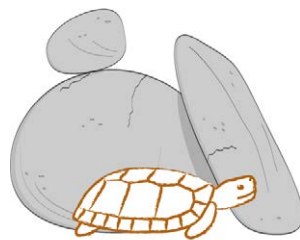


Ecology of the Karoo dwarf tortoise, *Homopus boulengeri*



Project proposal for a field study 2018–2020



Homopus Research Foundation

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The Homopus Research Foundation is a non-commercial organisation entirely run by volunteers. The aim of the foundation is to gather and distribute information on *Homopus* species, to facilitate their survival in the wild. This aim is achieved through scientific field studies, and through the development and study of captive studbook populations. Our results are published in scientific and popular outlets.

Introduction

Tortoises are among the most threatened vertebrates. Of the 52 extant tortoise species (Turtle Taxonomy Working Group, 2014), 39 have been assessed in the IUCN Red List of Threatened Species (IUCN, 2017). Assessments have categorised 82% Vulnerable, (Critically) Endangered or Extinct in the Wild. In addition, seven species are Extinct. These percentages exceed percentages for birds, mammals, amphibians, or sharks and rays (Turtle Conservation Coalition, 2011). The main threats to the survival of tortoises are habitat alteration (e.g., land development, overgrazing, mining) and collecting for consumption or the pet trade (Turtle Conservation Fund, 2002). Furthermore, climate change (e.g., Loehr, 2008) and predation by invasive predators (Berry *et al.*, 2013; Loehr, 2017) may impact tortoise populations. The morphology and life-history of tortoises, characterised by delayed maturity and iteroparous reproduction over many years, have helped them to survive millions of years, yet fail to protect against pressures imposed on them by humans.

South Africa harbours the most diverse tortoise fauna on earth; more than 25% of all extant species occur in South Africa (Bates *et al.*, 2014; Turtle Taxonomy Working Group, 2014). Moreover, nine species are endemic or near-endemic to South Africa (Bates *et al.*, 2014). This gives South Africa an important role and responsibility in the conservation of tortoises. Until recently, South Africa's tortoises appeared to be reasonably safe, with no species listed as Vulnerable and only one listed as Critically Endangered (IUCN, 2017). However, two species are currently being uplisted to Vulnerable, and one to Endangered (Turtle Taxonomy Working Group, 2014). This illustrates that South African tortoises are not spared in the overall decline of tortoise populations.



To develop effective conservation measures for threatened species, ecological information is crucial. The rich South African tortoise fauna demands a large research investment, but several species lack thorough studies. One species in particular, the Karoo dwarf tortoise (*Homopus boulengeri*), is poorly known. *Homopus boulengeri* occurs in the Great Karoo, from Montagu in the south-west eastwards to Somerset East, and northwards to Vanwyksvlei in the north-west and Britstown in the north-east (Boycott & Bourquin, 2000). In this area, it occurs in patches of suitable rocky terrain (Boycott, 1989; Boycott & Bourquin, 2000). Published information on its ecology is limited to a few notes on activity on cool summer days, predation by crows, egg size, mating and oviposition in captivity, translocation, and speculation on diet and natural egg-laying sites (Boycott, 1989; Haagner, 1990; Van Wijk & Bates, 1999; Boycott & Bourquin, 2000). There are no specific studies on *H. boulengeri*. Boycott & Bourquin (2000) stated that research is required to establish actual distribution limits, population size and dynamics, and conservation requirements. This appears urgent because recent intensive surveys of historic locations for *H. boulengeri*

yielded just a handful of individuals (Juvik & Hofmeyr, 2015). Moreover, the species is being uplisted to a Vulnerable conservation status (Turtle Taxonomy Working Group, 2014).

From 2005 to 2017, surveys in the *H. boulengeri* range have attempted to locate a population with sufficient density for an ecological field study. In February 2017, a suitable population was finally found (permit FAUNA 245/2/2015). The current document proposes a field study for the available population. This field study will run from 2018 to 2020.

Research aims

The primary aim of the proposed study is to gather and publish ecological information that is relevant for the conservation of *H. boulengeri*. It will focus on population structure and dynamics, tortoise growth rates, activity and movements, home ranges, diet, and reproduction. Results may simultaneously accommodate an academic interest. *Homopus boulengeri* is morphologically similar to *H. signatus*, and both inhabit a rocky habitat and produce single egg clutches. *Homopus signatus* has been well studied (Loehr, 2012; Loehr, 2015; Loehr, 2017; Loehr *et al.*, 2009). An important difference between the habitats of the two species is the rainfall pattern: summer rainfall for *H. boulengeri* and winter rainfall for *H. signatus*. Comparing the two species will provide insight in the effect of rainfall patterns on their ecologies. In addition, studying a second small rock-dwelling tortoise will consolidate the understanding of the ecologies of small tortoises that are restricted to rocky terrain.

