

RECOVERY PLAN FOR THE BERMUDA SKINK, *Eumeces longirostris*



GOVERNMENT OF BERMUDA
Ministry of Public Works

Department of Conservation Services

RECOVERY PLAN FOR THE BERMUDA SKINK, *Eumeces longirostris*

Prepared in Accordance with the Bermuda Protected Species Act 2003

Funded in part by:



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Cover photo: Bermuda skink, *Eumeces longirostris*, in captivity at the Bermuda Aquarium Museum and Zoo exhibit.

Photo by Alison Copeland, Biodiversity Strategy Action Plan Coordinator, Department of Conservation Services

Back page photo: Bermuda skink at Nonsuch Island, by Carolyn Copeland

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To conserve and restore Bermuda's natural heritage

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DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. We, the Department of Conservation Services, publish recovery plans, sometimes preparing them with the assistance of field scientists, other government departments, and other affected and interested parties, acting as independent advisors to us. Plans are submitted to additional peer review before they are adopted by us, and formulated with the approval of interested parties mentioned in Parts II and III of the plan. Objectives of the recovery plan will be attained and necessary funds made available subject to budgetary and other constraints affecting the parties involved. Recovery plans may not represent the views nor the official positions or approval of any individuals or agencies involved in the recovery plan formulation, other than our own. They represent our official position only after they have been signed by the Director of Conservation Services as approved. Approved recovery plans are subject to modifications as dictated by new findings, changes in species status, and the completion of recovery actions.

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An electronic version of this recovery plan will also be made available at www.conservation.bm and www.gov.bm.



Director
Department of Conservation Services
Government of Bermuda

20th DECEMBER 2010

Date

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EXECUTIVE SUMMARY

Current Species Status:

The Bermuda skink (or “Rock Lizard”) *Eumeces longirostris* is endemic to Bermuda where it is the only extant endemic terrestrial vertebrate species. Its global population distribution is limited to Bermuda where its abundance has suffered a severe decline. The species has been listed by the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources (IUCN) as Critically Endangered (IUCN 1996; 2005) and, more recently has been listed under Bermuda law (Protected Species Act 2003) as Critically Endangered (CR, B1, B2b, c, d, e) in accordance with IUCN criteria. Its listing under Bermuda law mandates active intervention as outlined in the present recovery plan. Additionally, for those individuals and/or populations inhabiting areas protected under the Department of Parks, as Parks, Nature Reserves or Woodland Reserves, protection by the Parks Authority is provided under the Bermuda National Parks Act 1986.

Habitat Requirements and Threats:

Bermuda skinks formerly occupied a broad range of habitats but are now found in small, fragmented areas within three types of coastal habitat (beach and dune, rocky coastal, and upland coastal). The total area of these habitats throughout Bermuda and the adjacent islets is 572 ha, of which less than 200 ha is estimated to be currently occupied by skinks. Skinks have been recently recorded from at least 24 separate locations but the largest known viable population consisting of more than 500 individuals is restricted to an offshore islet. Main threats have been identified as habitat loss due in part to impact from human development, habitat fragmentation, introduced plant species, introduced animal species, predators (namely, kiskadee flycatcher, rats and cats), and competitors such as the Jamaican anole. Other more common threats possibly affecting skink populations are litter, beach management procedures, pollution and climate change.

Recovery Objective:

The overall objective of this recovery plan is to restore populations of the Bermuda skink island-wide, such that population numbers increase to sustainable levels; more specifically, that Bermuda skinks demonstrate active reproduction and growth of populations in a minimum of 75% of sites deemed suitable, and that current fragmentation of populations is reduced.

Recovery Criteria:

Favourable conservation status will be achieved when:

- Populations of Bermuda skink occupy every potentially suitable area of its former natural range and the distribution of the species is neither being reduced nor is likely to be reduced in the foreseeable future.

- Sufficient habitat, including any physical links created between populations, is being managed and maintained in a condition suitable for the continued survival of Bermuda skinks.
- Population dynamics and other data on the Bermuda skink indicate that it is successfully maintaining itself on a long-term basis as a viable component of its natural habitat, with all populations exhibiting adequate levels of recruitment and genetic diversity.

Actions Needed:

1. Preservation of species' gene pool
2. Habitat protection
3. Natural population management and enhancement
4. Habitat management
5. Population monitoring
6. Public awareness campaign

Recovery Costs:

The total costs of recovery cannot be defined at this point. Funding needs to be secured, additional to the core funding obtained through government funds, for implementing population surveys, habitat management and captive breeding. Habitat management and predator control are estimated to account for 50% of total recovery costs. Developing budgets for each action are the responsibility of the leading party as outlined in the workplan.

Date of Recovery:

It is anticipated that it will take at least three years to ensure an adequate habitat range for Bermuda skinks, and a further 20 years to increase the extent of occupancy for a sustainable population across the island. Re-assessment of the status of this species will first be considered five years from the date of initial implementation.

PART 1: INTRODUCTION

A. BRIEF OVERVIEW

The Bermuda skink (or “Rock Lizard”) *Eumeces longirostris* is endemic to Bermuda where it is the only extant endemic terrestrial vertebrate species. This lizard has suffered a severe population decline largely as a result of habitat loss and fragmentation and the spread of invasive introduced fauna and flora. Due to the global distribution of this species being limited to Bermuda, and the serious conservation threat it faces, the Bermuda skink has been listed by the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources (IUCN) as Critically Endangered (IUCN 1996; 2005).

Until recently, relatively little was known about the Bermuda skink. However, since 1997 several studies, have significantly improved current knowledge. It has become apparent that Bermuda skinks are still declining across most of their known range and that the species faces extinction if additional conservation measures are not taken immediately.

This Recovery Plan has therefore been produced in an attempt to address this problem. The overall aims are to ensure that all currently known Bermuda skink populations are secure and recovering and that all potentially suitable habitats, free of predators, within the species’ former natural range are occupied by viable populations in 2030. Specific actions are recommended to ensure these targets are met and that a more favourable conservation status is achieved for the Bermuda skink. The plan also summarises new and previously unavailable information about the ecology of *Eumeces longirostris* and its distribution on Bermuda.

