Bluetail Mole Skink *(Eumeces egregius lividus)*
Sand Skink *(Neoseps reynoldsi)*

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
South Florida Ecological Services Office
Vero Beach, Florida

5-YEAR REVIEW
Bluetail mole skink/*Eumeces egregius lividus*
Sand skink/*Neoseps reynoldsi*

I. GENERAL INFORMATION

A. Methodology used to complete the review: This review is based on monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. The review was conducted by the lead recovery biologist for the bluetail mole skink and sand skink with the South Florida Ecological Services Office. Literature and documents on file at the South Florida Ecological Services Office were used for this review. All recommendations resulting from this review are a result of thoroughly reviewing all available information on the skinks. Comments and suggestions regarding the review were received from peer reviews from outside the Service (see Appendix A). No part of the review was contracted to an outside party.

B. Reviewers
Lead Region: Southeast Regional Office, Kelly Bibb, (404) 679-7132

Lead Field Office: Marilyn Knight, South Florida Ecological Services Office, (772) 562-3909
Cooperating Field Office(s): Mike Jennings, Jacksonville Ecological Services Office, (904) 232-2580

C. Background

1. FR Notice citation announcing initiation of this review: September 27, 2006. 71 FR 56545.

2. Species status: 2006 Recovery Data Call
Bluetail mole skink: Unknown. No recent range-wide information available.
Sand skink: Unknown. No recent range-wide information available.

3. Recovery achieved: 2006 Recovery Data Call
Bluetail mole skink: 1 (= 0-25% recovery objectives achieved)
Sand skink: 1

4. Listing history
Original Listing
FR notice: 52 FR 42658
Date listed: November 6, 1987
Entity listed: Bluetail mole skink: Subspecies
Sand skink: Species
Classification: Bluetail mole skink: Threatened
Sand skink: Threatened

5. Review History:

5-year review November 6, 1991 (56 FR 56884), In this review, different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors, threats, *etc.* as they pertained to the different species' recovery. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. In particular, no changes were proposed for the status of these skinks.

Final Recovery Plan 1999
Recovery Data Call 2006, 2005, 2004, 2003, 2002, 2001, 2000

6. Species' Recovery Priority Number at start of review (48 FR 43098):
Bluetail mole skink: 3 (a subspecies with high degree of threat and high recovery potential)
Sand skink: 1 (a monotypic genus with high degree of threat and high recovery potential)
(refer to section III, B. for additional information)

7. Recovery Plan or Outline
Name of plan: South Florida Multi-Species Recovery Plan (MSRP)
Date issued: May 18, 1999
Dates of previous plans: December 23, 1993 [Recovery Plan for the Sand Skink (*Neoseps reynoldsi*) and Bluetail Mole Skink (*Eumeces egregius lividus*)]

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. Is the species under review listed as a DPS? No.

2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy? No.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors*are addressed by that criterion. If any of the 5 listing factors are not relevant to this species, please note that here.

Criteria for delisting the bluetail mole skink and sand skink:

1. Risk assessment and population viability analyses demonstrate that a sufficient number of sites containing skink populations are protected and managed to ensure a 95 percent probability of persistence of the species over the next 100 years.

Population viability analyses and risk assessments have not been conducted for either species. Because these lizards live a fossorial lifestyle and are difficult to study, we lack the demographic information necessary to complete such analyses. Except for a few locations, we have little information about status and trends. Most skink studies have documented skink presence or absence or have estimated densities at specific locations but have not provided population estimates.

A study conducted by Turner et al. (2006) on scrub habitat along the central ridge of Florida indicated that bluetail mole skinks are known to occur in 23 locations, 22 of which are on the Lake Wales Ridge, and sand skinks are known to occur in 73 locations, 70 of which are on the Lake Wales Ridge. These data were compiled from managers whose methods varied considerably (Malatesta 2007 in litt.). It is not evident from their report how the term "location" is defined, but sand skinks are known to occur on more than three sites in Ocala National Forest on the Mt. Dora Ridge, and bluetail mole skinks are known from more than 22 sites on the Lake Wales Ridge (Moler 2007 in litt.). The few locations reported off of the Lake Wales Ridge require verification and may not be valid (Mushinsky 2007 in litt.).