Materials and Methods

Study site

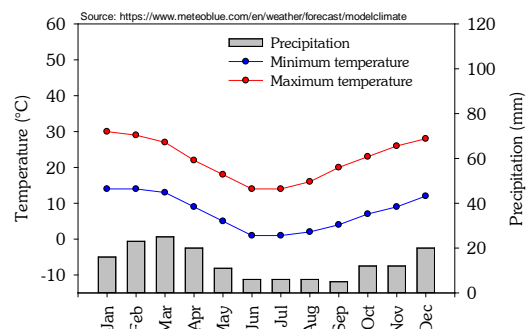
The study site consists of a 10–15 ha north-easterly facing hill, including rocky slopes and plateaus. I will model the site in GIS (e.g., elevations and microhabitats) and identify all plant species to facilitate dietary recordings. Any problematic identifications will be clarified by transporting and offering dried samples to Compton Herbarium (Kirstenbosch National Botanical Gardens, Newlands). A reference plant collection of dried herbarium specimens will be compiled and kept at the study site, for the identification of plant material in tortoise faeces. This reference collection will be used up and destroyed upon completion of the final sampling period in 2020.



I will use a stand-alone weather station to record rainfall, temperature and relative humidity throughout the study. In addition, I will annually quantify vegetation abundance and cover in ten permanent 1-m² plots.

Sampling design

Three sampling periods will enable the construction of a population model. The seasonal activity pattern of *H. boulengeri* is not known, however, most activity probably occurs in the rainfall season when water and food plants are available. Rainfall at the site, modelled for the past 30 years, peaks from October to May. Furthermore, egg-laying may occur from October onwards (Haagner, 1990; Boycott & Bourquin, 2000; Loehr, 2013). Consequently, annual sampling periods have been scheduled in the 2018–2020 rainfall seasons. The first and the final sampling periods will take 5 weeks, whereas the middle sampling period will take 12 weeks. I will methodically inspect the study site for tortoises daily (first and final sampling periods), or every few days (middle sampling period). In the end of the 2018 sampling period, 12 male and 12 female *H. boulengeri* will be



equipped with radiotransmitters, to track them in 2019 (males and females) and 2020 (females, which can carry longer-lasting radiotransmitters due to females' larger body size compared to males).

Data collecting

To facilitate comparisons with published data on *H. signatus*, much of the research protocol will be adopted from an earlier project on *H. signatus*. When a tortoise will be encountered, I will take the following records:

- Date and time
- Weather conditions (sun; partly cloudy; overcast; drizzle; rain; thunderstorm)
- Cloud cover (0–25; 25–50; 50–75; 75–100%)
- GPS coordinates
- Sun exposure (full sun; full shade; half shade)
- Type of retreat, when hiding (crevice or shrub; depth of crevice, and concealment of entrance)
- Body mass of the tortoise
- Shell dimensions (straight carapace length; maximum shell width, at xth marginal; shell width at the 7th marginal; maximum shell height, at xth vertebral; shell height at the 2nd and 4th vertebral; straight plastron length; size of the anal gap)
- Group (male; female; juvenile)
- Behaviour (basking; walking; hiding; feeding; combat; mating)
- Infrared temperature of the carapace, plastron and soil
- Reproductive status of females (radiography and/or ultrasonography)

When a tortoise will be recaptured using radiotelemetry (i.e., every 1–7 days, depending on activity), I will take the following records:

- Date and time
- Weather conditions (sun; partly cloudy; overcast; drizzle; rain; thunderstorm)
- Cloud cover (0–25; 25–50; 50–75; 75–100%)
- GPS coordinates
- Sun exposure (full sun; full shade; half shade)
- Type of retreat, when hiding (crevice or shrub; depth of crevice, and concealment of entrance)
- Behaviour (basking; walking; hiding; feeding; combat; mating)
- Reproductive status of females (radiography and/or ultrasonography, once every 21 days)

Each newly encountered tortoise will be notched (Honegger, 1979) and digitally photographed (plastron and carapace) for future identification. Continuous recordings of behaviour (1 day for each individual) will be made for all telemetered tortoises, to calculate activity budgets. In 2018 and 2019, when a handled tortoise will produce faeces, faeces will be dried and analysed against the reference plant collection to establish the diet of *H. boulengeri*.

Temporary removal of tortoises

In some cases, it will be required to remove tortoises temporarily (< 48 hrs) from their habitat:

- Attaching radiotransmitters (2018)
- Radiographing and/or ultrasound scanning females to determine their reproductive status (2018–2020)

In all cases, tortoises will be kept within the Northern Cape Province and as close to the study site as possible, and released at the site of capture.