The main partners involved in this Recovery Plan are the Bermuda Government Department of Conservation Services, the Bermuda Aquarium Museum and Zoo, and the Herpetological Conservation Trust (HCT). Ensuring the implementation of the plan is the responsibility of the Department of Conservation Services in Bermuda. The HCT is a UK-based body and will provide specialist herpetological expertise and advice, as well as general support and practical assistance with activities such as management planning and applications for funding. Furthermore, collaboration with the Durrell Wildlife Conservation Trust (DWCT) in Jersey is actively pursued at the time of writing, to ensure the safeguard of the species outside of Bermuda.

B. CURRENT PROTECTION STATUS

The Bermuda skink is listed under Bermuda law (Protected Species Act 2003) and in the IUCN Red List (2005) as Critically Endangered (CR, B1, B2b, c, d, e). Its listing

under Bermuda law mandates the development of a recovery plan within one year of listing.

Local Protection

Legal Protection

Under the Bermuda Protected Species Act 2003, offenders are liable to a fine of \$5,000, and up to \$10,000 for continuing offences. Currently, the Protected Species Act 2003 considers as an offence the wilful destruction, damage, removal or obstruction of a habitat, and the taking, importing, exporting, selling, purchasing, transporting or having in possession a protected species.

Habitat Protection

For those individuals and/or populations inhabiting areas protected under the Department of Parks, as Parks, Nature Reserves or Woodland Reserves, protection by the Parks Authority is provided under the overarching objective to “safeguard and maintain plants, animals and fragile ecosystems”. These areas are protected under the Bermuda National Parks Act 1986, which prohibits the taking of any flora or fauna within Parks.

Global Protection

The Bermuda skink has been listed by the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources (IUCN) as Critically Endangered (IUCN 1996; 2005).

C. TAXONOMY AND DESCRIPTION OF THE SPECIES

Class: Reptilia

Order: Squamata

Family: Scincidae

Genus: *Eumeces*

Species: *longirostris*

Common Name: Bermuda skink

Other Vernacular Names: Bermuda rock lizard, long-nosed skink

Conservation Importance: Flagship island endemic; extremely small and fragmented global range (probably less than 200 ha occupied in total); Bermuda’s only extant endemic terrestrial vertebrate

Morphology.

Bermuda skinks have long cylindrical bodies with smooth scales, small legs and clawed feet. The species is well adapted for burrowing and living among narrow rock crevices. Adult skinks range from 150–250 mm in total length. Males reach 80–85 mm snout-vent length (SVL), with a head width of up to 15 mm, head length up to 20 mm and a body mass of about 20–22g. Females attain 75–80 mm SVL, with a maximum head width of 10–12 mm, head length of 15–18 mm and total body mass of 13–16 g (Kitson, *unpub.*).

Colour.

Bermuda skink colouration undergoes ontogenetic changes during development. Hatchlings have sky blue tails and an iridescent bronze dorsum, with two sets of white and black dorsolateral stripes extending from the head to the base of the tail and salmon chin and cheeks (Figure 1). The hatchling colour phase lasts for the first year of life before the juveniles begin to lose the blue tail colouration, followed by the bronze dorsal colour and stripes that gradually become darker.



Figure 1. Hatchling skink *Eumeces longirostris* showing distinctive blue tail (Southampton Island, Bermuda). (Photo: J. Davenport)

Adult skinks either have mottled dorsal patterns (remnants of the hatchling stripes) or are universally dark brown or black on the body and tail (Figure 2). Adult ventral colours, including their feet pads, are greyish blue or salmon pink and they often have an orange chin and cheeks.



Figure 2. Adult skink *Eumeces longirostris* on Nonsuch Island (Photo: M. Pienkowski)

Sexual Dimorphism

Unlike many members of the family Scincidae, sexual dimorphism is not pronounced in the Bermuda skink and adult males and female are often indistinguishable. It is evident from captive breeding studies, however, that males have a

wider head, relative to the rest of the body, and that their overall adult size is greater

compared with females. Those males with larger head widths lack the stripes that are probably retained by the females for longer into their adult life. Some reproductive females have been found without stripes, however, indicating that both sexes eventually become universally dark on the upper half of their body. It has also been observed that the undersides of males are a lighter bluish grey to white, sometimes with an orange tint, whereas females have a darker orange underside. It has also been suggested that adult females possess a lateral indent either side of the tail, just below the base, which adult males lack (Wingate, *pers. comm.*).

D. ECOLOGY

Habitat Requirements

Bermuda skinks formerly occupied a much broader range of habitats but are now restricted to small, fragmented areas within three types of coastal habitat (Figure 3). The total area of these habitats throughout Bermuda and the adjacent islets is only 572 ha (Anderson *et al.*, 2001), of which probably less than 200 ha is currently occupied by skinks. These important skink habitats are:

1. Beach and Dune. Skinks occupy a few mature dune systems and also scavenge in the strandline that forms along beaches. The total area of this habitat on Bermuda is 77 ha.
2. Rocky Coastal (Figure 3). In between beaches and dunes, this habitat extends from the high water mark to 15 m, covers 149 ha of Bermuda and supports the most significant skink populations.
3. Upland Coastal. A total of 346 ha of upland coastal habitat occur on Bermuda. Skinks inhabit relatively few areas as most is now developed.

Figure 3. Rocky Coastal Habitat, Bermuda (Photo: A. Glasspool)



The distribution of Bermuda skinks within these habitats is most strongly correlated with the presence of rocky areas and crevices. Surveys of Southampton Island in 1997 (Davenport *et al.* 2001a) and 2004 (Glasspool and Outerbridge, 2004) found highest skink concentrations in association with bay grape (*Coccoloba uvifera*), although they have been found in many other types of coastal vegetation (Davenport *et al.*, 2001a). Moreover, Raine (1998) showed that skinks were significantly associated with areas dominated by sea oxeye (*Borrchia arborescens*) and salt grass (*Spartina patens*), but not with stands of bay grape, buttonwood (*Conocarpus erectus*) or Casuarina (*Casuarina equisetifolia*). Conversely, Hammond (2000) did find skinks inhabiting Casuarina (*Casuarina equisetifolia*) stands on Castle Island. Bermuda skinks are sometimes observed in other habitats, such as upland hillside, and there are also a few records of individuals from residential areas (Bermuda Biodiversity Project, unpublished 1998 public survey).

