

## TREKKING FOR THOBOSHANA –

### CONSERVING THE MALOTI MINNOW IN THE LESOTHO HIGHLANDS

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#### Abstract

The rivers of the Lesotho Highlands are home to several unique aquatic species, including the endangered (IUCN B2ab) Maloti minnow *Pseudobarbus quathlambae*, the area's only endemic fish. Maloti minnow is comprised of two evolutionarily significant units (ESUs): an "Eastern ESU" viz. *P. quathlambae* and a "Mohale ESU" viz. *P. quathlambae* cf. Mohale. Surveys conducted in 2013 revealed that the Mohale ESU population had disappeared from nearly all its native range. Moreover, the last survey conducted on the Eastern population was in 2000 and very little is known about its current status. As Lesotho's flagship biodiversity species, it was important that new information was obtained on the status of Maloti minnow populations. A fish distribution survey was undertaken incorporating 13 rivers in which 42 sites were sampled. Fish of the Mohale ESU are no longer present in their native range in the Senqunyane, Bokong and the Jorodane River upstream of Mohale Dam. Its disappearance is attributed to invasion by non-native smallmouth yellowfish *Labeobarbus aeneus*. Healthy populations of translocated Mohale ESU were recorded in the Jorodane- (above Pampiri Falls), Makhaleng, and Maletsunyane River but were absent from the Quthing River. Maloti minnow of the Eastern ESU were recorded in the Tsoelikane, Sani, Mothae, upper Matsoku, Senqu and Moremoholo River. Threats faced by Maloti minnow populations include inter-basin water transfer schemes (IBTs), non-native fishes and habitat degradation. Multi-faceted mitigation measures are required to ensure the survival of this species. A baseline has been established which will allow for the development of a holistic and ongoing monitoring and impact assessment approach incorporating both aquatic (fisheries, river health) and terrestrial (rangelands, wetland health) components. The study outlines the necessary conservation measures for the conservation of this unique but endangered species.

#### Introduction

The Maloti minnow *Pseudobarbus quathlambae* (Figure 1) is a small cyprinid (< 130mm total length (TL)) endemic to the highlands of Lesotho (Cambray, 1996) and the Kwazulu Natal Drakensberg, South Africa (Barnard, 1938). Its favoured habitats include low to moderate gradient streams on basalt or sandstone (Cambray and Meyer, 1988; Rall *et al.*, 1993; Skelton, 2001). Maloti minnow is comprised of two genetically distinct sub-populations or evolutionarily significant units (ESUs): an "Eastern ESU" viz. *P. quathlambae* and a "Mohale ESU" viz. *P. quathlambae* cf. Mohale (Swartz, 2005). The Eastern ESU occurs in several rivers of the Senqu catchment, while the Mohale ESU occurs in the upper reaches of the Senqunyane-, Bokong- and Jorodane River within the Mohale Dam catchment (Swartz, 2005) (Figure 1). The two ESUs are confined to only nine rivers and their distribution has become increasingly fragmented and limited due to three major threats: inter-basin water transfer schemes, non-native fishes, and habitat degradation (Skelton *et al.*, 2001; Shelton *et al.*, 2016). In 2007, Maloti minnow was classified as "endangered" in the IUCN Red List of Threatened Species (Swartz, 2007).



Figure 1: The Maloti minnow (*Pseudobarbus quathlambae*) (left); distribution of the Eastern ESU (black circles) and Mohale ESU (red circle) in the Lesotho Highlands.

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### *Mohale ESU – Native range*

Historically, the Mohale ESU was the only fish species that occupied the rivers upstream of Mohale Dam as the Semonkoaneng waterfall acted as a barrier to upstream migration of smallmouth yellowfish *Labeobarbus aeneus*, Orange River mudfish *Labeo capensis*, rock catfish *Austroglanis sclateri*, rainbow trout *Oncorhynchus mykiss*, and brown trout *Salmo trutta* (Steyn *et al.*, 1996). In 2003, a 32km long inter-basin transfer (IBT) tunnel was constructed, as part of the Lesotho Highlands Water Project (LHWP) Phase 1, linking Mohale Dam to Katse Dam. Steyn *et al.* (1996), Rall (1999), and Skelton *et al.* (2001) predicted that fishes from Katse Dam (smallmouth yellowfish, Orange River mudfish and rainbow trout), would colonise Mohale Dam following the construction of the IBT tunnel, potentially placing the Mohale ESU at risk of predation and/or competition. The Maloti Minnow Conservation Project (Skelton *et al.*, 2001) proposed a number of mitigation measures including the construction of a barrier to prevent invasions, translocation of Maloti minnow to areas above waterfalls, and breeding facilities for restocking purposes.