Planning, Permits and Ethical Clearance

The sampling periods and expected permit requirements for this study are shown in the table below. The Northern Cape Department of Environment and Nature Conservation will be requested to grant a research permit for the full study. The procedures that I will use have been approved by the Senate Research Committee of the University of the Western Cape (registration no: 04/4/11).



Sampling period	Activities	Permits
14 Feb–22 Mar 2018	• Taking GPS coordinates to model elevations and microhabitats	No
	• Placing rainfall, temperature and humidity dataloggers	No
	• Identifying plant species in the field (non-destructively)	No
	• Establishing 10 permanent 1-m ² plots, and quantifying vegetation abundance and cover (non-destructively)	No
	• Collecting, drying and transporting plant samples (1 per species) to Compton Herbarium (Newlands) for identification (max. 25 species)	Yes
	• Collecting and drying plant samples (1 per species) for reference collection (max. 100 species)	Yes
	• Locating and handling tortoises (max. 30 males and 30 females)	Yes
	• Temporarily removing max. 30 females from the study site for <ul style="list-style-type: none"> ◦ radiographing max. 30 females ◦ ultrasounding max. 30 females 	Yes Yes
	• Temporarily removing 12 males and 12 females from the study site to attach radiotransmitters	Yes
	• Collecting, drying and storing faecal samples	No
	12 weeks in Oct 2018–Mar 2019 ¹ (tentatively: 11 Dec 2018–4 Mar 2019)	• Identifying new plant species in the field (non-destructively)
• Quantifying vegetation abundance and cover (non-destructively)		No
• Collecting, drying and transporting new plant samples (1 per species) to Compton Herbarium (Newlands) for identification (max. 5 species)		Yes
• Collecting and drying new plant samples (1 per species) for reference collection (max. 5 species)		Yes
• Locating and handling tortoises (max. 30 males and 30 females)		Yes
• Temporarily removing max. 30 females from the study site <ul style="list-style-type: none"> ◦ radiographing max. 30 females ◦ ultrasounding max. 30 females 		Yes Yes
• Tracking telemetered males and females		Yes
• Recording continuous behaviour of telemetered males and females		No
• Collecting, drying and analysing faecal samples against reference plant collection		No

Sampling period	Activities	Permits
5 weeks in Oct 2019–Mar 2020 ¹ (tentatively: 31 Dec 2019–3 Feb 2020)	<ul style="list-style-type: none"> • Identifying new plant species in the field (non-destructively) • Quantifying vegetation abundance and cover (non-destructively) • Collecting, drying and transporting new plant samples (1 per species) to Compton Herbarium (Newlands) for identification (max. 5 species) • Locating and handling tortoises (max. 30 males and 30 females) • Temporarily removing max. 30 females from the study site <ul style="list-style-type: none"> ○ radiographing max. 30 females ○ ultrasounding max. 30 females • Tracking telemetered females • Removing all materials from the field 	<p>No</p> <p>No</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p> <p>No</p>

¹ Exact dates will be selected based on the 2018–2019 behavioural and reproductive results.

Results will be processed in the end of the field study. I will submit manuscripts for publication in international, peer-reviewed journals.

Budget

Expenses for this study (2018–2020) will be relatively low, for two reasons: (1) most of the research materials are already available at the Homopus Research Foundation (e.g., receiver, antenna, dataloggers, balances) or at the University of the Western Cape (e.g., X-ray machine), and (2) volunteers will provide the required capacity (including management). The remaining costs for the study as a whole are listed in the table below.

Item	Costs (€)	Source of funding
International travel expenses	10,000	Volunteers (4 persons in 2018 and 2020; 1 in 2019)
National travel expenses	5,000	Volunteers
Accommodation	8,000	Volunteers
Radiotransmitters	5,000	Homopus Research Foundation ¹
Identification plant species Compton	500	Homopus Research Foundation ¹
Radiography	500	Homopus Research Foundation ¹
Various field materials	500	Homopus Research Foundation ¹
Publication manuscripts	500	Homopus Research Foundation ¹
Unexpected - 10% of budget	3,000	Homopus Research Foundation ¹
Total	33,000	

¹ The Homopus Research Foundation may attempt to acquire funding from manufacturers, reptile societies, and other sponsors of herpetological research.

Collaboration

This study will be conducted in collaboration with the University of the Western Cape (Professor Emeritus M.D. Hofmeyr). Prof. Emer. Hofmeyr will conduct tracking of telemetered tortoises and ultrasound measurements. In addition, the scheduled continuous behavioural recordings may be conducted by a student.