Of the 23 locations on which the bluetail mole skink is reported to occur, 12.5 sites are protected and, as of 2004, 10 were managed. Of the 73 locations on which sand skinks are reported, 38.5 are protected and, as of 2004, 27 were managed (Turner et al. 2006). Bluetail mole skinks seem to be underrepresented in the reserve network of protected public lands, but Turner et al. (2006) could not determine if their absence reflects actual exclusion or a lack of survey effort. If the former is true, then

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A) Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

additional lands must be protected and managed in perpetuity to ensure the survival of this species (Turner et al. 2006).

Over the last 20 years, a concerted effort by public and private institutions to protect the remaining undeveloped areas of the Lake Wales Ridge has resulted in the acquisition of 21,498 acres (ac) of scrub and sandhill habitat (Turner et al. 2006). A variety of state and federal agencies and private organizations are responsible for management of these areas. All of these efforts have greatly contributed to the protection of imperiled species on the Lake Wales Ridge (Turner et al. 2006).

This criterion addresses listing factors A, D, and E.

2. When research and monitoring of the biology and ecology of this species determine the population is stable or increasing for no less than 6 years.

As indicated above, we have little information about the status and trends of the bluetail mole skink and sand skink and are not currently able to determine population stability of either species. The fossorial lifestyle of these two species hampers efforts of investigators to obtain solid density estimates, behavioral biology, and home range data (Telford 2007 in litt.). Because of the ongoing habitat loss and degradation on the Lake Wales Ridge, it is likely that overall populations of both species are declining (Moler 2007 in litt.).

Although it was not considered to be a significant problem at the time of listing, factor B (overutilization for commercial, recreational, scientific, or educational purposes) was included in the original listing package because it could become an issue. At present it is still not known to be a concern and is not addressed in the criteria. Listing factor C (disease and predation) does not appear to be a concern and is not addressed in the criteria (refer to 2. Five Factor Analysis for more detail).

C. Updated Information and Current Species Status

1. Biology and Habitat -

a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:
Except for a few locations, we have little information about the abundance and population trends of the sand skink and bluetail mole skink. Because both species spend much of their time beneath the surface of the sand, they are relatively difficult to study. More recent studies have merely looked for presence or absence or densities and have not provided population estimates.

A study conducted by Turner et al. (2006) on the state of scrub habitat along the central ridge of Florida indicated that bluetail mole skinks seem to be underrepresented in the reserve network of protected public lands, but the authors could not determine if their absence reflects actual exclusion or a lack of survey effort. Turner et al. (2006) reported that bluetail mole skinks are known to occur in 23 locations, 22 of which are on the Lake Wales Ridge, and sand skinks are known to occur in 73 locations, 70 of which are on the Lake Wales Ridge. The authors did not indicate where the single site occurs from which bluetail mole skink is reported off of the Lake Wales Ridge, but we believe that this record may be in error. The bluetail mole skink has not been documented elsewhere off of the Lake Wales Ridge and is believed to be restricted to this ridge alone (Moler 2007 in litt., Mushinsky 2007 in litt.). It is not evident from the Turner et al. (2006) report how the term "location" is defined because records may have been aggregated based on the distance of separation, but sand skinks are known to occur on more than 3 sites in Ocala National Forest on the Mt. Dora Ridge, and bluetail mole skinks are known from more than 22 sites on the Lake Wales Ridge (Moler 2007 in litt.). These data were compiled from managers whose methods varied considerably (Malatesta 2007 in litt.).

Approximately 60 enclosures (0.1 ac) (Sutton et al. 1996) have been constructed on the Lake Wales Ridge to calculate absolute densities of sand skinks (Mushinsky 2007 in litt.). Results indicate that time since fire is an important factor in determining densities. That is, a greater potential for high densities exists with longer times since fire. For example, preliminary results from 36 enclosures (0.1 ac) installed in March 2007 at Archbold Biological Station (ABS) show that the mean number of sand skinks is 5.33 (±1.04) in recently burned units, 5.58 (±1.58) in units burned 6-20 years ago, and 11.58 (±1.10) in units burned more than 20 years ago (Mushinsky 2007 in litt.).