In 2011, a gillnet survey of Mohale Dam showed that smallmouth yellowfish, that had colonised the dam through the IBT tunnel, had become extremely abundant in the dam although evidence of upstream invasion of the inflowing rivers (Senqunyane-, Bokong, Jorodane River) was, at this stage, only anecdotal (Hecht, 2011). However, in 2013, a comprehensive electrofishing survey of these rivers revealed the presence of smallmouth yellowfish in all three rivers (Shelton *et al.*, 2016). Moreover, only five minnows were recorded during that survey. Shelton *et al.* (2016) concluded that the Mohale ESU was on the verge of extinction.

### *Mohale ESU – Translocated Range*

In response to fears that invasion of the Mohale catchment by non-native rainbow and brown trout would lead to the extinction of the Mohale ESU, minnows were captured and translocated to the Quthing-, Makhaleng-, Maletsunyane- and Jorodane River (upstream of the Pampiri Falls) in 2002 (Rall, 2005). A survey of the translocated populations in 2006 showed that they had persisted in all rivers with the exception of the Quthing (Rall and Sephaka, 2008). No follow up surveys had been undertaken since.

### *Eastern ESU*

Comparatively less work has been undertaken on the Eastern ESU and this is probably a result of the isolation of the Eastern ESU populations from IBT impacts associated with the LHWP. Major threats to the Eastern ESU have historically included non-native fish, specifically trout, and habitat degradation. However, the last survey was undertaken in 2001 and since then there is no information on the status of these fishes.

Given the impacts of IBTs and non-native fish on the Mohale ESU (Shelton *et al.*, 2016) and uncertainty regarding the status of translocated Mohale ESU and Eastern ESU populations, it was critical that specialist surveys were undertaken, as part of a wider impact assessment approach, to guide conservation actions with a view to ensuring the survival of the Maloti minnow. The objectives of the surveys were:

1. Re-assess the status of **native** and **translocated** populations of Maloti minnow Mohale ESU.
2. Re-assess the status of Maloti minnow Eastern ESU populations.
3. Make recommendations for the conservation of both the Mohale ESU and the Eastern ESU.

## Methods

The locations of the survey sites are shown in Figure 3.

