Online Resource 1: Detailed methodological description of STAR score (re)calculation for the six species with outlier STAR-R values

Article Title**: Optimizing application of the Species Threat Abatement and Restoration (STAR) metric in meeting national biodiversity conservation targets: the case of Ethiopia**

Journal: Biodiversity and Conservation

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Prior to using the global STAR data for calculating national STAR scores for Ethiopia and conducting detailed individual threat level analysis, we undertook a preliminary data quality assurance analysis in order to ensure whether the global data (STAR scores, species and threats) were relevant to Ethiopian context. Accordingly, we examined the STAR scores, derived from global data, and found that the habitat restoration (STAR-R) component of the STAR metric represented more than 15 times the total STAR-T score for Ethiopia. We found that those surprising figures, very different from other countries's profiles, were due to six species (*Arvicanthis blicki, Ptychadena nana, Crocidura Lucina, Tachyoryctes macrocephalus, Leptopelis yaldeni* and *Crithagra ankoberensis*) with a very high STAR-R score (> 3000). These high STAR_R scores seemingly show that all species had very large ranges but are now very restricted and highly threatened (Vergez 2022). However, we found that the reason for the extremely large values was an error in calculation of the original and current area of habitat of each of these six species. For example, for *Tachyoryctes macrocephalus*, a species restricted to grassland and alpine moorlands of the Bale mountains, above 3000 m asl (Asefa et al. 2022), the current AOH was estimated in the original STAR calculation as 5,140 km^2 and historical range was estimated as 8,738km^2, with restoration area equals to 3,598km^2 (70% of current AOH). However, these extents are far greater than the total area of the Afroalpine moorlands and grasslands (which, in fact, is about 1,200km^2; Wraase et al. 2022) in the Bale mountains range above 300m asl, where the species' distribution is confined. Thus, instead of omitting these species with outlier data, we recalculated the STAR-R scores of these six species based on data

extracted on historical and current areas of habitat types of each species from land use/land cover studies and literature review, data from IUCN Red List and our experience.

In addition, we also added two more species not included in the original global STAR calculation and calculated new STAR scores. These procedures are described in the following sections.

Estimation of Extent of species' Restorable habitat

To recalculate STAR-R scores for the six species with outlier score values based on the global scale analysis, we derived original and current extent of area of habitats based on information on their known distribution, suitable habitat types and land use and land cover changes in their known range. *Tachyoryctes macrocephalus* is endemic to alpine grasslands and moorlands of the Bale Mountains. *Arvicanthis blicki, Ptychadena nana* and *Crocidura Lucina* are restricted to the Bale Mountains and the adjacent Arsi mountains (IUCN 2020). Earlier reports (Hillman 1986) show that crop cultivation and settlement were rare in forest ecosystem of the Bale Mountains prior to 1960s. Thus, we assumed that land covered by farmland and settlement prior to 1986s would be in the expense of grassland, wetland and shrub lands. Then, we obtained land use land cover changes analysis for the year 1986 and 2015 (Nigussie 2016). Thus, the summed areas of cultivation land, settlement, grassland, shrub land and wetland in the year 1986 likely represent the original habitat of the species, while the area of grassland, wetland and shrub land for the year 2015 is assumed to represent current area of habitat. However, this analysis encompasses the whole Bale ecoregion, including forests and other habitats down to 1500m asl – beyond the species range. From this, assuming uniform habitat changes across the ecoregion, we calculated percentage change in the extent of openland habitats (alpine grasslands and moorland, grassland and shurblands) between 1960 and 2015 and designated this as restorable habitat of the species

(Table S1). We followed similar approach for Arsi Mountains based on land cover land use analysis by Hailu (2014).

The two other species − *Leptopelis yaldeni* and *Crithagra ankoberensis* – are restricted to the northern western highlands of the country (BirdLife International 2018; IUCN 2020). Based on several literature review (see a review by Muluneh 2010) and our experience, we assumed that about 75% of the original habitats have been lost. Thus, we used this value to recalculate their STAR values.