Other density estimates of sand skinks in various scrub habitats regardless of fire history in Orange and Osceola Counties ranged from 100 to 600 skinks per hectare (ha) or approximately 11 skinks per 0.1 ac (Sutton 1996, Collazos 1998, Mushinsky and McCoy 1999). Christman (2005) estimated densities to be much lower in Polk and Highlands Counties, averaging approximately 6 sand skinks per 0.1 ac. Removing the sites from density calculations where skinks were completely absent, the averages for Orange and Osceola Counties were 15.6 per 0.1 ac and for Polk and Highlands Counties were 6.5 per 0.1 ac (Christman 2005). Christman (2005) found possible weak correlations between sand skink density and depth of loose surface sand, percent cover of bare sand, percent of soil particles >0.23 millimeter (mm) in diameter, and time since fire. Densities of skinks tended to be higher when the depth of loose surface sand was greater (Collazos 1998, Christman 2005). To get true baseline information, additional research is needed to address density, habitat, and microhabitat throughout the range of both species (Malatesta 2007 in litt.).

Density estimates were not available for bluetail mole skinks, as only two individuals were captured in the Polk and Highlands Counties study

(Christman 2005). This was not unexpected because densities of bluetail mole skinks are typically lower than those of sand skinks (e.g., only 1 bluetail mole skink may be captured for every 20 sand skinks) (Christman 1986, pers. comm.). However, Telford (2007 in litt.) suggests that this disparity in relative abundance of the two species may be explained by seasonal variation in activity and movements and that year-round surveys should be conducted over an adequate number of years to minimize the effect of variation in rainfall in order to obtain better estimates.

Demographic information has been obtained for sand skinks, but no new information is available for bluetail mole skinks. Recent demographic studies of sand skinks by Ashton (2005) resulted in findings similar to those of Telford (1959). Telford (1959) assumed that sand skinks become sexually mature during the first year following hatching, as the measured distance between snout and vent reaches a length of 45 mm. He suspected that most of the breeders in his study were in their second year and measured between 45 mm and 57 mm snout-vent length (Telford 1959). However, Ashton (2005) determined that sand skinks become sexually mature between 19 and 23 months of age and have a single mating period each year from February through May. A single clutch is produced each year between May and June with a mean clutch size apparently fixed at two (Ashton 2005). This is similar to Telford's (1959) findings in which he examined three gravid females and found each to have two eggs. In field studies this year, sand skinks have been observed with three or even four eggs (Mushinsky 2007, University of South Florida, pers. comm.).

Gianopulos (2001) found that the sex ratio of sand skinks captured in 1999 and 2000 did not differ significantly from 1:1, which corresponded to estimates obtained by Sutton (1996). Also, based upon size distributions, there were fewer sand skink juveniles captured in the spring than adults, but this was not significant. Telford (1998) found that 58 to 60 percent of the sand skink population in Ocala National Forest was in its second year, regardless of sampling period. However, between the August-October and April-June sampling periods, the proportion of juveniles in the population doubled and the proportion of 3-year-old or older skinks diminished by half (Telford 1998).

In an attempt to develop a method to determine age structure of sand skink populations, Shockley (1997) compared morphometric data to skeletochronology of cross sections of limb bones to estimate age. There was not enough significant variation exhibited in morphometric variables analyzed to correlate with age, and age could not be estimated using skeletochronology. Early studies indicated that sand skinks may live from 3 (Telford 1959) to 7 years (Sutton 1996). Gianopulos (2001) used Sutton's (1996) growth curve to estimate the age of one captured sand skink to be 8 years. However, Meneken et al. (2005) observed through mark-recapture studies that the life span of sand skinks may exceed previous estimates of longevity and reach 10 years or more. Ashton (2005) also stated that sand skinks can survive for 8 to 10 years, and that this long lifespan, along with low frequency of reproduction, small clutch size, and late maturity, is similar to that of other fossorial lizards.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding): The complete mitochondrial DNA sequence of bluetail mole skinks was determined from frozen tissue collections as a comparison to support the phylogenetic position of the green sea turtle (*Chelonia mydas)* (Kumazawa and Nishida 1999). Although the focus of the study was on the phylogeny of the turtle, the genetic analysis indicated that the skink has a slightly larger mitochondrial DNA genome due to tandem repeats and a long intergenic spacer. It was also noted that skink gene sequences probably evolved slowly.

Microsatellite loci were characterized for the sand skink from 156 individuals across 11 populations along the southern portion of the Lake Wales Ridge (Reid et al. 2004). All microsatellite loci were polymorphic and five of the eight loci showed significant deviation from equilibrium, probably attributable to inbreeding, selection and population structure, and/or the presence of null alleles. Reid et al. (2004) concluded that understanding genetic connectivity is critical for maintaining genetic variation in this species.

