CEPF FINAL PROJECT COMPLETION REPORT

I. BASIC DATA

Organization Legal Name: University of Stellenbosch

Project Title (as stated in the grant agreement): Effective Conservation of Amphibians and Reptiles in the Greater Cederberg Biodiversity Corridor (SCARCE)
Implementation Partners for this Project: University of Stellenbosch, Western Cape Nature Conservation Board (now CapeNature), Northern Cape Department of Agriculture, Land Reform, Environment and Conservation, South African National Parks, Mountain Club SA
Kontreitoere was co-opted as partner in 2004

Project Dates (as stated in the grant agreement): January 1, 2004 – March 31, 2008

Date of Report (month/year): May 2008

II. OPENING REMARKS

Provide any opening remarks that may assist in the review of this report.
In 2005, the South African Reptile Conservation Analysis (SARCA) was initiated. Data generated by SCARCE were incorporated in the SARCA database. SARCA's collated database for South African reptiles is accessible on their website (http://sarca.adu.org.za/) in the form of quarter degree distribution maps for all species. The new Red Data Book for Reptiles that is presently being compiled is based on this database. Contribution to SARCA's national database therefore replaced the original aim of SCARCE to compile a database for the GCBC alone as this would have led to unnecessary duplication.

III. ACHIEVEMENT OF PROJECT PURPOSE

Project Purpose*: To increase the understanding of and appreciation for the important ecological role that amphibians and reptiles play in the various ecosystems of the CFR, and particularly those of the Greater Cederberg Biodiversity Corridor.*

Planned vs. Actual Performance

Indicator	Actual at Completion
Purpose-level:	
1. Herpetofaunal data are being applied to planning and decision making processes in the Greater Cederberg Biodiversity Corridor in 50% of cases within one year and in 80% of cases within two years of project end date	Cannot tell at this stage, but see opening remarks
2. There is a gradual increase in the use of the Herpetofauna Website by the public from nine months after the project start date	Yes

Describe the success of the project in terms of achieving its intended impact objective and performance indicators.
We are convinced that the project has considerably increased the understanding of and appreciation for the important ecological role that amphibians and reptiles play in the various

ecosystems of the CFR, and particularly those of the Greater Cederberg Biodiversity Corridor. For the first time, patterns of reptile distribution in southwestern South Africa have been thoroughly analyzed and the significance of the GCBC for reptile conservation evaluated. In addition, for the first time we now understand the evolution of group-living among lizards and the recruitment abilities of fire sensitive species. We now also have a clear understanding of the climatic conditions associated with melanism and can make informed predictions regarding the fate of melanistic species in changing environments. Because of the involvement of the public and stakeholders in the general survey, we are also convinced that the project has raised awareness and resulted in a positive attitude towards the conservation of amphibians and reptiles in the GCBC. Owners of most ecotourism destinations were keen to include herpetofaunal elements as value-adding features in activities offered, and we believe that this will eventually impact positively on conservation of reptiles and amphibians in the GCBC.

Were there any unexpected impacts (positive or negative)?
Public enthusiasm was overwhelming.

IV. PROJECT OUTPUTS

Project Outputs:

Planned vs. Actual Performance

Indicator	Actual at Completion
Output 1: An information pack (brochure and website) on the megareserve amphibians and reptiles. Links with all ecotourism websites of the region will be established.	
1.1. Website operational after 9 months	yes
1.2 Brochure in circulation after 9 months	yes
Output 2: A comprehensive and up-to-date database (including distribution maps) on the distribution of the amphibians and reptiles of the region. The database will form part of the existing, combined database of the US and WCNCB, which is permanently maintained and accessible on the internet.	
2.1 Database operational after 6 months	yes
2.2 Areas to survey identified after 3 months	yes
2.3 Stakeholders are contributing to the database	yes
2.4 Civil society is contributing to the database	yes
2.5 Project team is contributing to the database	yes
Output 3: A conservation analysis of the herpetofauna of the region, the results of which will be utilised as strategic input for the design of the megareserve, as well as for a conservation management plan for the megareserve (not only that of the statutory conservation areas, but also conservancies, private nature reserves and other private conservation initiatives).	