Activity

Eumeces longirostris is a diurnal species and exhibits temperature related activity throughout the day. Bermuda skink activity levels are low in the early morning and rise until about midday, when they drop dramatically as temperatures in the sun reach a maximum of 43 °C, which is lethal for lizards. Skink activity increases again during the afternoon before dropping off just after sunset (Davenport *et al.*, 2001b).

Bermuda skinks were previously thought to hibernate during the cooler winter months as they were rarely observed in their usual habitats from late October until late March or April. However, the low temperatures in Bermuda throughout these months never fall to those that cause other North American skinks to hibernate, disputing this thought. Recent studies have shown that skinks do not in fact hibernate but remain active throughout the year, albeit at lower levels during the winter months (Kitson, *unpub.*).

Movements

Raine (1998) recorded individual Bermuda skinks travelling distances of up to 60 m. However, it was estimated that the majority of skink movements are limited to 10 m or less, indicating a small home range of around 0.01 ha. Bermuda skinks are therefore liable to suffer more from anthropogenic disruption to their habitat when compared to other lizard species with greater home ranges (Davenport *et al.* 1997, Raine 1998). Raine (1998) concluded that skinks move randomly within the inhabited area and are just as likely to be re-captured in the same place twice as they were 10 m away.

Reproduction

Bermuda skinks reach maturity in two to four years and individuals may live as long as 15 to 20 years (Kitson, *unpub.*; Wingate, *pers. comm.*). It is hypothesised that *Eumeces longirostris* has a life history similar to those of its probable relatives in North America. Adults are thought to court and mate in April/ May and have been observed,

both directly and indirectly, to lay one clutch of 3–5 eggs in June with hatchlings appearing in late July to early August (Kitson, *unpub.*). Females tend their eggs for the entire incubation period (as is the case with other skinks of the same genus) in order to protect them from individuals of the same species, which may attempt to eat the eggs, or other predators.

Dietary Requirements

It was originally believed that Bermuda skinks were primarily insectivorous (Heilprin, 1889) and although Bermuda skinks do feed on a variety of invertebrates, especially as hatchlings and juveniles, they also eat some plant matter, including fruits of the prickly pear cactus (*Opuntia dillenii*), and carrion (Davenport *et al.*, 2001b). Wingate and Madeiros (*pers. comm.*) have observed skinks opportunistically foraging in the nests and on the failed eggs of tropicbirds (*Phaethon lepturus catesbyi*) and Bermuda petrels (*Pterodroma cahow*). Indeed, when these birds were formerly more abundant, fish scraps, egg debris, dead chicks, avian parasites and flies probably formed a substantial part of the skinks' diet during the nesting season. The near extinction of the Bermuda petrel may have also added to the factors causing the decline of the Bermuda skink.

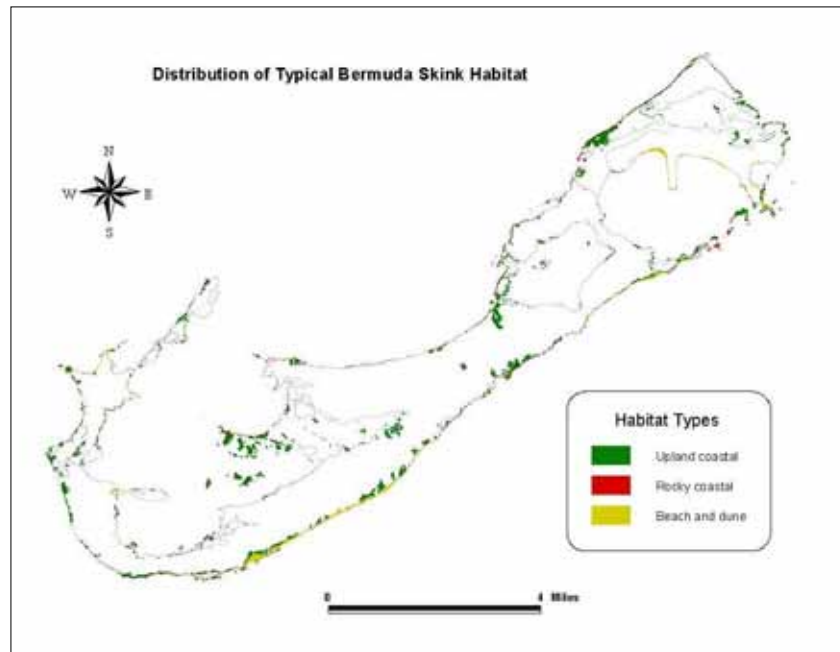
Natural Predators

It is unlikely that the early skinks had many natural predators (other than intraspecies predation) since early naturalists (Jones, 1859) stated that they were abundant throughout the island. A species of night heron was formerly native to Bermuda and, following their extinction, a related species (*Nyctanassa violacea*) was introduced from the United States and has since been observed preying on skinks. Egrets are also likely natural predators.

Natural Competitors

It is evident that Bermuda skinks formerly suffered little natural competition for resources from other species. The only other pre-colonial terrestrial vertebrates on the island were diamondback terrapins (*Malaclemys terrapin*), and skinks therefore had the luxury of dealing with little more than intraspecific competition. This may have been intense when natural populations attained very high densities and female Bermuda skinks are known to eat the eggs of other individuals when kept in the same small enclosure in captivity (Kitson, *unpub.*).

Figure 4. Distribution of typical skink habitat in Bermuda.



