

Table 3.29 Overall Present Ecological Status for EWR SWB

COMPONENT	INDIVIDUAL SCORE	OVERALL SCORE	OVERALL PES
Water quality	94	81.10	B/C
Vegetation	80.1		
Molluscs/Crustacea	77.5		
Fish	90		
Herpetofauna/Semi-aquatic mammals	65		
Birds*	80		

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.5 EWR Zone – Southern Basin (SB)

Figure 3.5 shows the location of the Southern Basin in relation to Lake Sibaya. Receding water levels have exposed vast sandy areas, with decomposing vegetation and animal material.

Receding water levels exposing vegetation and small animals (molluscs)

Figure 3.5 Southern Basin

3.5.1 Data availability

The data available at EWR SB are summarised in Table 3.30.

Table 3.30 Data available at EWR SB

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
Water quality	1980-2014: EC, pH, Cations/Anions Nutrients; 2010: DDT; Jul 2015: EC, cations/anions, pH, Turbidity, DO, DIN, DIP.	DWS WQ monitoring station W7R1; Humphries, 2013; This study.	3
Vegetation	Site visit (16 July 2015); collection of species height / depth relative to WL and vegetation assessment.	This report.	5
Molluscs	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give species and abundances per habitat and at different depths. Complementing this is Appleton's work on snails and Miranda's work on *Terebia*.	Hart (1979 & 80); Appleton (1977 & 1980); Miranda (2012 & 2014).	4
Crustacea	Detailed studies by Boltt and other researchers from Rhodes University in the 1970s (Hart 1979 & 1980) give	Hart (1979 & 80).	4

COMPONENT	DATA AVAILABILITY	REFERENCES	CONFIDENCE
	species and abundances per habitat and at different depths.		
Fish	Good information on biologies of selected species in Lake Sibaya. No site specific data. No quantitative data on abundances.	Bowen SH (1976).	3
		Bowen SH (1978).	
		Bruton MN (1979).	
		Bruton MN (1979).	
		Bruton MN (1980).	
		Bruton MN and Allanson BR (1974).	
Herpetofauna	Count data and nest censuses from EKZNW, and Combrink et al. (2011) which provide census data and the decline of crocodiles in Lake Sibaya.	EKZNW census files; Combrink et al. 2011.	5
Birds*	Counts of top 15 species for 1970 and 1976 (Bruton 1979); Bird checklist by Cyrus et al. (1980); Brief description by Bruton (1980); Phil Hockey count Dec 1981 (Ryan et al. 1988); Summer and winter CWAC counts 1992-2014; Field notes (R Taylor) Jul 2015;	See report.	5
Semi-aquatic mammals	Count data and life history parameters from EKZNW, and Taylor (2013) which provide census data and the decline of hippopotamuses in Lake Sibaya.	EKZNW; Taylor 2013.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.5.2 Ecological importance and sensitivity

The EIS of EWR SB, with motivations, is provided in Table 3.31.

Table 3.31 EIS of EWR SB

DETERMINANTS	SCORE	REASONING	CONFIDENCE
BIOTA	(0-4)		
Rare & endangered (range: 4=very high - 0 = none)	3.75	*Wolffellia denticulata* listed as VU D2 (http://redlist.sanbi.org/species.php?species=3873-1); last recorded at Sibaya 1973 by A.A. Mauve (http://sibis.sanbi.org/faces/SearchSpecimen/SpecimenDetails.jsp?1=1); not recorded at site but is possibly present. *Silhouettea sibayi* is listed as Endangered on the IUCN Red List of Threatened Species. Many other species are IUCN listed, albeit in the "Least Concern" category. Hippo and crocodiles are red data species. Presence of 7 bird species that are on the regional red data list (2014), though none in very large numbers except occasionally.	4.33
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.00	*Cyperus natalensis* restricted to area; falls within Maputaland Centre of plant endemism (Van Wyk & Smith, 2001) but mostly applicable to species not associated with the Lake; isolated distribution of swamp forest associated with western arm. Several species are endemic to southern Africa. *Aplocheilichthys myaposae* occurs in KZN only, so is	4.33