3.1 Areas of herpetological importance have been identified and mapped	Yes (see below)
3.2 Areas which are important for the maintenance of ecological processes among amphibians and reptiles have been identified and mapped	Yes (see below)
3.3 Threats to the herpetofauna have been identified and mapped	Yes (see below)
3.4 Conservation targets have been set for the herpetofauna	Yes (see below)
3.5 An optimal conservation area network for the effective conservation of the herpetofauna have been identified and mapped	Our data showed that this was unnecessary
Output 4: Biological profiles for threatened amphibian and reptile species and for selected species with ecotourism potential.	
4.1 Additional biological data available for all IUCN-listed amphibian and reptile species and for some species with ecotourism potential occurring in the area	Yes (see below)

Describe the success of the project in terms of delivering the intended outputs.

All the intended outputs were delivered, although not always in the format as originally planned. Via a website containing information on all amphibian and reptile species occurring in the Greater Cederberg Area, a poster distributed among all schools in the area, and a brochure distributed at tourist information centers, the public were invited to participate in the survey by taking and sending in photographs of frogs and reptiles they may encounter in the Greater Cederberg Area. The herpetofauna website was linked to most ecotourism websites of the Greater Cederberg Area and we believe that it played (and is still playing) an important role in increasing the understanding of and appreciation for the important ecological role that amphibians and reptiles play in the various ecosystems of the Greater Cederberg Biodiversity Corridor. At many cadastral units, ecotourism opportunities were pointed out to the owners. Photographic checklists of herpetofauna were prepared for the following cadastral units on request of the owners, and we believe that this has had a very positive effect on public appreciation of herpetofauna: Bizansgat (DeVille Wickens), Bushmans Kloof, De Pakhuys (Thys Kruger), Draaihoek (West Coast), Mr Engelbrecht (Sandveld); GCBC Stewardship (Cederberg area); GCBC Stewardship (Sandveld region), Gekko Backpackers; Groot Winterhoek Wilderness Area, KaggaKamma, Kareekloof; Keurbosfontein/Bakkrans, Matjiesrivier Nature Reserve, Mount Ceder, and several farms in the Tankwa region.

A number of cadastral units were selected for long-term surveys, in which assistants, nominated by the respective units and trained by the project team, partook. Several other localities, carefully selected to be representative of the whole GCBC, were visited once during the survey. The project resulted in 1213 reptile and amphibian records. The reptile records have already been transferred to the database of CapeNature and have also been included in the database of the South African Reptile Conservation Analysis (SARCA) where it will make a substantial contribution in the compilation of the new Red Data Book for Reptiles that is currently in progress. Several important records were received from the public, the most noteworthy being the finding of a chameleon at Bakkrans and of an as yet undescribed species near Lambert's Bay.

In addition to the general survey, the project also targeted specific issues of conservation concern. A detailed biogeographical and conservation analysis was conducted to evaluate the relevance of the GCBC for reptile conservation. The relevance of the GCBC for the conservation of the reptilian fauna in the area south of 31°S and west of 21°E was assessed. This entailed determining the GCBC's coverage of regional reptile diversity patterns and assessing its potential conservation significance during possible climate induced changes in reptile distributions.

Reptile species point distribution data from the preliminary (2007) SARCA (South African Reptile Conservation Assessment) database were used. Under-representation of the Tankwa Karoo in the dataset necessitated a comprehensive survey of this region. Additionally, the biogeographical influence of the arid Tankwa Karoo Basin on the distribution of reptiles in the south-western districts of South Africa was investigated. We established that turnover across the Basin is high, that species richness is lower than in surrounding mountainous areas and that there are no species endemic to the area. The Tankwa Karoo Basin acts as a dispersal barrier for many reptile species occurring in the surrounding more mesic areas. At the same time, the ranges of a number of typical northern, arid adapted species extend southward along the Tankwa Basin. A number of species range extensions in the region were reported.

Patterns of endemism, species richness and turnover were plotted from the point distribution data at quarter and eighth degree square resolution. Extensive sampling bias towards reserves and populated areas was apparent from the reptile species richness plots. This pattern is more pronounced for snakes than lizards. We found that reptile richness is particularly high along the north-south section of the Cape Fold Mountains and also relatively high along the south-western coast, peaking in the Lambert's Bay area. The majority of the 20 reptile species endemic to the study area are associated with one of two identified centers of endemism: the Greater Cederberg Area, or the narrow coastal zone stretching from the Lambert's Bay area to the Cape Peninsula. An additional third set of endemics comprised of melanistic forms restricted to a number of different refugia, notably, Landdroskop, the Cape Peninsula, Saldanha-Langebaan region, Piketberg Mountains and a confined area along the western section of the Cape Fold Mountains. Species richness and endemism patterns co-vary within the study area.