E. CURRENT THREATS

- *Habitat Loss* Bermuda's endemic and native flora and fauna have been disrupted since permanent human settlement in 1612. The forests and swamps, which once dominated the island, have been severely reduced and disrupted by invasive species. Commercial, industrial or residential land consumes 67% of Bermuda (Government of Bermuda, 2005) and the remaining 33% is predominantly characterised by introduced flora. This extreme loss and disruption of habitat was noted as the primary cause of population isolation and decline of Bermuda skinks by Raine (1998).
- *Habitat Fragmentation.* As a direct consequence of habitat loss and severe predation in some areas, surviving populations seem to be restricted to isolated pockets. Several studies have been carried out to investigate aspects of isolated skink populations (Davenport *et al.*, 2001a; Raine, 1998; Wingate, 1998; Hammond, 2000; Glasspool and Outerbridge, 2004, Kitson, *unpub.*). This work has provided further information on environmental and genetic stress, through analysis of locomotive fluctuating asymmetry (Raine, 1998), population size, distribution and structuring (Davenport *et al.*, 2001a, Raine, 1998, Hammond, 2000; Glasspool and Outerbridge, 2004) and the effects of the introduced Jamaican Anole, *Anolis grahami* (Wingate, 1998). Populations isolated by rising sea levels, show significant genetic differentiation (Kitson, *unpub.*) and it is possible that populations, which

are isolated due to human factors, are genetically distinct and or suffering from loss of genetic variability.

- *Introduced Plant Species.* Most of Bermuda is now invaded by introduced plant species, which continue to spread. What remains of woodland habitat has been dominated by densely foliated introduced species, which offer little sunlight penetration in which skinks can bask. This hostile habitat has replaced the open woodland of cedars and palmettos, which skinks originally are thought to have inhabited (Wingate, *pers. comm.*).
- *Introduced Animal Species.* Deliberate and accidental introductions of a variety of animal species since human colonisation have had dramatic effects on the unprepared skink population (Davenport *et al.*, 1997; Raine, 1998; Wingate, 1998).
- *Predators.* Cane toads, kiskadees, rats and both feral and domestic cats are among the known predators of Bermuda skinks. All are introduced aliens and it is certain that skink population densities were considerably greater on Bermuda before their introduction. *Anolis grahami* is known to prey on hatchling skinks (Griffith and Wingate, 1994) and so it is possible that the other two species of anole do the same. Following the extinction of an endemic species of night heron a relative from the United States, which may occasionally eat Bermuda skinks, has been successfully introduced to Bermuda.

The black rat (*Rattus rattus*) and brown rat (*Rattus norvegicus*) together with the domestic and feral cats (*Felis domesticus*) have been resident on the island since the early human settlers and potentially pose the most serious threats as introduced land predators. The introduced kiskadee flycatcher (*Pitangus sulphuratus*) is an adept skink predator (Samuel, 1975) and it is now perceived to be a major threat to the remaining skink population (Raine 1998, Davenport *et al.*, 2001b).

The cane toad (*Bufo marinus*) was introduced in 1885 to control insects on sugar cane but may have had a substantial ecological impact on skinks via competition for resources as well as potentially preying on skink hatchlings.

- *Competitors.* Anoles may also compete directly for resources. The Jamaican anole (*Anolis grahami*) was introduced in 1905. This lizard successfully colonised the mainland and most of the offshore islands. *Anolis grahami* is not considered a major threat to skinks because adults are primarily arboreal and so occupy a separate niche. Although the dietary overlap between the two species is thought to be slight (Simmonds, 1958), Wingate (1998) found evidence to suggest that this anole may have a significant impact on skinks with regards to competition in addition to predation. Juvenile Jamaican anoles can frequently be observed foraging on the ground in skink habitats,

and therefore almost certainly compete directly at times with hatchling and juvenile skinks. This alien species also adds to the cumulative impact from other herpetological introductions. These include two more species of anole that were introduced accidentally, the Antiguan anole (*Anolis leachi*) and the Barbadian anole (*Anolis roquet*), and two species of frog (*Eleutherodactylus* spp.).

- *Genetic Isolation* Raine (1998) noted morphological differences between isolated skink populations and genetic sub-structuring within this species has therefore subsequently been investigated (Kitson, *unpub.*). Analysis of two geographically isolated populations of skinks using microsatellite techniques has shown that there is significant genetic differentiation between mainland and offshore island populations. These results have implications for Bermuda skink conservation efforts, particularly with regard to the use of skinks from the viable population on Southampton Island for mainland re-introductions, since the preservation of genetically distinct subpopulations is essential.
- *Other Threats* A variety of other potential threats face the Bermuda skink.
 - Litter.** Glass and plastic bottles can fatally trap skinks. An abundance of these are frequently found in areas inhabited by skinks. Litter is dumped in nature reserves by visitors or washed up on beaches and blown further inland by storms. There are several organised marine and coastal clean ups during the year.
 - Beach Management.** Raking and tidying of beach strandlines (which are important foraging habitats for some skink populations) for tourism.
 - Pollution.** Oil spills, herbicide/pesticide use on golf courses and runoff, garden chemicals.
 - Climate Change.** Global warming, increased frequency of storms, erosion of coastal habitats.

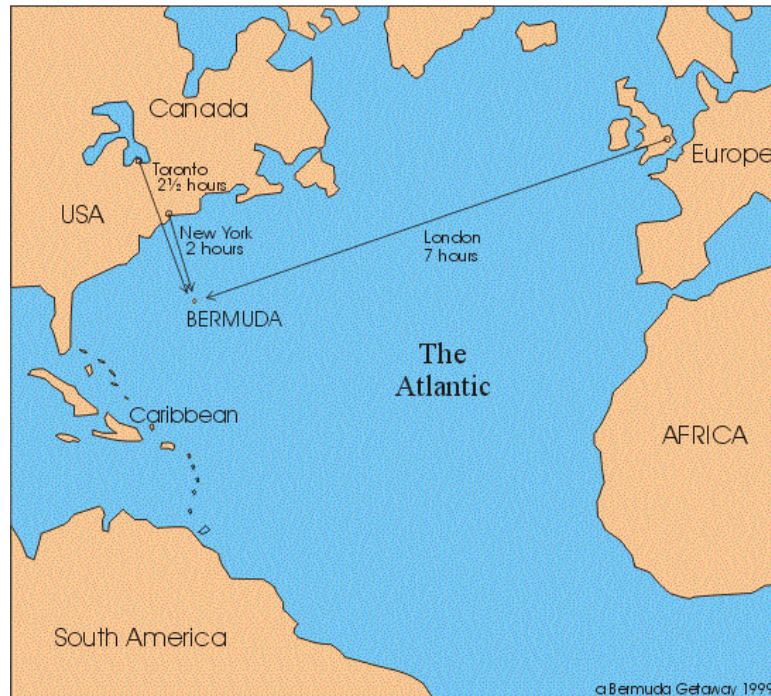
F. CURRENT STATUS

Global Distribution

Eumeces longirostris is endemic to Bermuda, an archipelago of approximately 150 small islands located in the Atlantic Ocean at latitude 32° 19' N and longitude 64° 46' W (Figure 4). The total combined land area of all Bermuda's islands is only 55 km² (5500 ha). The closest point of continental land is Cape Hatteras, North Carolina, on the eastern seaboard of the United States, which lies 965 km to the west. The influence of both the Gulf Stream, which flows to the east of the island, and the annual Bermuda-Azores high pressure system result in a mild sub-tropical climate. Mean monthly air temperatures range from 18.5 °C in February to 29.6 °C in August. The mean annual