Genetic analyses have been used for taxonomic evaluations (see C.1.c.). In addition, genetic analyses have examined diversity at the species level. Genetic diversity was assessed using mitochondrial cytochrome *b* sequences for three lizard species associated with the xeric, sandy scrub habitats of the Florida peninsula, including the bluetail mole skink and sand skink (Branch et al. 1999, 2003). Genetic diversity of all species was geographically partitioned. The mole skink (*Eumeces egregius*), which has five recognized subspecies including the bluetail mole skink, is the least habitat specific and had the lowest phylogeographic structure. The analysis of mitochondrial DNA found a link between the bluetail mole skink and the Florida Keys mole skink (*Eumeces egregius egregius*). Analyses also supported the assumption that the two central ridges with the oldest scrub habitat served as ancient refugia (Branch et al. 1999, 2003).

Branch et al. (1999, 2003) determined that sand skink populations on the Mt. Dora Ridge are genetically distinct from those on the Lake Wales Ridge but not as divergent as comparable mole skink populations, indicating an earlier separation for mole skinks. Genetic distinctions were found among sand skink populations from the Mt. Dora Ridge, the northern Lake Wales Ridge, the central Lake Wales Ridge, and the southern Lake Wales Ridge (Branch et al. 2003). The authors found only a single haplotype on the Mt. Dora Ridge, which is probably the result of a founder effect or genetic drift. Branch et al. (2003) recommended that if translocations are to be used as a conservation strategy, geographic distance between scrub patches, which is often correlated with genetic differences, as well as phylogeographic history, should be considered concurrently for maintaining genetic integrity of the populations.

c. Taxonomic classification or changes in nomenclature: The Integrated Taxonomic Information System (2007) was checked while conducting this review, and no changes in nomenclature for either skink were provided therein. However, there is evidence to suggest that the taxonomic classification of both skinks requires revision. A re-evaluation of the scincid genus *Eumeces* was conducted to phylogenetically analyze the major sub-groups of this genus using anatomical features (Griffith et al. 2000). Taxonomic groupings are typically accepted only if they are monophyletic (consisting of an inferred common ancestor and all its descendents). Results of the analysis of morphological characters indicate that the genus is paraphyletic (containing some but not all descendents of the most recent common ancestor) and suggest that the group should be divided into four genera, with the Pariocela section of East Asian and New World skinks retaining the *Eumeces* name through a request to re-designate type specimens (Griffith et al. 2000).

Schmitz et al. (2004) stated that this re-evaluation was based on a small morphological character matrix and questioned the appropriateness of some of the characters chosen for the analysis. Instead, Schmitz et al. (2004) used a molecular data set to assess the taxonomic evaluation and amplified a section of the mitochondrial 16S ribosomal RNA gene using polymerase chain reaction (PCR) techniques. Schmitz et al. (2004) determined that the recently named taxonomic groups were monophyletic, but some of the proposed names violated the standard naming rules of the International Code of Zoological Nomenclature.

Brandley et al. (2005) also found the genus *Eumeces* to be paraphyletic and recommended taxonomic changes but did not support all recommendations made by Griffith et al. (2000). Specifically, they did not concur with re-designating the type specimen and suggested changing the generic name for all species of the East Asian and North American clade, including *Neoseps*, to *Plestiodon*. However, there is some concern with basing taxonomic changes solely on genome analysis without using a defined percentage of genetic difference to justify taxonomic change (Telford 2007 in litt.).

The recent molecular and phylogenetic studies indicate that sand skinks and bluetail mole skinks are very closely related sister species (Brandley et al. 2005, Richmond and Reeder 2002, Schmitz et al. 2004). Showing only 5% genetic differentiation between the two, Schmitz et al. (2004) found the level of genetic differentiation to be comparable to levels found between other North American skinks and suggested that the genus *Neoseps* be synonymized with the genus *Eumeces*. Griffith et al. (2000) proposed that the *Eumeces* group of scincid lizards be split into several genera and the name *Eumeces* be used to describe only the group of North American and most Mexican species through a change in type specimens. Before the International Commission on Zoological Nomenclature accepted the change, Schmitz et al. (2004) rejected the proposal and suggested that the name *Eumeces* remain with the African species. Brandley et al. (2005) and Smith (2005) then formally proposed that the name *Plestiodon* be used to describe the North American skinks. Therefore, the new commonly accepted scientific names are *Plestiodon reynoldsi* (sand skink) and *Plestiodon egregius lividus* (bluetail mole skink). Because these names are described in peer-reviewed literature and are generally accepted by the scientific community, we concur with these changes in nomenclature.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range): Both skinks are endemic to the sandy ridges of central Florida. The bluetail mole skink occurs on the Lake Wales Ridge in Highlands, Polk, and Osceola Counties, and the sand skink occurs on the Lake Wales, Winter Haven, and Mt. Dora Ridges in Highlands, Lake, Marion, Orange, Osceola, Polk, and Putnam Counties (Service 1999). Putnam County was only recently listed as part of the known range of the species based on the capture of two individuals by Telford (1998). In addition, a second location has been documented in Putnam County (Bugbee 2007 in litt.). Despite intensive sampling efforts in scrub habitat with similar herpetofauna, the sand skink and bluetail mole skink have not been recorded at Avon Park Air Force Range on the Bombing Range Ridge (Branch and Hokit 2000).

