

1 JBS32 (EFR O2: BOEGOEBERG (ORANGE RIVER))

The information is summarised from WFA (2010a;b).

1.1 SITE DESCRIPTION

The site is situated below the Boegoeberg Dam and falls within MRU Orange D, RAU D1 which is delineated as the river reach below Boegoeberg Dam up to Augrabies Waterfall. The site falls within a reach that is less disturbed with no cultivation in the riparian zone and a canal is present on the left bank. This is a bedrock anastomosing reach, with well-vegetated bedrock core bars and islands between the distributary channels, and large bedrock riffle areas in the active channels. The macro-channel is approximately 400 – 500m wide with an average depth of 3 m. Flow sensitive habitats for fish (fast shallow (FS) and fast deep (FD)) are very well represented at site. High habitat diversity is present with various secondary canals.

Location	EFR O2 Boegoeberg	Altitude	871 m
Longitude	22.16225	Latitude	-29.0055
EcoRegion	Nama Karoo 26.05	Quaternary catchment	D73C
Water Management Area	Lower Orange River	Geomorphological zone	Lowland River



EFR O2, Lower Orange River. There is a high degree of physical habitat diversity associated with the numerous distributary channels at this site.

1.2 PRESENT ECOLOGICAL STATE (PES)

Geom	<p>Although the flows are critically reduced at the site, this has been in some ways compensated for by the reduced sediment loads (since much is trapped in upstream dams). The site is generally not very sensitive to the impacts of base flow and small flood changes, nor to small changes in sediment load.</p> <p>The key issue for this site is the loss of large floods that scour and maintain the distributary channels and beds. The very large dams now in place in the upstream catchment will probably prevent any sufficiently large scour events to occur in future, and thus stabilisation and increasing vegetation on the lower banks and bars will occur in the future. There are some indications in the historical aerial photographs of slight encroachment of vegetation in to the channels.</p>
WQ	<p>Salt ions are not problematic although sulphate, sodium and chloride show increases from the reference condition (RC), particularly sulphate and chloride. Site is downstream from Boegoeberg dam and significant changes in temperature and oxygen is expected. Some toxicant levels are problematic.</p>
Fish	<p>All the expected fish species are still present in this river reach albeit in a slightly to moderately reduced FROC (<i>Labeo umbratus</i>, <i>Barbus anoplus</i> and <i>L. kimberleyensis</i>). Some loss of marginal zone overhanging vegetation due to altered hydrological regime also impact fish assemblage negatively. The negative impacts associated with the alien species – <i>Ctenopharyngodon idella</i>, <i>Gambusia affinis</i>, <i>Cyprinus carpio</i> – include: loss of vegetation and habitat, bio-turbation and habitat loss, water quality alteration, and predation on native fish eggs and larvae.</p>
Inverts	<p>2010 SASS5 score: 116 No of Taxa: 20 ASPT: 5.8</p> <p>The most obvious change from natural has been outbreaks of pest blackflies (mainly <i>Simulium chatteri</i>) following impoundment. The bivalve <i>Corbicula fluminalis</i> was noticeably absent during the site-visit. This bivalve is particularly sensitive to elevated sediments, and its absence is probably associated with the periodic emptying of Boegoeberg Dam, which releases high concentrations of sediment. Other taxa that were expected but not observed included Heptageniidae, Ecnomidae, Hirudinea, Sisyridae, Corixidae and Ceratopogonidae. The most sensitive taxa recorded at the site were Atyidae, Tricorythidae and Leptophlebiidae. Elevated nutrients lead to excessive growth of epilithic algae, particularly during low-flow periods, and this reduces the suitability of substrates for colonisation of benthic invertebrates. The chironomid <i>Cardiocladius africana</i> thrive under these conditions. Monthly data on aquatic invertebrates were collected at Gifkloof, near Upington, between 1991 and 1996. These data provide a reliable indication of the key ecological drivers that affect the diversity and abundance of benthic macroinvertebrates in the middle and lower Orange River.</p>
Rip veg	<p>Marginal Zone: Cobble and bedrock areas have a vibrant population of <i>Gomphostigma virgatum</i>. Other dominants however are <i>Salix mucronata</i>, <i>Phragmites australis</i>, <i>Cyperus marginatus</i>, <i>Persecaria decipiens</i>, <i>P. lapathifolia</i> and <i>Cynodon dactylon</i>.</p> <p>Lower Zone: Well wooded in places with <i>G. virgatum</i>, and <i>S. mucronata</i> mainly, but also with <i>Acacia karoo</i> recruits. Areas which are open (mainly cobble/boulder) or dominated by non-woody vegetation (<i>P. australis</i>, <i>Crinum bulbispermum</i>, <i>C. marginatus</i>, <i>Persecaria</i> and <i>C. dactylon</i> mainly) make up the mosaic.</p> <p>Upper Zone: The right bank (RB) has extensive open areas (cobble or boulder) with <i>Tamarix usneoides</i> mainly. Otherwise the zone is predominantly woody with common species on both banks but the left bank (LB) mainly being <i>T. usneoides</i>, <i>Accacia karoo</i>, <i>Rhus pendulina</i>, <i>Ziziphus mucronata</i>, <i>Diospyros lycioides</i>, <i>Lycium hirsutum</i>, <i>A. erioloba</i>, <i>Prosopis glandulosa</i>, and <i>Prosopis velutina</i>). A single specimen of <i>Combretum erythrophyllum</i> was found.</p> <p>Macro Channel Bank: similar to upper zone, but without the cobble/boulder beds Floodplain: Similar to Macro Channel Bank, with terrestrial species and dominated by woody thickets.</p>
Diatoms	<p>Diatom results are based on samples taken during 2005, 2008 – 2010 at various sites situated in the reach from Boegoeberg Dam to Augrabies. The biological water quality fluctuated between a B and C EC during 2005, 2008 – 2009, and 2010. It is evident that there is a gradual deterioration within the reach from Boegoeberg Dam to Augrabies. Nutrient levels are elevated throughout the reach and agriculture seems to be the major impact</p>