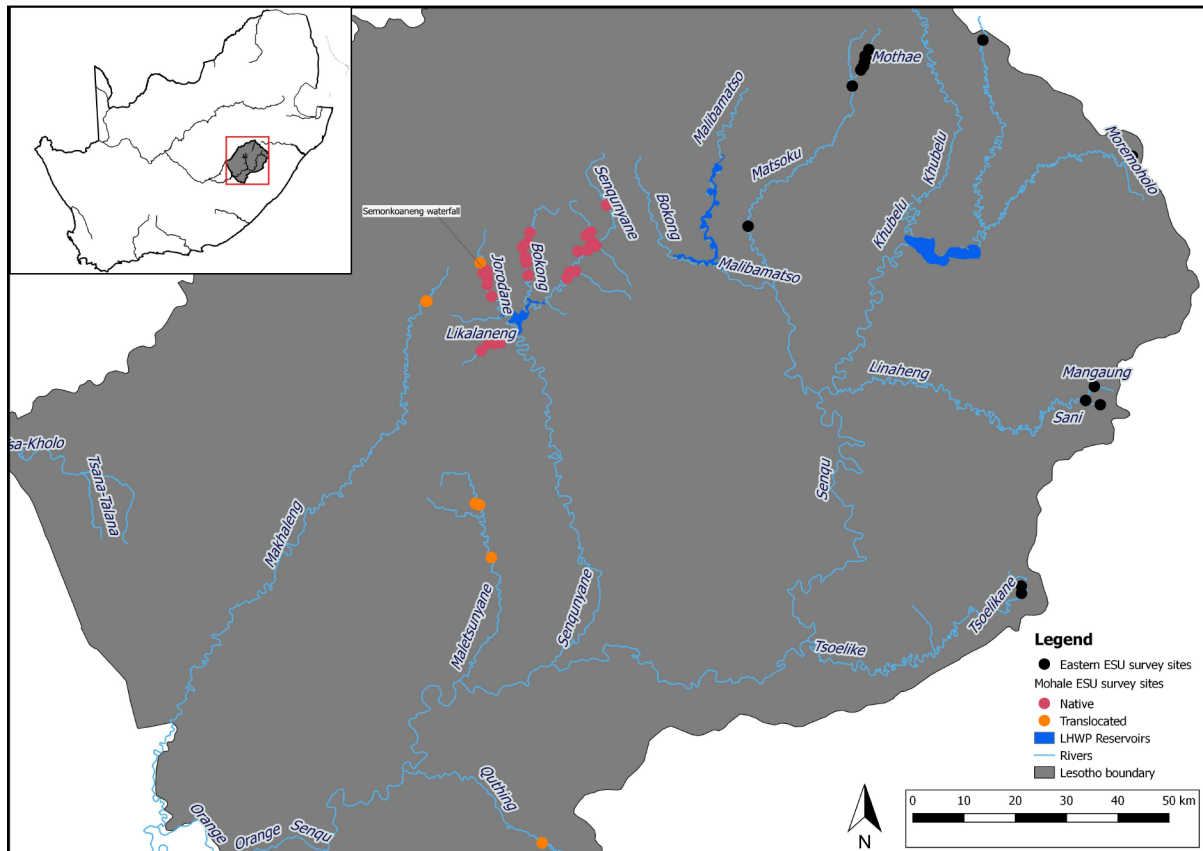


Figure 1: Survey sites for the Mohale ESU and the Eastern ESU, August 2017.

All rivers were surveyed with a SAMUS SE 1000 backpack electrofisher, a 12V battery, trailing cathode and an anode attached to a hand-held net. Water quality parameters including water temperature ( $^{\circ}\text{C}$ ), dissolved oxygen ( $\text{mg. L}^{-1}$ ), electrical conductivity (EC) ( $\mu\text{S.cm}^{-1}$ ) and pH were recorded at three random points at each site.

Presence/absence data for fish at each sampling site were compared with previous surveys (Steyn *et al.*, 1996; Skelton *et al.*, 2001; Paxton, 2011; Shelton *et al.*, 2016), where specific sampling site data were available. Habitat data were log-transformed and one-way PERMANOVA was conducted with the fixed factor “Year” in order to determine if there were any significant differences from previous surveys (Steyn *et al.*, 1996) (Note: there were no previous habitat data recorded from Eastern ESU rivers).

## Results

### *Mohale ESU – Native Range*

The presence/absence of fish from surveys conducted in 1995, 2006, 2013 and 2017 is shown in Table 1.

Table 1: Presence/absence of Maloti minnow and smallmouth yellowfish in the Senqunyane-, Bokong- and Jorodane River from surveys conducted in 1995 (Steyn *et al.*, 1996), 2006 (Rall and Sephaka, 2008), 2013 (Shelton *et al.*, 2016), and 2017. “+” = present; “-” = absent

		Survey Year			
River	Species	1995	2006	2013	2017
Senqunyane	<i>Maloti minnow</i>	+	+	-	-
	<i>Smallmouth yellowfish</i>	-	-	+	+
Bokong	<i>Maloti minnow</i>	+	+	+	-
	<i>Smallmouth yellowfish</i>	-	-	+	-
Jorodane	<i>Maloti minnow</i>	+	+	+	-
	<i>Smallmouth yellowfish</i>	-	-	+	-

Only Maloti minnow were recorded in the 1995 and 2006 surveys of the Senqunyane-, Bokong- and Jorodane River, while smallmouth yellowfish were the only fish recorded during the 2013 and 2017 surveys of the Senqunyane River (no fish were recorded in the Bokong- nor Jorodane River in 2017). There were no significant differences in habitat and water quality conditions between August 1995 and August 2017 for the Senqunyane- ( $Pr > F = 0.668$ ), Bokong- ( $Pr > F = 0.1$ ) nor Jorodane- ( $Pr > F = 0.3$ ) River.

#### *Mohale ESU – Translocated Range*

Maloti minnow were recorded in the Jorodane-, ( $n = 38$ ), Makhalleng- ( $n = 11$ ), and Maletsunyane River ( $n = 41$ ) (Table 2). No fish were recorded in the Quthing River.

Table 2: Presence/absence of Maloti minnow in the Jorodane-, Makhalleng-, Maletsunyane- and Quthing River from surveys conducted in 2006 (Rall and Sephaka, 2008) and 2017.