It appears that skinks are still distributed throughout their historic range, although we believe their numbers have likely declined substantially because of habitat loss and degradation. One study found that sand skink populations were patchily distributed on the landscape, and distribution was clumped (Gianopulos et al. 2001), but additional work is needed in this area. Hokit et al. (1999) studied the distribution of another scrub endemic lizard, the Florida scrub lizard (*Sceloporus woodi*), in naturally fragmented habitat and found that distribution was explained by patch size and patch isolation. In their study, lizards were only present in 43 of 132 patches (Hokit et al. 1999). Bluetail mole skinks also appear to have a patchy distribution, although little to no work has been done specifically on this species. The degree of soil compaction affects sand skink activity, with low soil compaction being favored (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001, Christman 2005). Sand skink presence is also positively related to soils with a greater proportion of large particle sizes, low soil moisture, and low soil temperature (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001). Although studies have not determined exact classes of soil sizes that are preferred by skinks, particles sifted through sieves with 0.38-mm and 0.23-mm mesh openings have been shown to be positively correlated with skink presence (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999). Vegetation also seems to affect sand skink presence, as percent of bare, loose surficial sand and low average understory vegetation are important factors (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001, Christman 2005). It is generally thought that bluetail mole skinks require similar microhabitat conditions.

These microhabitat conditions are necessary to enable thermoregulation. Presence of vegetation and loose soils moderate soil temperatures, providing a range of temperature options available to sand skinks (Hill 1999, Mushinsky and McCoy 1999, Gianopulos et al. 2001). Based on Collazos' (1998) findings that sand skink density was positively correlated with canopy density, Gianopulos et al. (2001) surmised that skinks may not do well in areas that have been recently burned or cleared. Conditions within the soil are still more important to sand skinks than vegetation above it, however, and vegetation alone can not be used to predict abundance or distribution (Hill 1999). Sand skink distribution appears to be correlated with microhabitat conditions. To really understand distribution patterns, range-wide surveys on public and private lands need to be initiated for both skink species.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): Turner et al. (2006) reported that development and agriculture have resulted in the loss of approximately 85% of the scrub and sandhill habitats on the Lake Wales Ridge, and what remains contains high concentrations of imperiled species. Over the last 20 years, more than 87 square kilometers (km$^{2)}$ (48.9%) of the remaining 187 km^2 of these habitat types on the Lake Wales Ridge have been acquired and protected (Turner et al. 2006). Therefore, only 6.3% of pre-settlement scrub and sandhill habitats are currently protected (Turner et al. 2006).

In addition to the need for these remaining scrub and sandhill habitats to be protected, these habitats along with those on sites that have already been acquired for conservation depend upon active management, most often prescribed fire, to persist long-term (Turner et al. 2006). Much of the remaining habitat occurs in small, isolated fragments surrounded by residential areas or citrus groves, making them difficult to protect and manage. Many of these fragments are overgrown and in need of restoration. Habitat degradation on these sites continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding. If not acquired for conservation, privately-owned sites remain at risk of being developed and management remains a concern.

Where prescribed fire is not feasible as a management technique for habitat because of smoke management and other concerns, mechanical treatment is sometimes used. However, heavy machinery disturbs the soil more than prescribed burning, and it removes often limited nutrients from the soil (Mushinsky et al. 2001). This changes the nutrient levels in the topsoil, affecting the vegetative composition of the site, whereas fire releases nutrients (Mushinsky et al. 2001). Also, if logs are removed from a site after mechanical treatment, prey abundance (termites) may be lower than it would be after a fire (Mushinsky et al. 2001).