We identified Northern, Southern, Central and Western biotic regions and described four species assemblages on the basis of these biotic regions. The Northern assemblage can be described as an arid zone one and the Southern assemblage as a mesic zone one. The Central assemblage, comprising mainly rock-dwelling forms, represent evolutionary leftovers as a result of climate change induced cycles of contraction and expansion of the arid and mesic faunas. The West Coast assemblage can be considered a sub-assemblage of the Northern one, with particular adaptation to the coastal climate. Environmental characterization of the biotic regions revealed that these groupings are supported by a strong environmental signal. The contiguity of four distinct sets of reptiles, each with its own set of environmental requirements, in this relatively small geographic area clearly indicates that the south-western region of South Africa is biogeographically complex.

We showed that the GCBC incorporates the largely coinciding centres of endemism and richness along the West Coast and the greater Cederberg area. Although the centre of endemism for melanistic reptile forms in the Saldanha-Langebaan area falls just south of the GCBC boundary, the Corridor fulfils the requirements for effective conservation of reptiles in the area to a large degree. The north-south dispersal pathways provided by the Corridor along the Cape Fold Mountains is believed to be adequate to buffer climate change effects, however there is concern about its ability to contribute to the persistence of the assemblage associated with the narrow coastal zone in the west. Our survey showed that there are no critical conservation issues in the GCBC as far as its herpetofauna is concerned. The majority of Greater Cederberg endemics are rock-dwelling forms which are adequately protected in the mountainous areas. The status of coastal species should, however, be continuously monitored.

Detailed studies were also conducted on melanistic lizard species occurring in the Corridor and considered to be highly sensitive to environmental change, on the post-fire recruitment abilities of arboreal lizards, normally suffering heavy losses during fire, and on the role that termitophagy plays in the grouping behaviour of the threatened armadillo lizard (*Cordylus cataphractus*). We first identified those climatic conditions associated with the distribution of melanistic cordylid lizards, five of which occur within the boundaries of the GCBC, using GIS and a principal component analysis. Coastal melanistic species were found to be associated with a high incidence of fog, while montane melanistic species are associated with a high incidence of cloud cover and orographic fog. In contrast to the other melanistic species, which have very restricted distributions, the graceful crag lizard *Pseudocordylus capensis* is widely distributed even in hot lowland areas. We established that this species, which we consider a key ecotourism species in the GCBC as it frequents waterfalls and areas of huge piled up rock formations, which are often also tourist attractions, is buffered against the constraints of melanism in hot environments. Its unique morphology allows it to scale vertical surfaces and thereby to use a wide range of microclimatess enabling it to thermoregulate effectively. These results allow us to make the informed prediction that the graceful crag lizard, unlike other melanistic species occurring in the GCBC, will not be adversely affected by global climate change.

Several arboreal lizard species occur in the GCBC and all of them suffer heavy losses during fires. We investigated the behaviour of these species in the event of fire and also their recruitment potential, information which is crucial for effective fire management. We established that dwarf chameleons (*Bradypodion*), three species of which occur within the boundaries of the GCBC, all showed an aseasonal reproductive cycle with relatively high clutch sizes for their body size and the possibility of individual females producing multiple clutches per year. Male *Bradypodion* have sperm available throughout the year. Dwarf chameleons, regardless of habitat and associated climatic conditions, are thus able to reproduce throughout the year. It has also been demonstrated in *B. pumilum* that both sexes are able to store sperm and it is expected that other *Bradypodion* species would also possess this character. This type of reproductive strategy is highly unusual for viviparous, temperate-zone lizards. It is likely that the cooling of the climate due to the development of the Benguela current facilitated the transition to viviparity in *Bradypodion*. *Bradypodion* may be aseasonal reproducers for a number of reasons, but they most likely have a high reproductive output due to their intense vulnerability to predation. The proposed hypothesis that the unusual reproductive characteristics of *B. pumilum* (and possibly the ancestral *Bradypodion*) were due to inhabiting a fire-prone environment now appears an unlikely explanation. However, even if this extraordinary reproduction was not in direct response to fire, the strategy appears beneficial in this type of unpredictable environment. The dwarf chameleon species occurring in the GCBC are thus pre-adapted for life in fire-prone habitats and despite heavy losses during fire, populations have the ability to quickly recover after a fire.