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		highly localised. This lake is also unique in its fish assemblage having relict remnants of an estuarine assemblage, despite being isolated from the sea since the Pleistocene. Estuarine relic molluscs, crustacea and herptofauna. No, though several bird species at the edge of range in SA.	
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.50	Aquatic and emergent macrophytes highly dependent on lake level High water levels and connectivity with adjacent swamps, pans and wetlands are needed for several species of fishes. This includes facultative use by two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*). Climbing perch (*Ctenopoma multispine*) have a more obligative need for reaching these peripheral habitats for breeding. Shallow, gentle sloping shelves are needed for several other species as well, including those that are numerically dominant. These habitats (and therefore these fauna) are sensitive to lake water level fluctuations. Most of the herpetofauna, crustacea, molluscs and mammal species are 'generalists'. Several species have relatively narrow habitat requirements.	3.33
Species/taxon richness (range: 4=very high - 1=low/marginal)	3.00	Falls within the Maputaland-Pondoland region of plant endemism with app. 7000 taxa (Van Wyk & Smith, 2001). Species richness of KZN freshwater fishes is naturally low (south of the Pongola). This lake has elevated species richness because of the relict estuarine component in its fish fauna. There is a tropical richness, but reduced a bit by the isolation causing an 'island' effect.	4.00
HABITATS	(0-4)		
Diversity of types (4=Very high - 1=marginal/low)	3.00	Aquatic, littoral, pan adjacent and off-lake wetland, open sandy beach areas, protected coves, stream inflow areas, coastal dune, swamp forest. This is one of very few coastal lakes in the country. It is the only system that has lost its estuarine connection, but which retains a relict estuarine fauna. The high diversity of submerged, emergent and floating plants, together with connect pans, swamps and wetlands, provides a very high diversity of freshwater habitats not found anywhere else at one locality. High diversity of habitats, reduced by the even morphology of the basin, few rocks and consistent sized sand grains.	4.00
Refugia (4=Very high - 1=marginal/low)	2.75	Refugia for smaller similar systems during extended drought. This is one of the few (and possibly only) permanent deep freshwater bodies on the Maputaland flats. It becomes a refuge during drought and centre of distribution for fishes that inhabit pans, swamps and wetlands on the wider coastal plain. The embayments are very important to the mammals, herpetofauna, crustacea and molluscs.	4.00
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.75	Large ground water dependant system more resilient to change. The main habitat types, gentle banks and shallow water with submerged vegetation, are susceptible to lake water level drop. Because of the systems morphology these habitats are lost very	3.67

DETERMINANTS	SCORE	REASONING	CONFIDENCE
		rapidly below critical water levels. Affected by water level changes.	
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.40	Large ground water dependant system more resilient to change. At very low levels saltwater intrusion might occur, which will result in the loss of (vegetated) habitat as well as primary freshwater elements of the fish assemblage. Most species would be affected. Lake water levels would need to drop below sea level for this to occur. At levels above this water quality should remain suitable for all fishes in the lake. Flow translates into Water level in these lakes. WQ parameter influenced by lake level is EC The dystrophic water is easily enriched with nutrients.	3.75
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	2.00	Occurs within a string of such systems along the coastline but not likely to be important for plant species migration. The lake itself is not used as a migration route, but high water levels do facilitate migration to adjacent swamps, pans and wetlands for several species of fishes. Lake arms and smaller basins have greater proximity to a higher area of such peripheral wetlands and are therefore more important than the Main Basin in this regard. These include two species of catfish (*Clarias theodorae* and to a lesser extent *Clarias gariepinus*) as well as climbing perch (*Ctenopoma multispine*). This is an endorheic system - but hippopotami, crocodiles and birds do move between waterbodies.	3.33
Importance of conservation & natural areas (range, 4=very high - 0=very low)	4.00	Within iSimangaliso and largest freshwater lake in southern Africa, RAMSAR site. This is a unique lake in that its biota retains a relict fauna of a geological past. It remains in good condition and its catchment can still be managed to protect its ecological integrity as a relatively pristine freshwater lake adjacent to a World Natural heritage site. This is a Ramsar and World Heritage Site - the highest conservation rating that can be given.	4.33
MEDIAN OF DETERMINANTS	3		
EISC	HIGH		

3.5.3 Reference conditions

The expected reference condition at EWR SB is described in Table 3.32.

Table 3.32 Reference condition at EWR SB

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
Water quality	DO, Turbidity and Conductivity as Present. DIN ~0.07 mg/l (deeper waters) and 0.1 mg/l (shallower waters, reflecting some input from peripheral vegetation under natural); DIP ~0.02 mg/l.	2	Expert judgement based on available data; De Villiers & Thiart, 2007.
Vegetation	The aquatic zone is expected to be well developed, in keeping with lacustrine	4	Mucina & Rutherford, 2006; Allanson, 1979;

