

Future of the studbook on *Chersobius signatus*

Discussion paper

Dwarf Tortoise Conservation
Victor Loehr

30 July 2023

Introduction

The studbook population *Chersobius signatus* has developed from a small number of founders. Careful management to maximise genetic diversity has led to a population that is still demonstrably free of inbreeding after almost 30 years. This was accomplished by strictly combining pre-determined, genetically unrelated bloodlines to breed successive generations. Because the availability of such bloodlines is directly related to the number of founders in the population, we will soon run out of possibilities to form new genetically unrelated breeding couples.

Example of pre-determined combinations of genetically unrelated bloodlines

Offspring from founders 1×2 was combined with offspring from founders 37×38, and offspring from founders 1×3 was combined with offspring from founders 35×36. In the next generation, F2 offspring from (1×2)×(37×38) was combined with offspring from 35×36 to produce partial F3 offspring without inbreeding. Similarly, F2 offspring from (1×3)×(35×36) was combined with offspring from 37×38. See also Appendix 1 of the [studbook management plan](#).

The [studbook management plan](#) anticipates on gradually increasing the number of founders in the captive population, but the plan requires an update in 2023. The last addition of founders in 2015 was less successful than expected, so that we should evaluate our methods. Furthermore, the conservation status of *C. signatus* in the wild has deteriorated, demanding thorough consideration of any additional captures in the wild. As part of the upcoming studbook management plan update, it should be assessed if the current (conservation) aim of the studbook is still valid and realistic, or if we should downgrade the aim and accept degradation of the genetic quality of the captive population.

To succeed in achieving studbook aims, it is essential that participants understand and support them. Therefore, a meeting will be held on 9–10 September 2023 to discuss our strategy for the next 5–10 years. The current discussion paper was drafted in preparation for the meeting. It also enables participants who will be unable to attend (e.g., the zoos of Amsterdam, Plzen, Wroclaw and Wuppertal due to an EAZA meeting, and operational studbook coordinator Martijn Kooijman due to work obligations) to provide their input prior to the meeting.

Historical timeline of the studbook

1995: Import of 2.2 founders and start of the studbook
1996: First production of offspring (F1)
2001: Import of 2.2 founders
2002: First zoo participating in the studbook (Wuppertal Zoo)
2003: First production of second-generation offspring (F2)
2008: Studbook management plan drawn up
2013: Studbook management plan 5-yearly update
2015: Import of 5.5 founders
2016: Studbook management plan update after adding founders
2018: Studbook management plan update after *C. signatus* was assessed Endangered by the IUCN
2020: First production of third-generation offspring (F3)
2023: 86 live tortoises, 34 participants (5 zoos) in 11 countries

Permit requirements

The collecting permits issued to the Homopus Research Foundation (currently known as Dwarf Tortoise Conservation) contain strict conditions that help us acknowledge the view of the South African authorities on exploitation of wild tortoise populations (i.e., wild tortoise populations may not be used for commercial trade). The following conditions are particularly relevant:

Collecting permit issued by the Western Cape Province in 1995:

“Any hatchlings that have been bred in captivity must stay the property of the studbook and may not be used for commercial purposes.”

Collecting permit issued by the Northern Cape Province in 2001:

“Collected specimens may not be sold, traded, or used for any other commercial purposes.”

Memorandum of Understanding between the Homopus Research Foundation and the Northern Cape Province, signed in 2001:

“Subject to clauses 2 and 4 below, the Applicant may use the material and progeny or derivatives thereof (such as modified or unmodified extracts) for non-commercial purposes only.”

“Under this agreement, the Applicant may not commercialise the material or any progeny or derivatives thereof.”

“The Applicant may not transfer the material or any progeny or derivatives thereof to any third party [this includes studbook participants VL] without the prior informed consent in writing of the Director and then only under a written agreement containing terms no less restrictive than those contained in this agreement unless otherwise agreed in writing by the Director. The Applicant agrees to take every reasonable precaution to prevent the material coming into the possession of any unauthorised third party.”

Especially the last condition in the Memorandum of Understanding necessitates Dwarf Tortoise Conservation to enter formal agreements with studbook participants, transferring conditions to participants. Currently, every studbook participant in the studbook *C. signatus* (including zoos) has signed this agreement. The foundation has discussed with the South African authorities that it will act as an “operational manager”, so that it is not necessary to ask the authorities permission for each transfer.

Global trade of *C. signatus*

During the past 30 years, there has been virtually no legal commercial trade of *C. signatus* (Table 1). The last authorised commercial exports from South African were to the USA in 1993–1994. Within the EU, CITES authorities have legalised at least two confiscated *C. signatus* (one of which died soon thereafter), but it appears that their very limited offspring are all genetically related. Virtually all legal, captive *C. signatus* globally are owned by Dwarf Tortoise Conservation and managed by the studbook.

Table 1. All legal trade of live *Chersobius signatus* in the past 30 years. Green numbers indicate trade within the studbook. Red numbers indicate possible unauthorised trade (i.e., not reported by an importer or exporter).