rainfall is 150 cm and is not highly seasonal being distributed throughout the year although October (16 cm average) is the wettest month and April is the driest (10 cm). Humidity is uniformly high at 70–82% year round (Anderson *et al.*, 2001).

Figure 5. Bermuda's geographical location



Local Distribution

Eumeces longirostris occurs in small, isolated pockets throughout the Bermuda archipelago (Figure 5). Skinks have been recently recorded from at least 24 separate locations but the largest known viable population consisting of more than 500 individuals is restricted to an offshore islet. The total island-wide (hence global) population of Bermuda skinks is roughly estimated to be 2300–3500 adult lizards (Kitson, *pers. comm.*). Distribution surveys are continuing, however, and it is very likely that further skink sites will be located on the main island and that the true population size is around 5,000 animals (Kitson, *pers. comm.*), possibly larger. Even so, populations of Bermuda skink are small and highly fragmented and all recent research indicates that the species is suffering serious declines and genetic bottlenecking problems across much of its remaining range. The distribution of Bermuda skinks, as it is currently understood, can be summarised as follows:

- *Main Island:* (at least 16 surviving populations; estimated total 1,000–1,800 adult skinks). The largest recorded population of skinks surviving on the main island of Bermuda is found at Spittal Pond Nature Reserve. This was estimated to be about 124 lizards (Raine, 1998) but after further studies

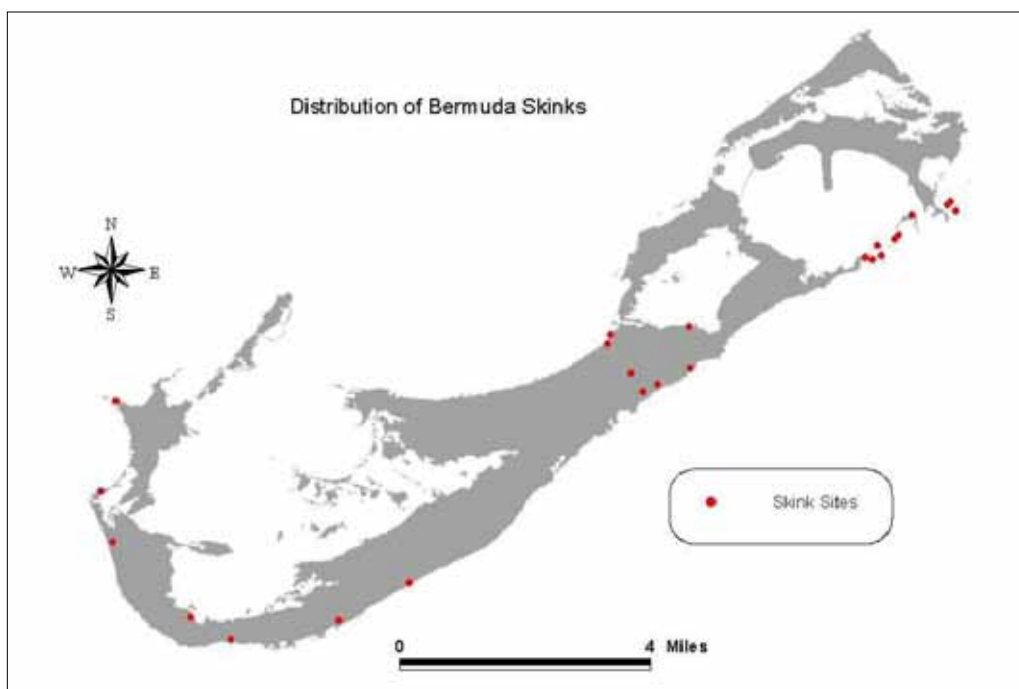
within this reserve it is thought that the population is approximately double that size (Kitson, *unpub.*). Raine (1998) found morphological evidence to suggest that the skinks here are suffering from genetic and environmental stress. Genetic analysis indicated a genetically healthy population that has either undergone a recent decline or is divided by some kind of barrier (perhaps geographical) (Kitson, *unpub.*). Following an island-wide skink survey conducted by public questionnaires (Bermuda Biodiversity Project, unpublished 1998 public survey), more thorough distribution surveys have been conducted using pitfall and Sherman traps (Kitson, *unpub.*). To date, at least 15 additional small populations of Bermuda skinks have been discovered or confirmed across the mainland (Figure 6). The status of these populations is currently unknown, although due to their apparent fragmentation their genetic viability is almost certainly declining. Nonetheless, their persistence is fortunate and will make future attempts to link skink populations via habitat corridors more feasible and worthwhile. The secretive nature of these animals means that some populations may have been overlooked and other potential sites, including some on cliffs that are almost inaccessible, have yet to be surveyed.