Derivation of STAR scores for *Nilopegamys plumbeus*

The Amphibious Rat (*N. plumbeus*), one of the two new species we added to the STAR calculation (the other species is ***Lophuromys pseudosikapusi*** and is discussed in the main manuscript), is Ethiopia's endemic rodent species currently listed as Critically Endangered in the IUCN Red List. This semiaquatic-life species (inhabiting permanent, inland wetlands /Rivers/ Streams) is known from a single specimen collected at a locality known as "Little Abbai River" in the 1920s from highland, riparian habitat (Peterhans & Lavrenchenko, 2008). This confinement of the entire known population of N. plumbeus to this site has triggered designation of the "Little Abbai River" AZE site. This site has an area 904.7 km2. Two recent attempts to recollect this species were ended up without any success (Peterhans & Lavrenchenko, 2008), suggesting that it may now be extinct. The habitat where the type locality specimen was collected is now already severely degraded and today is pure pastureland (Peterhans & Lavrenchenko, 2008). Information both on its historical and current AOH is unavailable for N. plumbeus. Based on this background knowledge, the STAR-T score for the species is 400.

To derive the STAR-R for the species, based on literature and experts' opinion, we assumed that the area (904.7 km2) of the "Little Abbai River" AZE site represents historical AOH of the species and that about 75% (678.5 km2) of this historical/ original AOH has been lost, showing that current available AOH is 226.2 km2. The extent of restorable AOH for species, expressed as a percentage of the global species' current AOH, is 300. From this, the STAR-R score for the species is estimated as 348 (300*4*0.29].

For the species, The IUCN Red List records only one level 1 threat, 2. Agriculture & Aquaculture, 2. Agriculture & aquaculture -> 2.3. Livestock farming & ranching -> 2.3.2. Small-holder grazing, ranching or farming, which is on-going with Low Impact (score = 3) (Peterhans and Lavrenchenko, 2008). Thus, for both global and national levels, STAR-T score for this threat based on this species, both at global and national levels (since it is an endemic species), is 400 (100*4*1).

Table S1. Species-specific information on IUCN red list category, geographical range of distribution, elevation (Min-Max), extent of Restorable AOH and habitat type of the species. Restorable AOH was given as relative to current available AOH. * New added species

Scientific name	IUCN red list category	Distribution	Elevation (Min-Max) (meters asl)	Restorable AOH (unit?)	Habitat
Ptychadena nana	Endangered	Arsi and Bale mountains	2000-3000	57.37	3.7. Shrubland - Subtropical/Tropical High Altitude 4.7 Grassland-subtropical high altitude 5. Wetlands (inland)
Arvicanthis blicki	Near threatened	Arsi and Bale mountains	2500-4500	99.97	4.7 Grassland-subtropical high altitude
Crocidura lucina	Vulnerable	Arsi and Bale mountains	3000-4050	57.37	4.7 Grassland-subtropical high altitude 5.4. Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands
Tachyoryctes macrocephalus	Endangered	Bale mountains	3000-4150	99.97	4.7 Grassland-subtropical high altitude
Leptopelis yaldeni	Vulnerable	Gojjam	2000-2700	300	4.7 Grassland-subtropical high altitude 5.4. Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands
Crithagra ankoberensis	Vulnerable	NW	2800-4300	300	4.7 Grassland-subtropical high altitude 6. Rocky areas (eg. inland cliffs, mountain peaks)
*Nilopegamys plumbeus**	Critically endangered	Little Abbai River, NW	2600	300	2.3. Livestock farming & ranching

Threat Impact scores

We calculated threat impact score for each Level 2 IUCN threat types reported for each species, based on IUCN additive scores version 1.0 (revised version based on implementation in SIS) (see Table S2). From this, we calculated relative threat impact score (Cs,t) for each threat type to each species, by adding the Timing, Scope and Severity scores of each threat (Table S2). The Timing, Scope and Severity options and their scores are the following:

Timing options (and scores) are:

- On-going (3)
- Future (2)

Scope options (and score values) are:

• Affects the whole population (>90%; score = 3)

• Affects the majority of the population (50–90%; score = 2)

• Affects the minority of the population (<50%; score = 1)

Severity options (and scores) are:

• Causing or likely to cause very rapid declines (3)

• Causing or likely to cause rapid declines (2)

• Causing or likely to cause relatively slow but significant declines (1)

• Causing or likely to cause fluctuations (1)

• Causing or likely to cause negligible declines (0)

• No declines (0)

The expected percentage population decline over 10 years or three generations from combinations of scope and severity scores per threat (see table below).

Table S2. Relative threat impact scores (Cs,t) for each threat to each of the six species with extremely large STAR R values in the originally estimated calculation.

Species	Threat	Timing	Severity	Scope	Sum	Cs,t
Ptychadena nana	1.1 Housing & urban areas	3	2	1	6	0.35294
	2.1. Annual & perennial non-timber crops	3	2	2	7	0.41176
	9.2. Industrial & military effluents	3	0	1	4	0.23529
Arvicanthis blicki	2.3. Livestock farming & ranching	3	2	2	7	1
Crocidura lucina	2.1. Annual & perennial non-timber crops	3	1	2	6	0.5
	2.3. Livestock farming & ranching	3	1	2	6	0.5
Tachyoryctes macrocephalus	2.3. Livestock farming & ranching	3	2	3	8	1
Leptopelis yaldeni	1.1 Housing & urban areas	3	1	1	5	0.41667
	2.1. Annual & perennial non-timber crops	3	2	2	7	0.58333
Crithagra ankoberensis	2.1. Annual & perennial non-timber crops	3	2	2	7	0.29167
	2.2. Wood & pulp plantations	3	1	1	5	0.20833
	2.3. Livestock farming & ranching	3	2	2	7	0.29167
	10.1. Habitat shifting & alteration	1	1	3	5	0.20833
Nilopegamys plumbeus	2.3. Livestock farming & ranching	3	3	3	9	1

Recalculated STAR values

From the above steps, we finally calculated STAR scores for each threat to each species (Table S3).

Table S3. Recalculated STAR values, as well as originally estimated STAR-R scores for each threat to each species. NA = not available

Scientific name	IUCN red list category	Threat	STAR-T	STAR-R	Original STAR R scores from global data source
Ptychadena nana	Endangered	1.1 Housing & urban areas	105.88	17.62	15631.00
		2.1. Annual & perennial non-timber crops	123.53	20.55	15631.00
		9.2. Industrial & military effluents	70.59	11.74	15631.00
Arvicanthis blicki	Near threatened	2.3. Livestock farming & ranching	100.00	28.99	95853.42
Crocidura lucina	Vulnerable	2.1. Annual & perennial non-timber crops	100.00	16.64	15766.00
		2.3. Livestock farming & ranching	100.00	16.64	15766.00
Tachyoryctes macrocephalus	Endangered	2.3. Livestock farming & ranching	300.00	86.97	6142.80
Leptopelis yaldeni	Vulnerable	1.1 Housing & urban areas	83.33	72.50	1773.11
		2.1. Annual & perennial non-timber crops	116.67	101.50	3546.21
Crithagra ankoberensis	Vulnerable	2.1. Annual & perennial non-timber crops	58.33	50.75	NA

		2.2. Wood & pulp plantations	41.67	36.25	NA
		2.3. Livestock farming & ranching	58.33	50.75	NA
		10.1. Habitat shifting & alteration	41.67	36.25	3484.90
Nilopegamys plumbeus		2.3. Livestock farming & ranching	400.00	348.00	NA

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