The Cape Grass Lizard, *Chamaesaura anguina*, is another arboreal snakelike lizard occurring in the southern parts of the GCBC. In the event of fire, grass lizards attempt to flee from it by grass-swimming. Mortality is normally extremely high. We investigated why these lizards select to flee from fire rather than to search for safe shelters. In the laboratory, we found that the lizards ignored burrows as a shelter option and only used grass tufts to shelter in overnight. When only burrows were available as shelter, the lizards ignored them and preferred not to shelter at all. When confronted by a human posing as a predator, grass lizards selected to flee by grass-swimming rather than to hide in burrows which were provided. A comparison of vertebrae length of several snakelike reptile species showed that grass lizards have relatively long body and tail vertebrae. We concluded that an arboreal, sit-and-wait foraging strategy in a grass/restio habitat would require a relatively long and rigid snakelike body to effectively distribute body weight and to reach over openings. Large body size and high body rigidity would make fleeing from predators by grass-swimming highly effective, but in the event of fire would preclude the effective use of safe shelters. This leaves fleeing by grass-swimming as the only option in the event of fire. The majority of grass lizards would die in the event of fire, but a number may reach the safety of footpaths and road verges where they can survive for quite some time depending on local conditions. These refugia, however need careful monitoring and if necessary survivors need to be relocated to adjacent unburnt areas. Poor fire management practices can lead to local extinction of grass lizards in isolated patches of fynbos because recolonization from unburnt areas cannot take place. In such cases reintroduction of grass lizards is required.

We have conducted several studies on the Armadillo Lizard *Cordylus cataphractus*. This species exhibits one of the clearest and most complete manifestations of a permanently group-living lifestyle of any lizard species, and possesses numerous unique physiological and behavioural characteristics related to its grouping behaviour. It is endemic to the Succulent Karoo Biome in South Africa and has been identified as a key species in the GCBC, both from a conservation and an ecotourism point of view. Reliance on the southern harvester termite *Microhodotermes viator* as a food source appears to have been instrumental in the evolution of group-living. It is possible that termitophagy enables *C. cataphractus* to survive the summer-autumn period of low food availability and high maintenance cost associated with a winter-rainfall regime. The peak in arthropod abundance at the end of the rain season coincides with the mating season of the lizard. It is possible that this allows for a single period of heightened activity and an expected overall decrease in exposure to aerial predation.

In another study, we investigated possible differences in the consumption of termites (*Microhodotermes viator*) by individuals in different sized groups of *C*. *cataphractus* during different times of the year. We found termite consumption to be generally greater in larger than smaller groups throughout the year. Individuals in all group categories utilized termites throughout the year, but consumption was low at the end of winter, a time when general insect abundance is high. We conclude that termitophagy is important to individuals living in large groups, particularly during the dry period of the year, most probably to reduce intragroup competition for food.

In a third study, we compared site fidelity among solitary and group-living individuals in a population of *Cordylus cataphractus.* We also compared the incidence of solitary individuals between the sexes and between different seasons. We found that solitary individuals were significantly less loyal to their rock shelters than individuals living in groups, and solitary females appeared to be less loyal than solitary males. Solitary males were significantly smaller in body size than group-living males, but did not have more scars or other deformities than the latter. The significantly lower site fidelity displayed by solitary than group-living individuals supports the conclusion that being in a group must be the optimal situation for individuals of this relatively slow-moving cordylid. The data also suggest that the exclusion of less competitive males from groups may in part be responsible for the occurrence of solitary males.

Cordylus cataphractus developed heavy dermal armour and a distinctive tail-biting anti-predator mechanism to protect it against terrestrial predators it encounters when away from the crevice. However, this species is also preyed upon by avian predators against which speed is an essential means of escape, but due to its heavy armour *C. cataphractus* is relatively slow and clumsy. Therefore, in *C. cataphractus*, the selective pressure from terrestrial predation associated with termite foraging excursions led to the evolution of a heavily armoured morphology, and due to the contrasting demands of terrestrial and aerial predation on morphology, this species' anti-predator defence against birds of prey should thus be a behavioural one. Predation is considered one of the most important selective pressures on free-ranging animals and is regarded a driving force for the development of sociality in many species. One major advantage of grouping is "safety in numbers", i.e., group membership can confer anti-predatory benefits to an individual through a reduction in predation risk. The hypothesis that *C. cataphractus* individuals gain anti-predatory benefits from group membership through a reduction in avian predation risk was investigated. We found that *Cordylus cataphractus* individuals in larger groups spent significantly more time in a state of reduced vigilance (as indicated by eye state and head movement rate), detected and responded to an approaching aerial threat significantly quicker, and re-emerged from the crevice significantly faster compared to individuals in smaller groups. These results provide overwhelming support for the hypothesis that *C. cataphractus* obtains significant anti-predatory advantages through group-living.