Volunteers

Previous field studies and surveys on *Homopus* conducted by the Homopus Research Foundation have benefited from volunteer assistance in the field. Most volunteers were private tortoise keepers, biology students or zoo staff. When involving volunteers in field studies, risks and benefits need careful consideration. An obvious risk is the publicization of tortoise localities and the associated risk of poaching. This risk may be minimised by instructing volunteers not to share localities with others, and not to reveal photographs depicting landmarks or containing locality metadata. In the history of the Homopus Research Foundation, there have been no incidences of poaching or other impacts due to the involvement of volunteers. Our experience is that the benefits of involving volunteers outweigh the risks. Volunteers provide expert capacity, allowing the capture and processing of many tortoises in little time, at virtually no costs. Moreover, volunteers have shown to be eager to learn about tortoise conservation, and shared this information with others (e.g., lectures), increasing awareness of the plight of tortoises. Therefore, the current study will continue to involve volunteers.

Literature cited

- Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, and G.J., De Villiers, M.S., 2014. Atlas and red list of the reptiles of South Africa, Lesotho and Swaziland. First edition, second impression. South African National Biodiversity Institute, Pretoria.
- Berry, K.H., Yee, J.L., Coble, A.A., Perry, W.M., and Shields, T.A., 2013. Multiple factors affect a population of Agassiz's desert tortoise (*Gopherus agassizii*) in the northwestern Mojave Desert. *Herpetological Monographs* 27:87-109.
- Boycott, R. and Bourquin, O., 2000. The southern African tortoise book: a guide to southern African tortoises, terrapins and turtles. Privately printed, Hilton, South Africa.
- Boycott, R.C., 1989. *Homopus boulengeri*, Karoo padloper; Boulenger's padloper; Red padloper; Biltong tortoise (English), Karooskilpadjie; Rooiskilpadjie; Donderweerskilpad; Biltongskilpad (Afrikaans). Pages 78-79 in Swingland, I.R. and Klemens, M.W., IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, The Durrell Institute of Conservation and Ecology editors. The conservation biology of tortoises: Occasional papers of the IUCN Species Survival Commission no. 5. IUCN, Gland, Switzerland.
- Haagner, G.V., 1990. *Homopus boulengeri*, Karoo padloper, egg size. *Journal of the Herpetological Association of Africa* 37:51.
- Honegger, R.E., 1979. Marking amphibians and reptiles for future identification. *International Zoo Yearbook* 19:14-22.
- IUCN, 2017. The IUCN Red List of Threatened Species. Version 2016-3. <www.iucnredlist.org>. Downloaded on 5 March 2017.
- Juvik, J.O. and Hofmeyr, M., 2015. Vanishing with little fanfare: Boulenger's tortoise on the South African Karoo. *The Tortoise* 1:142-149.
- Loehr, V.J.T., 2008. The ecology of the world's smallest tortoise, *Homopus signatus signatus*: effects of rainfall. University of the Western Cape, South Africa.
- Loehr, V.J.T., 2012. High body temperatures in an arid, winter-rainfall environment: thermal biology of the smallest tortoise. *Journal of Arid Environments* 82:123-129.
- Loehr, V.J.T., 2013. *Homopus femoralis* (greater padloper). Reproduction. *Herpetological Review* 44:304-305.
- Loehr, V.J.T., 2015. Small vernal home ranges in the Namaqualand speckled tortoise, *Homopus signatus*. *Journal of Herpetology* 49:447-451.
- Loehr, V.J.T., Hofmeyr, M.D., and Henen, B.T., 2009. Small and sensitive to drought: consequences of aridification to the conservation of *Homopus signatus signatus*. *African Journal of Herpetology* 58:116-125.
- Loehr, V.J.T., 2017. Unexpected decline in a population of speckled tortoises. *Journal of Wildlife Management*; DOI: 10.1002/jwmg.21217.
- Turtle Conservation Coalition [Rhodin, A.G.J., Walde, A.D., Horne, B.D., Van Dijk, P.P., Blanck, T., and Hudson, R. (Eds.)], 2011. *Turtles in trouble: the world's 25+ most endangered tortoises and freshwater turtles*. Lunenburg, MA.
- Turtle Conservation Fund, 2002. A global action plan for conservation of tortoises and freshwater turtles. Strategy and funding prospectus 2002. Conservation International and Chelonian Research Foundation, Washington DC.
- Turtle Taxonomy Working Group [van Dijk, P.P., Iverson, J.B., Rhodin, A.G.J., Shaffer, H.B., and Bour, R.], 2014. *Turtles of the world, seventh edition: annotated checklist of taxonomy, synonymy, distribution with maps, and conservation status*. Pages 000.329-000.479. Conservation biology of freshwater turtles and tortoises: a compilation project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group.
- Van Wijk, J.C.P. and Bates, M.F., 1999. *Homopus boulengeri* Duerden, 1906. Karoo padloper. *African Herp News* 29:42-43.