- *Southampton Island, Castle Harbour*: (one population; estimated total 600–800 adult skinks). A 1997 survey on Southampton Island, where there are few invasive alien plants or introduced predators or competitors, showed that the population was healthy and exhibited adequate recruitment. A more recent survey undertaken in 2004 indicated that the population was still stable, although the 2003 cohort appeared to have been decimated by Hurricane Fabian. Without doubt, this is the largest viable Bermuda skink population left in Bermuda and the island is estimated to have reached a carrying capacity of approximately 600–800 animals (Kitson, *unpub.*), although recent hurricane damage has since reduced the available habitat. Davenport *et al.* (2001) found that the population was unevenly distributed, with concentrations of skinks around the old fort walls and close to tropicbird nests, and in bay grape stands. These nests are thought to be an important source of carrion (Wingate, *pers. comm.*). Glasspool and Outerbridge (2004) found that the population had become more evenly distributed, occupying more of the low scrub on the central plateau.
- *Nonsuch Island, Castle Harbour*: (one population; estimated total <100 skinks). This is a protected nature reserve that is progressively being restored to a natural, pre-colonial Bermudian environment. Detailed observations and surveys of *Eumeces longirostris* have been made on Nonsuch Island since the 1970s (Wingate, *pers. comm.*). In 1997, however, a survey of the island's skinks indicated an ageing and failing population. This was thought to be due to excess competition with, and/or predation by, Jamaican anoles, kiskadees and giant toads, which is preventing sufficient recruitment (Davenport *et al.*, 2001b). More recent observations indicate a

serious decline in skink numbers (Wingate, *pers. comm.*), with little recent evidence of breeding success, and the population probably no longer exceeds 100 adults. Davenport *et al.* (2001b) predicted that, without control of introduced predators and competitors, the imminent extinction of the once significant Nonsuch Island population is inevitable.

- *Other Castle Harbour Islands:* (six populations; estimated total 600–800 adult skinks). Apart from Southampton and Nonsuch Islands, skinks occur on at least six more islets in Castle Harbour – Charles Island, Inner and Outer Pear Islands, Castle Island, Rushy Island and Horn Rock). While Raine (1998) found that skinks on Charles and Inner Pear Islands were suffering from significant levels of environmental and genetic stress, both populations appear to remain healthy, with high recruitment and sufficient numbers of juveniles in relation to sub-adults and adults.

Figure 6. Distribution of *Eumeces longirostris* in Bermuda



G. CURRENT CONSERVATION ACTION

Captive breeding of Bermuda skinks was first achieved at the Bermuda Aquarium Museum and Zoo in 1983 (Barnes and Eddy, 1986), and has occurred several times since then, although there is currently no co-ordinated re-introduction programme. Control of introduced predators occurs on some of the islands that have been

designated national parks in and around Castle Harbour, particularly those where Bermuda petrels (cahows) and tropicbirds (longtails) nest. These activities obviously also benefit skinks. Although there is no control of rats or cats on the mainland, an animal welfare organisation is neutering (but then releasing) feral cats in many areas, which at least is a form of control.

Habitat protection is achieved in part through positive management of invasive plants in national parks on the mainland and on some of the Castle Harbour islands, as well as in other nature reserves. This involves the spot clearance of various species, such as *Casuarina sp.*, which are encroaching on native plants. This work is maintaining or improving Bermuda skink habitat in some areas.

Conservation activities focusing on the Bermuda petrel (*Pterodroma cahow*) and the white-tailed tropicbird (*Phaethon lepturus catesbyi*) may also coincidentally reinforce conservation of the Bermuda skink. There is increasing evidence that skinks co-exist with these sea birds (Madeiros, *pers. comm.*), and with their recovery, skinks might be expected to benefit.

Past skink studies involved mark and recapture methods but only partial surveys of the potential range of the species (Davenport *et al.*, 2001a; Raine 1998; Hammond, 2000; Glasspool and Outerbridge, 2004; Wingate, *pers. comm.*). These have been supplemented by a more comprehensive distribution survey employing pitfall and Sherman traps (Kitson, *unpub.*). There is currently no regular monitoring of skink populations and status.

Previous studies have included Davenport *et al.* (1997; 2001 a; 2001b), Raine (1998), Wingate (1998), Hammond (2000) and Glasspool and Outerbridge (2004). A research project, carried out by a Bermudian student through University College Cork, Ireland, focused in more detail on Bermuda skink distribution, genetics, seasonal activity, diet, habitat preferences, reproductive biology and growth rates (Coughlan *et al.*, 2004; Kitson, *unpub.*).

Raising awareness on the endangered status of this species is continuous. Bermuda skinks are housed in a permanent exhibit, including interpretive displays, at the Bermuda Aquarium Museum and Zoo. Staff organise lectures and public 'encounters' during open days, and other special events, which are always popular with local people. A formal education programme, including school visits, is planned for the future. Skink conservation is also discussed during nature tours to Nonsuch Island and other protected areas. Bermuda skinks have featured in several newspaper reports, as well as articles in both the Bermuda Zoological Society and Ministry of Environment newsletters. The public questionnaire survey carried out in 1998 was sent to all 33,000 households and also helped to raise public awareness about Bermuda skinks. In 2004, a Bermuda Government grant was awarded for the production of 10,000 leaflets in order to raise awareness about the Bermuda skinks. The focus of these leaflets was on how members of the public could make their gardens more suitable for skinks. Additionally, ongoing public feedback via telephone and email

was encouraged (reporting where skinks have been seen). These leaflets have been distributed throughout the island and several schools have created skink habitats in response.

PART II: RECOVERY

A RECOVERY GOAL

The principal aim of this Recovery Plan is to stimulate various conservation measures that will improve the distribution, habitat, status, and population viability of the Bermuda skink, thereby ensuring the species' long-term survival. These measures, if successfully realised, will halt the decline of all existing populations and ultimately contribute to the restoration of the Bermuda skink (across those parts of its past range where this is physically possible) to a 'favourable conservation status'.

In the short term, conservation measures to re-establish the status and viability of existing skink populations must receive priority, coupled with simultaneous planning for the implementation of future work. In the long-term, it is recommended that the extent of occupancy be increased in order to reduce the fragmentation of populations, and promote the sustainability of the species on Bermuda. The optimisation and implementation of captive breeding techniques will assist as a tool to achieve re-establishment of populations, as well as provide further understanding on the requirements for growth and reproduction of the species. The 'Recommended Actions' outlined in Part III further identify the practical steps that need to be taken to achieve these Species Action Plan targets.