Group-living in *C. cataphractus* is a well-established and year-round phenomenon, and this species lives in permanent groups throughout its range. There is, however, substantial variation in group size within *C. cataphractus* populations. The most important physical variables that influence group size were investigated. *Cordylus cataphractus* prefers mainly horizontal crevices, the opening of which is orientated in a westerly to north-westerly direction, and which is close to ground level and ground cover. It appears that the size of the crevice, the length of the crevice opening, the size of the perching area, and the proportion of the surrounding area visible to a lizard perched outside the crevice are important determinants of group size in *C. cataphractus*. Additionally, since it will take some time for a large group to form and be established, and since group size will naturally fluctuate due to stochastic events, the age of a group is another factor that may be important in influencing group size. Adult male territoriality and aggression further add to the complexity involved in the expansion of a single-male (i.e., small) into a multi-male (i.e., large) group. Variation in the size of *C. cataphractus* groups thus seems to be an extremely complex issue, and more research is needed to fully understand its cause and significance.

Chemical cues in the form of glandular secretions may play an important role in the location and selection of shelters in lizards. We investigated the possible existence and significance of a composite group signal in *Cordylus cataphractus*. *Cordylus cataphractus* is very sluggish and probably extremely vulnerable during periods away from the crevice. A group signal would aid dispersing or lost individuals in locating groups of conspecifics in the shortest possible time. Choice experiments to determine shelter selection were conducted in the laboratory as well as in the field, in order to test specific predictions following from the group signal hypothesis. In the laboratory, there was a statistically significant preference for shelters marked with conspecific glandular secretions above unmarked shelters. In the field, individuals strongly avoided crevices occupied by conspecifics. It seems likely that a composite group signal does exist, and that such a signal may be used to locate groups of conspecifics. Whether an individual will actually join a group seems to be determined by the interaction of a number of complex factors.

We also conducted preliminary studies on another group-living species occurring in the GCBC. Bibron's gecko (*Chondrodactylus bibronii*) is very common in the Greater Cederberg Area and to the frustration of land-owners, often enters outbuildings and holiday cottages where it can become quite a nuisance. In the wild, individuals are often found in small groups. Because it is so abundant in the GCBC, we are of the opinion that this species can be a key species in ecotourism, but that more information on its general biology is required. We therefore initiated a research program on this species. As a first step, we investigated aggregation behaviour in this species. In a laboratory setup, individuals were provided with an excess of shelters to determine whether limited availability of optimal shelters may be the cause of this species' aggregation behaviour in the wild. *Chondrodactylus bibronii* grouped significantly more than predicted by the urn model of random occupation, hinting at mutual conspecific attraction as a possible mechanism for the observed aggregating behaviour. In addition to the laboratory study, a field-survey was conducted to investigate the incidence, size and composition of groups. The proportion of solitary *C. bibronii* individuals in our sample was more than double that found in the group-living lizard, *Cordylus cataphractus* where the mechanism for aggregation behaviour is known to be mutual conspecific attraction. Similar to small groups of *C. cataphractus*, the *C. bibronii* groups in our sample never contained more than one adult male. Like in *C. cataphractus*, solitary males were also found to be significantly smaller in body size than group-living ones. Unlike in *C. cataphractus*, there was no statistical difference in the proportions of solitary males and solitary females in our sample. It thus remains unclear whether aggregation in *C. bibronii* is induced by limited availability of optimal shelters or whether it is the result of mutual conspecific attraction. Our data provide support for both mechanisms.