Turner et al. (2006) indicated that bluetail mole skinks seem to be underrepresented on protected public lands, but the authors could not determine if their absence reflects actual exclusion or a lack of survey effort. If the former is true, then additional lands must be protected and managed in perpetuity to ensure the survival of this species (Turner et al. 2006). Of the 23 locations on which the bluetail mole skink occurs, 12.5 sites are protected and, as of 2004, 10 were managed. Of the 73 locations on which sand skinks are reported, 38.5 are protected and, as of 2004, 27 were managed (Turner et al. 2006). However, it was not evident from Turner et al. (2006) whether management was specifically appropriate for skinks on all of these managed sites. Results of genetic analyses by Branch et al. (2003) indicated that sand skink populations have genetic distinctions based on phylogeography across the species' range. It will be important to determine if the protected lands identified by Turner et al. (2006) are distributed across these genetically different populations in order to preserve the genetic uniqueness across the range.

Another concern is whether relatively small properties are able to maintain viable populations. Pike et al. (2006 abstract) monitored a population of sand skinks and quantified vegetation change in six conservation areas that were restored to a more natural state using fire and canopy thinning to be set aside for conservation in neighborhoods. They documented a severe decline in occupancy and relative density of sand skinks and hypothesized that indirect impacts from surrounding development, such as changes in soil hydrology, may have caused the decline. They suggested that hydrologic changes in the soil may have occurred as a result of construction of retention ponds or run-off from neighborhoods that caused a rise in the groundwater level (Pike et al. 2006 abstract). However, Mushinsky (2007 in litt.) suggests that the population decline of skinks that the authors noted may have been the immediate result of prescribed burning used to restore these sites.

Conservation of New Zealand's grande skink (*Oligosoma grande*), which also lives in small, patchy distribution as a result of land use practices, faces similar challenges with respect to habitat fragmentation, limited dispersal, and genetic isolation (Berry et al. 2005). The New Zealand researchers found that if establishing corridors is impractical (e.g., strips of high-quality habitat that facilitate animal dispersal between fragmented patches), an alternative management strategy may be to connect populations in certain situations by managing the vegetation matrix between populations (e.g., habitat that is often thought of as uniform and ecologically unimportant).

There is evidence of an edge effect on sand skink distribution on isolated scrub fragments bordered by non-scrub habitat, which appears to be a function of micro-habitat conditions (Gianopulos 2001, Mushinsky et al. 2001). On scrub fragments bordered by non-scrub habitat, sand skinks were detected more frequently within the middle of the sites than along the edges bordered by non-scrub habitat, and this difference was detected as far as 50 meters (m) [164 feet (ft)] into the sites (Gianopulos 2001, Mushinsky et al. 2001).

f. Other: Other research that has been accomplished since the completion of the recovery plan (Service 1999) includes studies on sampling efficiency, skink activity, movement, territoriality, management, and reintroduction. As was the case with previous sections on recent biological information obtained, sand skinks were the subject of study rather than bluetail mole skinks. Bluetail mole skinks are more limited in distribution, occurring in only three counties, and smaller capture rates of bluetail mole skinks limit the ability to obtain sample sizes that are sufficient for statistical analyses.

Mushinsky and McCoy (1999) looked at the sampling efficiency of coverboards and pitfall traps for detecting sand skink presence and found that both methods were equally successful in terms of detection and ability to assess overall activity and total abundance. However, they found that coverboards were more efficient (Mushinsky and McCoy 1999).

Studies conducted to assess peak times of activity of sand skinks found that they were most active from early March to late May but activity peaked in mid-to-late April (Gianopulos 2001, Mushinsky et al. 2001). They also noted that in all but one year, there was a small peak in activity followed by a larger one. Ashton and Telford (2006) examined activity periods of sand skinks using museum specimens and population studies in Highlands and Marion Counties and found skinks to be active year-round. Capture rates increased from February through May, coinciding with increased mating activity during this time-frame, and August through October, coinciding with the emergence of hatchlings beginning in late July (Ashton and Telford 2006).

Researchers found that the number of captures per month is not directly related to temperature or precipitation but is related to timing of reproductive activities, at least in the southern portion of the range (Ashton and Telford 2006). Rainfall does, however, reduce daily surface activity because moisture compacts the soil and impedes movement (Ashton and Telford 2006). Sand skinks are not limited by temperature extremes because other environmental conditions allow skinks to thermoregulate and remain active on most days throughout the year (Ashton and Telford 2006). These conditions that allow year-round activity include amount of canopy cover for shading, presence of leaf litter or other debris, and depth within the soil layer to which sand skinks can maneuver to obtain suitable temperature levels for thermoregulation.