B. RECOVERY OBJECTIVES AND CRITERIA

Favourable conservation status will be achieved when:

- Populations of Bermuda skink occupy every potentially suitable area of its former natural range and the distribution of the species is neither being reduced nor is likely to be reduced in the foreseeable future.
- Sufficient habitat, including any physical links created between populations, is being managed and maintained in a condition suitable for the continued survival of Bermuda skinks.
- Population dynamics and other data on the Bermuda skink indicate that it is successfully maintaining itself on a long-term basis as a viable component of its natural habitat, with all populations exhibiting adequate levels of recruitment and genetic diversity.

These overall objectives translate into specific targets set out below.

Short-term target (three years). To ensure that all currently known Bermuda skink

populations are being maintained in the wild in a viable state and that programmes are in place to ensure the appropriate management of all potential skink habitat and the future expansion of wild populations.

Long-term target (20 years). To restore populations of the Bermuda skink island wide, such that population numbers have increased to sustainable levels, distribution has expanded to fill all available habitats and monitoring indicates that favourable conservation status has been achieved.

C. RECOVERY STRATEGY

The species addressed in this recovery plan is restricted geographically by population number and by available habitat. In general, recovery efforts should be focused on habitat protection and management, thus minimising impact from human development and landscaping and ensuring an adequate area of occupancy for Bermuda skinks. Given the known fragmentation of the existing populations, genetic analyses of pocket populations are recommended to ensure the preservation of genetic diversity if present. In order to enhance existing population, captive breeding should be considered as a tool for the re-establishment of populations in sites considered adequate. Although preliminary investigations have shown the potential for breeding the species under controlled conditions, further studies are required to optimise techniques. Overseas collaborations with institutes such as the Durrell Wildlife Conservation Trust (DWCT) in Jersey (Channel Islands, U.K.) will be beneficial not only in the exchange of information on techniques, but also in safeguarding a breeding population of this endemic species. Should the population of Bermuda suffer dramatic decline due to natural disasters or other threats, restoration of the species will be possible through the ex-situ breeding pairs.

D. TOOLS AVAILABLE FOR RECOVERY

Methodology for survey techniques has been developed and tested in Bermuda, and can be relied upon as a basis for further updating population distribution information. Breeding techniques for other species of skinks have been developed and tested in overseas partner institutions, which facilitate the optimising of captive breeding protocols for the Bermuda skink. This warrants a close collaboration with partner institutions and transfer of techniques to Bermuda-based staff. The availability of facilities and staff trained in animal husbandry at the Bermuda Aquarium Museum and Zoo enable the establishment of a captive breeding area and continuity in ensuring the implementation of recovery through breeding and subsequent transfer to the natural environment. Finally, preliminary information obtained through previous research will serve as a stepping-stone to habitat management, identified as a necessary component to recovery of the species.

E. STEP-DOWN NARRATIVE OF WORKPLAN

Abbreviations used in Sections E and F:

AZA – American Zoo Association

BAMZ – Bermuda Aquarium Museum and Zoo

BSAP- Biodiversity Strategy Action Plan

BZS – Bermuda Zoological Society

DCS – Department of Conservation Services

DWCT- Durrell Wildlife Conservation Trust

HCT – The Herpetological Conservation Trust

Parks –Department of Parks

The actions needed to achieve recovery are as follows:

1. Ensuring Preservation of Species Gene Pool

Actions proposed:

- Population level genetics evaluating homogeneity of skink populations across the island.
- Establish breeding pairs in overseas institution (DWCT, Jersey), ensuring preservation of population genetic diversity.

Work Team: DCS, BAMZ, DWCT

Team Leader: DCS

Assistance: BAMZ staff

Outputs: safeguard of breeding stock for re-establishment of populations, population level genetic scientific publication, database for re-introduction strategy

List of equipment required: trapping and shipping material. Funds for genetic analysis

2. Habitat Protection

The current fragmentation of available habitat for skinks is addressed through the creation of corridors, and through increased legal habitat protection

Actions proposed:

- Identify and protect Critical habitats under the Protected Species Act 2003.
- Develop and implement guidelines for a ‘best practice’ approach to development, landscaping and future land zoning to safeguard mainland skink populations.
- Provide input into the Development Plan to ensure that consideration is given to the need for habitat corridors for skinks and to encourage rockery building and planting of vegetation suitable for skinks.

Work Team: DCS, Department of Planning

Team Leader: Protected Species Coordinator (DCS)

Assistance: DCS staff (GIS mapping, terrestrial conservation officer, BSAP coordinator)

Outputs: Legislated habitat protection, best practice guidelines pamphlets

List of Equipment required: funding for publications of guidelines

3. Natural Population Management and Enhancement

The protection of existing populations is proposed through control of competition and predation, and their enhancement is proposed through captive breeding and habitat restoration.

Actions proposed:

- Investigate importance of competition from, and predation, by introduced animal species.
- Reduce and control predators, such as feral cats and rats, on as many Bermuda skink sites as possible.
- Assess effects of invasive introduced plants on Bermuda skink habitat, ecology and behaviour.
- Produce a re-introduction strategy for the Bermuda skink, taking into account population genetics, ecology and behaviour of skinks.
- Optimise captive breeding techniques with overseas institutions and partner zoos through the American Zoo Association (AZA) Species Survival Programme.
- Analyse habitat requirements identifying suitable sites on both the mainland and offshore islands.
- Assess requirements for optimal transfer of captive-bred individuals to suitable habitats and develop transfer programme.

Work Team: DCS, PARKS, BAMZ, DWCT, HCT

Team Leader: DCS

Assistance: volunteer interns from BAMZ for transfer trials, graduate students for research studies

Outputs: Re-introduction strategy report, identification of suitable sites, captive breeding report, data on transfer requirements for optimal survival, data on growth and survival requirements

List of Equipment required: captive breeding facility at BAMZ, exclusion cages, transfer material, predator control materials

4. Habitat Management

Actions proposed:

- Produce habitat management guidelines for Bermuda skinks, incorporating modifications as and when new information dictates.
- Develop skink related management proposals for individual mainland sites and offshore islands.
- Produce a 'Skink Link' plan, incorporating detailed proposals for habitat corridors between sites and produce guidelines for making public gardens more skink friendly.
- Carry out the habitat management necessary to improve existing and potential Bermuda skink sites and to create suitable habitat corridors (avoiding conflict with the interests of other native species).