Scientific outputs of the project

<u>Publications in peer reviewed journals</u>

1. **Visagie, L., Mouton, P.le F.N. & Bauwens, D.** 2005. Experimental analysis of grouping behaviour in cordylid lizards. *Herpetological Journal* 15: 91-96.
2. **Du Toit, D.A., Mouton, P.le F.N., Flemming, A.F., & Van Niekerk, A.** 2005. Climate and the presence of generation glands in female girdled lizards: A case study of the *cordylus-niger-oelofseni* complex. *Journal of Herpetology* 39: 384-388.

3. **Costandius, E., Mouton, P.le F.N., & Flemming, A.F. 2006.** The effect of intergroup distance on group fidelity and neonate dispersal in the group-living lizard, *Cordylus cataphractus*. *African Journal of Herpetology* 55: 61-68.
4. **Effenberger, E., & Mouton, P.le F.N.** 2007. Space-use in a multi-male group of the group-living lizard, *Cordylus cataphractus*. *Journal of Zoology (London)* 272: 202-208.
5. **Hayward, J. & Mouton, P.le F.N.** 2007. Group location in the group-living lizard, *Cordylus cataphractus*: the significance of occupancy and a group signal. *Amphibia-Reptilia* 28: 329-335.
6. **Meyer, A. & Mouton, P.le F.N. 2007.** Aggregation in Bibron's gecko, *Chondrodactylus bibronii. African Journal of Herpetology* 56: 137-147.
7. **Shuttleworth, C., Mouton, P.le F.N. & Van Wyk, J.H.** 2008. Group size and termite consumption in the armadillo lizard, *Cordylus cataphractus. Amphibia-Reptilia* 29:171-176.
8. **Mouton, P.le F.N., Shuttleworth, C. & Van Niekerk, A.** 2007. Why the armadillo lizard, *Cordylus cataphractus* is restricted to an arid winter-rainfall area. *Journal of Arid Environments* (submitted)
9. **Mouton, P.le F.N., Glover, J.L. & Flemming, A.F.** The significance of solitary individuals in populations of the group-living lizard, *Cordylus cataphractus. Herpetological Journal* (submitted).

Publications in preparation:

1. **Meyer, A., Mouton, P.le F.N., Mucina, L., Van Niekerk, A. & Turner, A.** Reptile biotic regions and assemblages in south-western South Africa: Implications for conservation
2. **Meyer, A., Mouton, P.le F.N., Mucina, L., Van Niekerk, A. & Turner, A.** Reptile diversity patterns in south-western South Africa.
3. **Meyer, A., Mouton, P.le F.N., & Mucina, L.** The biogeographical influence of the Tankwa Karoo Basin on reptile distribution in south-western South Africa.
4. **Hayward, J. & Mouton, P.le F.N.** Anti-predatory advantages of group-living in the Armadillo lizard, *Cordylus cataphractus*.
5. **Hayward, J. & Mouton, P.le F.N.** Factors determining group size in *Cordylus cataphractus*.
6. **Janse van Rensburg, D.A., Mouton, P.le F.N. & Van Niekerk, A.** Melanism and climate: A case study of melanistic cordylid lizards.
7. **Janse van Rensburg, D.A. & Mouton, P.le F.N.** Melanistic cordylids in warm environments: Morphological adaptations and habitat selection.
8. **Janse van Rensburg, D.A. & Mouton, P.le F.N.** Space use and territoriality in the Graceful Crag lizard, *Pseudocordylus capensis*.
9. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** Reproductive asynchrony in female Cape Dwarf Chameleons(*Bradypodion pumilum*) in a Mediterranian environment
10. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** Reproductive parameters of the male Cape Dwarf Chameleon, *Bradypodion pumilum*.
11. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** Sperm storage in the Cape Dwarf Chameleon, *Bradypodion pumilum*.
12. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** The reproductive strategy of Dwarf Chameleons (genus *Bradypodion*).
13. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** The origin of viviparity and extraordinary reproduction in Dwarf Chameleons (genus *Bradypodion*).

Theses com[pleted:

1 **C. Shuttleworth*.** M.Sc. December 2006 (full-time). The ecology of the armadillo lizard in the greater Cederberg area.

2 **A. Meyer*.** M.Sc. (full-time). The relevance of the Greater Cederberg Biodiversity Corridor for herpetofaunal conservation.

3 **J. Hayward***. M.Sc. (full-time). Group dynamics and anti-predatory advantages of group-living in the armadillo lizard, *Cordylus cataphractus*.