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
	environments, with species distribution varying according to water clarity (which affects light penetration) and the degree of wind and wave disturbance. In shallow, more secluded areas Water Lilies (*Nymphaea nouchali var. caerulea*) and Broad-leaved Pondweed (*Potamogeton schweinfurthii*) are expected to be highly abundant, with Water Hornwort (*Ceratophyllum demersum var. demersum*) in quiet deeper waters. In more exposed areas where wind and wave action is more frequent and vigorous, the aquatic zone is more likely to be dominated by Fennel-leaved Pondweed (*Stuckenia pectinatus*) and Saw Weed (*Najas marina subsp. armata*). Spiked Water-milfoil (*Myriophyllum spicatum*), native to Europe, Asia and North Africa, is expected to be absent. Emergent macrophytes in the littoral zone are expected to be well developed in most areas not exposed to prevailing winds. Along most shores the dominant plant form is likely to be sedges and reeds, (notably *Schoenoplectus scirpoides, Phragmites australis* and *Eleocharis acutangula*) which should variously span the transition area from shoreline to the aquatic environment, growing well into the water and mixing with aquatic zone species. In sheltered areas, species more sensitive to wind and wave action (including *Typha capensis, Cyperus papyrus, C. prolifer, Ludwigia octovalvis* and *Hydrocotyle bonariensis*) should be abundant with 100% (or near 100%) aerial coverage. Alien and woody species would be absent from this zone. Shoreline macrophytes are those species that occur between the emergent macrophytes and the tree line and along open exposed beach areas where those occur. This zone should be dominated by a mixture of grasses and sedges (notably *C. natalensis, Juncus oxycarpus, Dactyloctenium geminatum* and *Imperata cylindrica*) and should be free of alien or woody species. The tree line is where woody vegetation starts and should characteristically be in keeping with the surrounding vegetation type. This is mostly Northern Coastal [Dune] Forest but with some areas of Maputaland Coastal Belt. The beginning of this zone should remain clearly defined and usually indicates a level beyond which inundation is rare. Some encroachment of the		Ricky Taylor, per com.

COMPONENT	REFERENCE CONDITION	CONFIDENCE	REFERENCES
	shoreline zone by woody species is natural but should be transient and reduced by lake level fluctuations. High woody aerial cover should dominate this zone and alien species should be absent.		
Molluscs	Condition with no *Tarebia*.	5	Miranda (2012)
Crustacea	Before habitat alteration by *Myriophyllum* - no info available of this condition.	3	
Fish	Part of an oligo-mesotrophic, endorheic lake with seasonally connected swamps and shallow pans. Large, deep basin with naturally fluctuating water level. Good water quality characterised by well oxygenated, clear waters with naturally elevated chloride and calcium concentrations. At high levels large areas of shallow shelf areas are used and fish gain access to flooded marginal habitats and allocthonous carbon inputs. Shallow areas become increasingly wave washed with decreasing water level and during drought are poor fish habitat because aquatic vegetation has died back and been impacted by waves, summer day time water temperatures are too high for adults of several species, and detritus and microphytobenthic beds (diatoms) are churned up.	H	Allanson BR (ed) (1979). Lake Sibaya. Monographiae Biologicae 36: 1-394. Dr W. Junk Publishers, The Hague
Herpetofauna	There were more crocodiles present.	5	EKZNW census data
Birds*	The avifauna was dominated by Reed & Whitebreasted Cormorants. Other common species included three species of kingfishers, African Fish Eagles (7prs), several large herons, African Darter and Greyheaded Gull. The area was an important breeding area for Whitefronted Plover, and supported few other waders. The sheltered bays had a distinctive fauna characterised by African Jacana, Black Crake, African Purple Gallinule and Common Moorhen. Little Grebe (=Dabchick) was the most common species found in open water areas.	3	Bruton (1979)
Semi-aquatic mammals	More hippopotami used to occur than are present.	5	EKZNW census data

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.5.4 Baseline ecological condition

This section summarises the outcome of the discipline specific Ecoclassification assessments, which are provided in Volume 3: specialist reports.

3.5.4.1 Causes and sources

Causes and sources for the Present Ecological State at EWR SB are summarised in Table 3.33.

Table 3.33 Causes and sources of PES at EWR SB

COMPONENT	CAUSES	SOURCES	FLOW OR NON-FLOW RELATED	CONFIDENCE
Water quality	DIN/DIP enrichment in shallow waters; DDT contamination in muddy extremities.	Increased rural/forestry development; Spraying of DDT for malaria	Non-flow	2
Vegetation	Altered species composition in the aquatic zone.	Presence of *M. spicatum* in the aquatic zone.	Non-flow	5
	Altered species composition in the shoreline vegetation.	Encroachment of zone by woody species including alien species (*S. cordatum* and *C. equisetifolia*).	Flow	5
	Reduced non-woody cover in emergent macrophytes and shoreline vegetation.	Thinning and mortality due to water stress from receding lake levels.	Flow	4
Molluscs	Invasion of an alien species *(Tarebia).*		Non-flow	5
Crustacea	Habitat altered by the invasion of an alien species *(Myriophyllum).*		Non-flow	3
Fish	Lake water level reductions.	Surface water and groundwater abstraction.	Flow	5
Herpetofauna	Severe poaching (of crocodiles and nests) has decimated numbers.		Non-flow	5
Birds*	Water level, emergent vegetation, shallow backwater areas, exposed shoreline etc.	Various	Largely flow related	4
Semi-aquatic mammals	Severe poaching of hippopotami has decimated numbers.		Non-flow	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.5.4.2 Trends

Trends in the Present Ecological Status for all components of EWR SB are summarised below in Table 3.34.