Work Team: DCS, BAMZ, HCT, PARKS

Team Leader: DCS

Assistance: Dept of Planning, DCS staff (terrestrial conservation officer, BSAP coordinator, GIS mapping, terrestrial conservation team)

Outputs: Habitat management guidelines, 'skink link' plan, ongoing programme for habitat management

List of Equipment required: Field material for culling of plants and predator control

5. Population monitoring

Actions proposed:

- Complete island-wide surveys of current Bermuda skink distribution.
- Implement 3–5 yearly monitoring programmes to assess the status of Bermuda skink populations as well as the success of habitat management, corridor creation, re-introductions and other actions.
- Undertake a formal Population Viability Analysis incorporating information from all research and monitoring programmes.
- Develop a database system to record and evaluate overall progress of the Species Recovery Plan.

Work Team: DCS, BZS, HCT

Team Leader: DCS

Assistance: volunteer interns and students from BAMZ and BZS for population surveys, and database entry

Outputs: comprehensive assessment of existing and re-established populations, skink database

List of Equipment required: software for database, materials for population surveys (traps, calipers, bait, paint, GPS handheld).

6. Public Awareness campaign

Actions proposed:

- Develop a Bermuda skink public awareness campaign via talks, walks, leaflets, newspapers, radio, TV and the Internet to publicise conservation measures, raise funds and explain the importance of responsible public behaviour (such as picking up trash, minimising pesticide use and controlling pets). Carry out regular public surveys to assess the impact and effectiveness of this campaign.
- Plan an island wide ‘Skinks in Gardens’ campaign to promote skink friendly gardening practices.
- Publish scientific papers and articles, based on the research and monitoring, to back up funding applications, public awareness campaigns and Species Recovery Programme progress reports.

Work Team: DCS, BZS

Team Leader: BSAP coordinator (DCS)

Assistance: Barritt’s Bottling Co., Community clubs (eg. The Garden Club), local NGOs (e.g. Bermuda National Trust, Keep Bermuda Beautiful –KBB)

Outputs: awareness raising documents, engagement of community

List of Equipment required: funds needed for publication of material and costs for survey

F. ESTIMATED DATE OF DOWN LISTING

It is anticipated that it will take at least three years to ensure an adequate habitat for Bermuda skinks, and a further 20 years to increase the extent of occupancy for a sustainable population across the island. It is only once implemented actions are evaluated, that Bermuda skinks demonstrate active reproduction and growth of populations in a minimum of 75% of sites deemed suitable, and that current fragmentation of populations is reduced that down listing of the Bermuda skink will be considered. Re-assessment of the status of this species will first be considered five years from the date of initial implementation.

G. RECOVERY COSTS

The total costs of recovery cannot be defined at this point. Funding needs to be secured, additional to the core funding obtained through government funds, for implementing population surveys, habitat management and captive breeding. Habitat management

and predator control are estimated to account for 50% of total recovery costs. Dedication of personnel is also critical to the success of this recovery plan, ensuring the coordination and implementation of monitoring, research, habitat management planning, captive breeding programmes, re-establishment of populations and public awareness campaigns. Developing budgets for each action are the responsibility of the leading party as outlined in the workplan.

PART III: IMPLEMENTATION

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in the species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other action necessary to provide for full recovery of the species.

| Priority # | Task # | Task Description | Task Duration | Responsible Party | |
|------------|-----------|---|-------------------------------------|-------------------|------------|
| 1 | | Preserving species' gene pool | 24 months | | |
| | 1 | Population level genetics | 24 months | DCS | |
| | 2 | Ensure species survival outside of Bermuda | 12 months | DCS | |
| 1 | | Habitat Protection | 24 months | | |
| | 3 | Critical Habitat protection | 12 months | DCS | |
| | 4 | Best practice guidelines on mainland | 12 months | DCS | |
| | 5 | Include corridors in Development Plan | 12 months | DCS | |
| 2 | | Population management and enhancement | Indefinite | | |
| | 6 | Assess competition and predation | 24 months | DCS | |
| | 7 | Reduce and control skink predators | Indefinite | DCS | |
| | 8 | Assess effects of invasive species | 24 months | DCS | |
| | 9 | Produce skink re-introduction strategy | 3 years | DCS | |
| | 10 | Optimise captive breeding techniques | 36 months | DWCT, BAMZ | |
| | 11 | Identification of suitable habitats | 24 months | DCS | |
| | 12 | Transfer trials programme | 3 years | DCS | |
| | 2 | | Habitat Management | Indefinite | |
| | | 13 | Skink habitat management guidelines | 3 years | DCS |
| | | 14 | Site management plans/proposals | 12 months | DCS, Parks |
| 15 | | Produce 'Skink Link' plan | 12 months | DCS | |
| 16 | | Site improvement and creation | ongoing | DCS, Parks | |
| 3 | | Monitoring | Indefinite | | |
| | 17 | Complete island wide skink surveys | 24 months | DCS | |
| | 18 | Implement monitoring programmes | Every 3–5 years | DCS | |
| | 19 | Population Viability Analysis | 12 months | HCT | |
| | 20 | Develop Bermuda skink database | 12 months | BSAP | |
| 3 | | Public Awareness | Indefinite | | |
| | 21 | Awareness campaign through brochures, media, lectures | ongoing | BSAP | |
| | 22 | 'Skinks in Gardens' promotion | ongoing | BSAP | |
| | 23 | Publications (general public and scientific) | ongoing | DCS | |

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WEB SITES

Species Recovery Plan Partners

Bermuda Aquarium Museum and Zoo: www.bamz.org (includes pages on the Bermuda skink Project, the Bermuda Biodiversity Project and the Bermuda Zoological Society)

Department of Conservation Services: www.conservation.bm

Durrell Wildlife Conservation Trust: www.durrell.org

The Herpetological Conservation Trust: www.herpcontrust.org.uk

Other Relevant Web Sites

American Zoo and Aquarium Association: www.aza.org

EMBL Reptile Database: www.embl-heidelberg.de/~uetz/LivingReptiles.html

Fauna and Flora International: www.fauna-flora.org

IUCN Red List of Threatened Species: www.redlist.org

UK Overseas Territories Conservation Forum: www.ukotcf.org