		Survey Year	
River	Species	2006	2017
Jorodane (above Pampiri Falls)	Maloti minnow	+	+
Makhalleng	Maloti minnow	+	+
Maletsunyane	Maloti minnow	+	+
Quthing	Maloti minnow	-	-

There were no significant differences ( $p > 0.05 = 0.291$ ) in habitat and water quality parameters between the Jorodane-, Makhalleng-, Maletsunyane- and Quthing River.

#### *Eastern ESU*

Maloti minnow was recorded in the Tsoelikane River above and below the Tsoelikane Falls, in the Sani-, Mothae-, upper Matsoku-, Senqu- ( $n = 15$ ) and Moremoholo River (Table 3). In contrast to 2000, no Maloti minnow was recorded in the Mangaung- or lower Matsoku River (Site JR22). No rainbow trout were recorded at any of the sites.

Table 3: Presence/absence of Maloti minnow and rainbow trout in the Tsoelikane-, Mangaung-, Sani-, Mothae-, Matsoku-, Senqu- and Moremoholo River from surveys conducted in 2000 (Skelton *et al.*, 2001), 2011 (Paxton, 2011) and 2017. “+” = present; “-” = absent.

		Survey Year		
River	Species	2000	2011	2017
Tsoelikane (below falls)	<i>P. quathlambae</i>	+		+
	<i>O. mykiss</i>	+		-
Tsoelikane (above falls)	<i>P. quathlambae</i>	+		+
Mangaung	<i>P. quathlambae</i>	+		-
	<i>O. mykiss</i>	+		-
Sani	<i>P. quathlambae</i>	+		+
	<i>O. mykiss</i>	+		-
Mothae	<i>P. quathlambae</i>		+	+
Matsoku (upper)	<i>P. quathlambae</i>	+		+
Matsoku (lower)	<i>P. quathlambae</i>	+		-
Senqu	<i>P. quathlambae</i>	+		+
Moremoholo	<i>P. quathlambae</i>	+		+

## Discussion and Conclusions

Maloti minnows of the Mohale ESU are no longer present in their native range in the Senqunyane-, Bokong- or Jorodane River (below Pampiri Falls). Its disappearance is most likely a result of predation by and possibly competition for habitat and food from smallmouth yellowfish. The analysis of habitat data from August 1995 and August 2017 show no significant differences in habitat conditions in any of the rivers. There was no apparent land use activity at the survey sites that would result in riparian habitat degradation severe enough to contribute to the disappearance of Maloti minnow.

The translocated Maloti minnow populations in the Jorodane-, Makhaleng-, and Maletsunyane River have persisted and the translocation into the Quthing River has probably failed. It is possible that the failure of Maloti minnow to establish in the Quthing River is due to habitat degradation in the catchment. Conservation planning and resource allocation should now focus on these translocated populations that are the last remaining remnants of the Mohale ESU. Threats to these populations include habitat degradation e.g. overgrazing and potential malicious introductions of non-native fishes e.g. trout for angling purposes. It is recommended that comprehensive follow-up surveys, including river health and rangeland assessments, are conducted in order to determine baseline habitat conditions and monitor trends in habitat quality. The LHDA has committed to embarking on follow-up surveys which will inform the development of an holistic monitoring plan for the Mohale ESU.

Minnows of the Eastern ESU were recorded in all rivers sampled by Skelton *et al.* (2001). Furthermore, Maloti minnow (Eastern ESU) is not extinct in the Tsoelikane River below the falls as previously suggested by Skelton *et al.* (2001). This may be due to periods where environmental conditions do not favour rainbow trout, and predation of Maloti minnow is reduced. Major threats to the Eastern ESU include habitat degradation (overgrazing, infrastructure development, mining activities) and non-native rainbow trout. Moreover, the construction of Polihali Dam is likely to lead

to high densities of yellowfish in the Senqu and Moremoholo River catchments. A comprehensive assessment of the suitability of the waterfalls in preventing upstream invasions of yellowfish will be conducted shortly by the LHDA.

The story of the Maloti minnow showcases the need to consider multi-faceted mitigation measures to address a wide range of impacts. A baseline has now been established which will allow for the development of a holistic and ongoing monitoring and impact assessment approach incorporating both aquatic (fisheries, river health) and terrestrial (rangelands, wetland health) components. Finally, there is an urgent need to develop a strategic roadmap for the conservation of the translocated Mohale ESU and the Eastern ESU populations. Conservation measures must be implemented to ensure the survival of one of Lesotho's severely threatened, flagship symbols of biodiversity, the endemic *thoboshana*.

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