	<p>in this reach. Chloride concentrations were problematic during July 2005 in this reach. Although elevated at times organic pollution does not seem to be a major problem in this reach. Nutrients were elevated for all sampling years indicating continuous impact, while salinity may be problematic at times. The Ecological Category (EC) for this reach which is delineated as Management Resource Unit D is a B/C.</p>
--	---

1.3 MAIN IMPACTS AT THE SITE

	PES	Causes	Sources	F ¹ /NF ²
WQ	C	Elevated nutrients and potential toxicant loads due to fertilizer and pesticide use.	Agriculture, resulting in some toxicant and nutrient loading expected.	NF
Geom	C	Reduced frequency and size of large floods.	Large dams.	F
		Reduced sediment load.	Although upstream dams have reduced the sediment load, annual flushing of the upstream dam reintroduces some sediments.	
Rip veg	B	Increased vegetation cover.	Reduced base flows especially in summer and reduced moderate and large floods.	F
		Altered species composition.	Small percentage of perennial exotic species.	NF
Fish	C	Decreased overhanging vegetation as cover for fish result in decreased Frequency of Occurrence (FROC) of species with preference for these habitats. Loss of habitat (cover) also results in increased exposure to predators.	Increased bank erosion, flow modification and inundation.	F
		Decrease in FROC and abundance of fish species with preference for fast habitats.	Farming: removal or change in riverine vegetation.	NF
		Decreased water quality.	Decreased base flows.	F
		Decreased species diversity and abundance.	Presence of toxics, agriculture, dams trapping silt altering water clarity, stratification in dams.	NF
		Increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish (especially impact on LUMB breeding habitats).	Presence of alien predatory species (GAFF) feeding on indigenous fish eggs and larvae.	
		Decreased native species diversity and abundance as result of presence of alien species.	Presence of alien CCAR which cause bio-turbation. Dams create habitat for undesirable species.	NF
		Decreased abundance, and therefore FROC related to over utilization for human consumption.	Alien species will have negative impact on native species – Clarias gariepinus (CCAR) – bio-turbation; GAFF - predation on eggs and fry; CIDE - loss of aquatic vegetation and habitat.	
		Reduced spawning success resulting in decreased FROC of many species.	Poaching and over-fishing of fish using nets (gill and seine nets, often home-made).	
		Presence of migration barriers reduces migration success (breeding, feeding and dispersal) of some species.	Flow modification: Absence of spring flushes, reduced habitat suitability and stimuli, flow pattern disrupts normal breeding cycle.	F
		Some dams/weirs (incl. Boegoeberg Dam).	NF	
Macroinvertebrates	C	Elevated low flows.	Discharges to meet demands for winter power generation and irrigation demands.	F
		Water quality deterioration	Agricultural return flows.	
		Aseasonal releases.	Operation of Vanderkloof Dam.	
		Pesticides.	Blackfly Control Programme.	NF/F
		Elevated sediment.	Periodic emptying of Boegoeberg Dam for maintenance, usually during winter (i.e. low flow).	NF

	PES	Causes	Sources	F ¹ /NF ²
		Toxic algal blooms, such as <i>Microcystis</i> .	Annual overturn of vanderkloof Dam, plus inputs from Harts River (Spitzkop Dam).	

1 Flow related

2 Non Flow related

1.4 RESULTS: PRESENT ECOLOGICAL STATE

Driver Components	PES	Trend
GEOMORPHOLOGY	C	Stable
WATER QUALITY	C	Stable
DIATOMS	B/C	
Response Components	PES	Trend
FISH	C	Stable
MACRO INVERTEBRATES	C	Stable
INSTREAM	C	
RIPARIAN VEGETATION	B	Stable
ECOSTATUS	C	

The main reasons for the PES is a loss of frequency of large floods, agricultural return flows, higher low flows than natural in the dry season, drought and dry periods, decreased low flows at other times, release of sediment, presence of alien fish species and the barrier effects of dams.

1.5 SUITABILITY AS FUTURE BIOMONITORING SITE

Habitat at the site is very good for biotic monitoring. The site represents the delineated reach and is in a better state than the majority of the reach especially as agricultural clearing is high in the reach. The site is downstream of Boegoeberg Dam and is suitable for detecting impacts relating to an altered hydrological regime which seems to be the biggest problem in this reach. Elevated flows may be problematic and therefore gauge records should be checked when planning routine monitoring.