Table 3.34 Trends in PES for EWR SB

COMPONENT	ABSENT/POSITIVE/NEGATIVE	CONFIDENCE
Water quality	Negative.	2
Vegetation	Negative for alien species; negative for receding lake levels.	4
Molluscs	Negative - the *Tarebia* arestill having and increasing impact.	3
Crustacea	Absent - system has now stabilised since the introduction of *Myriophyllum* (>50 years ago) which altered habitat.	3
Fish	Negative.	5
Herpetofauna	Negative - Crocodile numbers declining rapidly.	5
Birds*	Negative for Cormorants, darters, king fishers and birds of prey which have decreased; positive for other species as they have increased with recent drying.	4
Semi-aquatic mammals	Negative - Hippo numbers still declining rapidly.	5

* Birds were assessed for the overall Lake and not individual Basins/ Arms

3.5.5 Ecostatus

The Present Ecological Status and the Recommended Ecological Category of each component at EWR SB is summarised below in Table 3.35.

Table 3.35 Present Ecological Status of all components at EWR SB

COMPONENT	% EC	EC	REC	OF SIGNIFICANCE/REASON FOR REC
Water quality	94	A	A	Water quality resetting mechanisms (e.g. flushing) in lakes are very weak, thus maintain high WQ.
Vegetation	54.2	D	B	The EIS of the area is HIGH so the system should be managed towards a B.
Molluscs	70	C	C	*Tarebia* cannot be controlled.
Crustacea	85	B	B	*Myriophyllum* stable.
Fish	85	B	A	Prolonged WL drop has reduced habitat for key elements of the fish assemblage. This habitat loss in fairly pronounced in this basin, and of more concern is that it has separated from the rest of the lake in recent months. Continued loss of water and WL reduction (which is accelerated compared to the rest if the lake under separation) renders this basin more susceptible to water quality impacts. Fish species remaining in the system and will recover should WL recover. The lake is borders a World Heritage Site and is unique in the fish fauna assemblage it supports. This includes relict estuarine species, species of conservation significance, and species which are rare and threatened in KZN and SA.
Herpetofauna	65	C	A	Poaching can be stopped.
Birds*	80	B	A	Protected area; unique habitat; refuge function.
Semi-aquatic mammals	65	C	A	Poaching can be stopped.

* Birds were assessed for the overall Lake and not individual Basins/ Arms

In order to calculate PES the scores for Molluscs/ Crustacea and also Semi-aquatic mammals/ herpetofauna were first combined before averaging the scores across the disciplines (Table 3.36).

Table 3.36 Overall Present Ecological Status for EWR SB

COMPONENT	INDIVIDUAL SCORE	OVERALL SCORE	OVERALL PES
Water quality	94	75.95	C
Vegetation	54.2		
Molluscs/Crustacea	77.5		
Fish	85		
Herpetofauna/Semi-aquatic mammals	65		
Birds*	80		

* Birds were assessed for the overall Lake and not individual Basins/ Arms

4 ECOCLASSIFICATION, ECOLOGICAL SENSITIVITY AND IMPORTANCE, AND THE RECOMMENDED AND ALTERNATIVE ECOLOGICAL CATEGORIES

This section summarises the outcome of the discipline-specific Ecoclassification (PES) and Ecological Importance and Sensitivity assessments (EIS), which are provided in Volume 3: Specialist reports.

4.1 Present Ecological Status and Ecological Importance and Sensitivity

The PES and EIS of each of the EWR Zones are provided in Table 4.1.

Table 4.1 PES and EIS of each of the EWR Zones in Lake Sibaya

AREA	CODE	PES	EIS
Main Basin	MB	B/C	HIGH
Northern Arm	NA	B/C	HIGH
Western Arm	WA	B/C	HIGH
South-western Basin	SWB	B/C	HIGH
Southern Basin	SB	C	HIGH

4.2 Recommended and alternative ecological categories

The recommended and alternative ecological categories for each of the Sibaya EWR zones are provided in Table 4.2. These are based solely on ecological considerations.

Table 4.2 Recommended and alternative ecological categories (EC) for each of the EWR Zones

ZONE	CODE	REC	AEC1
Main Basin	MB	B/C	C
Northern Arm	NA	B/C	C
Western Arm	WA	B/C	C
Southwestern Basin	SWB	B/C	C
Southern Basin	SB	B/C	C

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