4 **J.C. Jackson*.** Ph.D. (full-time). Reproduction in Dwarf Chameleons (*Bradypodion*) with particular reference to *B. pumilum* occurring in fire-prone fynbos habitat.

Theses in progress (to be completed 2008)

1. **D.A. Janse van Rensburg.** Ph.D. (part-time) Effective conservation of melanistic lizard species in the Greater Cederberg Biodiversity Corridor.
2. **I.J. du Plessis**. M.Sc. (full-time). Resource partitioning among terrestrial lizards on the Tankwa Flats: Implications for conservation.
3. **K. Hopkins**. M.Sc. (full-time). Population dynamics, morphology and habitat use in the Cape dwarf Chameleon, *Bradypodion pumilum*.

Conference outputs

1. **Mouton, P.le F.N**. Grouping behaviour by cordylid lizards in arid environments. Royal Society / BIOTA Colloquium: Adaptations in Desert Fauna and Flora, Apollo Theatre, Victoria West, 26-29 August 2004. (oral)
2. **Effenberger, E. & Mouton, P.le F.N**. Space-use in multi-male groups of the group-living lizard, *Cordylus cataphractus*. Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004. (poster)
3. **Mouton, P.le F.N**. Grouping behaviour by cordylid lizards in arid environments. Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
4. **Mouton, P.le F.N., Baard, E.H.W., Turner, A., De Villiers, A.L., & Alblas, A.** Effective conservation of amphibians and reptiles in the Greater Cederberg Biodiversity Corridor. Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
5. **Jackson, J.C., Mouton, P.le F.N. & Flemming, A.F.** Life history characters of *Bradypodion pumilum*: adaptions or preadaptations for life in a fire-prone environment? Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
6. **Shuttleworth, C**., **Mouton P.le F.N**., & Van Wyk, J.H. Is the southern harvester termite (*Microhodotermes viator*) an essential item in the diet of the group-living lizard, *Cordylus cataphractus*? Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
7. **Alblas, A., Flemming, A.F. & Mouton, P.le F.N**. Structure and secretory activity of the urodeal glands in the lizard, *Cordylus cataphractus*. Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
8. **Du Toit, Mouton P.le F.N., & Van Wyk, J.H.** Effective conservation of melanistic lizard species in the greater Cederberg Biodiversity Corridor (poster). Seventh Herpetological Association of Africa Symposium, Bayworld, Port Elizabeth, 6-9 October 2004.
9. **Du Toit, D.A. & Mouton, P.le F.N.** Morphological and habitat correlates of melanistic cordylid lizards, with special reference to *Pseudocordylus capensis*. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
10. **Du Toit, D.A., Mouton, P.le F.N. & Van Niekerk, A.** Climatic correlates of melanistic cordylid lizards. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
11. **Hayward, J. & Mouton, P.le F.N.** Group location in the group-living lizard, *Cordylus cataphractus*: the significance of occupancy and a group signal. Eight Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
12. **Hopkins, K., Mouton, P.le F.N. & Tolley, K.** Population genetics, morphology and habitat use of the Cape Dwarf Chameleon. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.

13. **Jackson, J.C., Flemming, A.F. & Mouton, P.le F.N.** Dwarf chameleons producing at large! Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
14. **Meyer, A., Mucina, L. & Mouton, P.le F.N.** The relevance of the Greater Cederberg Biodiversity Corridor for herpetofauna conservation. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
15. **Mouton, P.le F.N. Fell, R. & Flemming, A.F.** Grouping behaviour in a melanistic girdled lizard, *Cordylus peersi*. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.
16. **Shuttleworth, C. & Mouton, P.le F.N.** The southern harvester termite, *Microhodotermes viator*, as an essential dietary component of the group-living lizard, *Cordylus cataphractus*. Eighth Herpetological Association of Africa Symposium, North-West University, Potchefstroom, 24-27 November 2006.

Were any outputs unrealized? If so, how has this affected the overall impact of the project?

All outputs were realized, although sometimes in a slightly different form than originally planned.

V. SAFEGUARD POLICY ASSESSMENTS

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

Not applicable

VI. LESSONS LEARNED FROM THE PROJECT

Describe any lessons learned during the various phases of the project. Consider lessons both for future projects, as well as for CEPF's future performance.