Year	Importer	Exporter	Origin	Importer reported quantity	Exporter reported quantity	Purpose	Source
1993	JP	ZA		7	7	T	W
1993	US	ZA		18		T	U
1993	US	ZA			7	T	W
1994	US	ZA			13	T	
1995	NL	ZA		1		S	W
1998	US	AR			7	P	C
1999	US	ZA			4	B	W
2001	NL	ZA			4	S	W
2003	CZ	NL		2	2	Z	C
2007	GB	NA		1			I
2011	JP	ZA			15	T	C
2015	NL	ZA		10		B	W
2015	NL	ZA			10	N	W
2016	CH	IT	BE	1		B	C
2016	CH	IT	NL	1		B	C
2016	CH	IT			2	B	C
2017	CH	BE		1	1	T	F

Aim and methods in the current studbook management plan

The studbook management plan has been formulated in consultation with the South African authorities. The current plan (2018) aims to develop the captive population in such a way that it can serve as donor for reintroductions might the need arise in the (long-term) future (i.e., conservation breeding). To this end, the genetic diversity of the captive population is maximised by:

- acquisition of at least 31.31 founders (currently effective 9.10);

- delaying reproduction into subsequent generations of offspring (first reproduction at age 10 years in all generations);
- avoiding inbreeding.

In addition, the maximum size of the captive population was set at 300–350 individuals, to ensure that it will remain manageable and that no tortoises will become lost for the studbook. The maximum population size translates to a required production of approximately 6.6 F1 offspring per founder (i.e., surviving offspring that eventually reproduces into F2).

Results relatively to the aims in the studbook management plan

The [annual reports of Dwarf Tortoise Conservation](#) compare progress of the studbook on *C. signatus* with the aims in the studbook management plan. Overall, the following is relevant:

- Three deceased founders have no surviving offspring in the captive population (i.e., these bloodlines have gone extinct).
- None of the 5.5 founders imported in 2015 (currently 3.3 deceased) have yet produced the required 6.6 F1 offspring.
- Reproduction into F2 is skewed (i.e., not all F1 offspring have produced similar numbers of F2 offspring).
- Breeding quota per breeding couple have been implemented to avoid further skewness.
- Many studbook participants keep couples that should breed, but fail to produce the offspring needed. Studbook participants have been urged to follow the husbandry and incubation guidelines prepared by Dwarf Tortoise Conservation.

Summarising, the captive population has not reached maximum achievable genetic quality, despite the lack of inbreeding.

Example of skewed reproduction into F2

Founder 2 has produced 14 offspring (F1). Four of these have produced a total of 27 offspring (F2), whereas the remaining F1 offspring have not reproduced. According to the studbook management plan, 12 offspring (F1) should each have produced two offspring surviving and reproducing into F2.

Scenarios for the future

In light of the above, there are several scenarios how the studbook could proceed, each with its pros, cons, and requirements.

1. *Maintaining the studbook aim of conservation breeding*

In this scenario, the current aim and methods in the [studbook management plan](#) would remain in place.

Pros	Cons
Studbook continues to facilitate future conservation	Additional founders needed (preferably in 2024)
Coordinators/participants used to aim and methods	Survival of new founders should be improved
Aim is motivational for coordinators/ participants	Skewness in breeding F1...Fx needs to be solved
Requirements	
Volunteers to apply for permits, to finance, and to capture and export founders	
Permits issued by the South African authorities	
Plan to improve founder survival (e.g., importing smaller numbers of founders to successful locations)	
Plan to reduce skewness (e.g., transferring nonbreeding couples to successful locations)	

2. *Downgrading the studbook aim from conservation breeding to captive-conservation*

In this scenario, we would no longer pursue a conservation aim, but we would still optimise the genetic quality of the captive population (e.g., minimise inbreeding) to preserve it in captivity. The coordination of the studbook would mostly remain similar to the current situation (e.g., arranging combinations of certain bloodlines and setting breeding quota). Given the small number of founders, this aim might require a further increase of generation time (i.e., less breeding).

Pros	Cons
Few or no additional founders needed	No conservation benefit for wild population
No dependency on South African authorities	Skewness in breeding F1...Fx needs to be solved

Pros	Cons
	Further decrease of captive breeding
	Possibly too few founders for long-term success
Requirements	
Participants prepared to keep but not breed tortoises	
Plan to reduce skewness (e.g., transferring nonbreeding couples to successful locations)	

3. *Downgrading the studbook aim from conservation breeding to administrative*
 In this scenario, we would no longer manage the genetic quality of the captive population, but only its maximum size (e.g., 300–350 individuals, to avoid loss of tortoises from the studbook). Coordinators would merely register births, transfers and deaths, but not arrange certain combinations of bloodlines and breeding quota. All tortoises would still remain the property of Dwarf Tortoise Conservation, following permit conditions.

Pros	Cons
Simplified management of the population	No conservation benefit for wild population
Initially, removal of breeding quota	Rapid degradation of genetic quality (e.g. skewness)
Documentation of possible effects of inbreeding	Possible increase of genetic disorders
Requirements	
Coordinators willing to spend time on rather meaningless administration	

4. *Phasing out the studbook*
 In this scenario, we would give up the studbook entirely. Breeding would cease and the population would exist until the last tortoise will have died.

Pros	Cons
Simplified management of the population	No conservation benefit for wild population
Eventually, discharge of permit obligations	No captive data generated and published
	Efforts of the past 28 years in vain
Requirements	
Participants prepared to keep but not breed tortoises	
Coordinators willing to spend time on rather meaningless administration	

Concluding remarks

The current conservation aim of the studbook is linked to actual conservation in the wild. In 2018, the (conservation breeding) studbook was included in the [IUCN Red List](#) assessment. In 2020, the Endangered Wildlife Trust (South Africa) started surveys and habitat preservation work in which Dwarf Tortoise Conservation participates. And in 2023, CapeNature (South Africa) provided a support letter to Dwarf Tortoise Conservation acknowledging the work of the studbook, accepting the occasional need of wild-caught founders.