- For a project of this nature, a fulltime coordinator was needed. All the people involved in the project (excluding the students) had normal 8-5 jobs and it was a nightmare organizing fieldtrips, meetings, etc. The part time student coordinator just did not have the experience to drive the project efficiently.
- The maintenance of partnerships in many cases demanded considerable effort while in the end they did not significantly contribute to the outcomes of the study. Partners should be selected very conservatively and window dressing should be avoided at all costs.
- To maintain interest, continuous communication with all stakeholders is important. Although not originally planned, we soon instituted a monthly newsletter. On the same note, to maintain public interest, a project of this kind must continuously receive coverage in the media. We were fortunate in that Stellenbosch University had a person appointed to facilitate publicity for research projects.
- When conducting a survey such as this one, young assistants without family and work commitments (preferably students) and who can go to the field for extended periods of time, are needed.
- It is important that a project team includes enough male members to accompany female members on field trips for safety reasons. In our case lack of enough males created problems.
- Turnover of guides at ecotourism destinations was too high to make the training of guides in herpetology effective.
- It is important for university academics to always think in terms of scientific publications. All research undertaken must culminate in publications otherwise the academics will soon pay the price when it comes to university performance ratings and NRF-ratings.

CapeNature and other parastatal organisations, as well as many funding bodies, are project driven, with scientific publications not high on the list of priorities. It is important that both sides are sensitive to this difference in priorities.

Project Design Process: (aspects of the project design that contributed to its success/failure)

- The opportunity for the public to contribute to the survey by sending in digital photographs of amphibians and reptiles they encountered in the GCBC worked very well. On our recommendation this method of public involvement was also adopted by the South African Reptile Conservation Analysis (SARCA) and resulted in the idea of a virtual museum (see www.saherps.net/sarca). Our biogeographical analysis of the reptiles of southwestern South Africa highlighted the poor quality of the present distributional data and we suggested that the only solution is a virtual museum system whereby the public can contribute to the database indefinitely. SANBI is now investigating the possibility of establishing a permanent virtual museum facility.
- The training of assistants at selected cadastral units to help with the survey was not particularly successful. Very few ecotourism destinations had people available for training and at others the turnover of staff was high, negating our efforts. It soon became apparent that for the effective use of amphibians and reptiles in ecotourism, information must be summarized in book form. The available field guides do not contain enough information to be of much use to field guides other than to identify species. We have compiled such a book and hope to make this available soon.

Project Execution: (aspects of the project execution that contributed to its success/failure)

- In the end, only three of the original partners listed, partook in the project, namely Stellenbosch University, CapeNature and Kontreitoere. Although many discussions were held with Kontreitoere on investigating methods of information transfer, these never materialized. Although CapeNature made important contributions in preparing species profiles and distribution maps, their commitment to actual surveys was disappointing.
- The success of the project is largely the result of the involvement of students. The students were able to commit themselves fulltime to the project. Unfortunately, only one male student was involved and it was sometimes difficult to get a male to go with the female students on surveys.

VII. ADDITIONAL FUNDING

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Category A

Donor	**Type of Funding***	**Amount**	**Notes**
NRF South Africa	Student bursaries	ZAR605 000	Only ZAR220 000 for operating costs, the rest for bursaries

Additional funding should be reported using the following categories:

A *Project co-financing (Other donors contribute to the direct costs of this CEPF project)*

B *Complementary funding (Other donors contribute to partner organizations that are working on a project linked with this CEPF project)*

C *Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)*

D *Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)*

Provide details of whether this project will continue in the future and if so, how any additional funding already secured or fundraising plans will help ensure its sustainability.
This project will only continue until the end of 2008. A new funding application will be put in with the NRF for 2009-2012: Vulnerability of reptiles to climate change in southern Africa's winter rainfall zone. This project will include the GCBC area.

VIII. ADDITIONAL COMMENTS AND RECOMMENDATIONS

- To sustain public interest in herpetofauna and to continuously increase public understanding of and appreciation for the important ecological role that amphibians and reptiles play in the various ecosystems of the GCBC, it is critically important that some herpetological research activity is maintained in the region.
- At the same time it is important that the website containing species descriptions and distribution maps be maintained indefinitely. The website is presently maintained by the University of Stellenbosch, but it needs to be incorporated in the CapeNature website.

VIII. INFORMATION SHARING

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned and results. One way we do this is by making programmatic project documents available on our Web site, www.cepf.net, and by marketing these in our newsletter and other communications.

These documents are accessed frequently by other CEPF grantees, potential partners, and the wider conservation community.

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