Based upon recapture data, Gianopulos (2001) found that sand skinks did not appear to move large distances within an active season, probably not much farther than 35 m (115 ft). However, this study did indicate that sand skinks may move farther at some times of the year than others. Other studies indicate that dispersal capabilities of sand skinks are generally underestimated but vary among individuals, with some adults moving more than 140 m (459 ft) (Mushinsky et al. 2001, Penney 2001, Penney et al. 2001). Mushinsky et al. (2001) reported that some sand skinks in their study moved up to 140 m (459 ft) within a 14-day time period and found some evidence that smaller individuals may move longer distances than larger ones. They indicated that this may still be an underestimate of skink dispersal capability.

Penney (2001) stated that the movement of a few adults over large distance may be a response to limited resources, a reflection of large home range sizes, or an indicator that some adults act as "floaters" and tend to move more than others. Because of these dispersal abilities, natural colonization of individuals may occur in restored habitat in close proximity to suitable scrub habitat, but establishment may be difficult or impossible in restored isolated patches of habitat (Mushinsky et al. 2001, Penney 2001).

It is not clear whether or not skinks exhibit territorial behavior. Penney (2001) did not see convincing evidence that sand skinks establish distinct home ranges in the 6 years of her study because several individuals were found relatively far from the original site of capture. However, skinks that were captured more than two times were often caught within three trap distances of the original capture location (Penney 2001). There was evidence of aggressive behavior between males that were captured in the same trap based upon bite marks on the heads of the individuals (Penney 2001). However, whether or not sand skinks would defend a territory in a subterranean environment is unknown (Penney 2001).

Experimental studies were conducted to investigate the effects of management techniques such as clear-cutting and prescribed burning on sand skink populations inhabiting sand pine scrub over 5 years (Mushinsky and McCoy 1999, Gianopulos 2001, Gianopulos et al. 2001, Mushinsky et al. 2001). There was a decrease in relative abundance of skinks immediately following treatments associated with both clear-cutting and burning and then a significant increase in skink captures in the clear-cut plots over the 5-year period, but there was no apparent trend in the burned plots (Gianopulos et al. 2001, Mushinsky et al. 2001). Mushinsky et al. (2001) noted that significantly larger skinks were captured in the burned plots, indicating that more insect prey may have been available from decaying logs or that older skinks inhabited these sites.

Mushinsky and McCoy (1999) reported that the first year after management treatment showed the greatest effects on sand skink abundance on the plots. Skink populations may take time to significantly increase after the application of treatments (Mushinsky et al. 2001). Navratil (1999) stated that it was too early to surmise whether or not there was a difference in skink response to treatment method with only 3 years of data from his study. The most appropriate land management technique for skink conservation appears to depend more on the microhabitat conditions of the area treated than the treatment method, as sand skink distribution is correlated with various microhabitat features (Gianopulos et al. 2001, Mushinsky et al. 2001).

Comparisons of persistence, recruitment, and survival were used to determine translocation success of sand skinks on two restored scrub sites for 6 years following relocation (Mushinsky et al. 2001, Penney 2001, Penney et al. 2001). One site established a self-sustaining population, while the other did not. It was determined that site location, habitat suitability, and initial propagule size were the factors affecting success (Mushinsky et al. 2001, Penney et al. 2001). Researchers concluded that the chances of long-term survival may improve when habitat is restored and skinks are introduced to sites close to intact scrub, rather than to isolated sites (Mushinsky et al. 2001, Penney 2001).

2. Five-Factor Analysis -

a. Present or threatened destruction, modification or curtailment of its habitat or range: Continued habitat loss, fragmentation, and changes in land use threaten the existence of bluetail mole skinks and sand skinks. Although many populations are on sites that are publicly owned, populations on private sites are threatened with destruction or habitat modification due to improper or lack of management. Although not much is known about these fossorial species, they are known to occur from the Lake Wales Ridge, Winter Haven Ridge, and Mt. Dora Ridge. Although we do not have estimates of acreage for all of these ridges, we do know that the largest of these, the Lake Wales Ridge, encompasses approximately 517,303 acres (ac) (Archbold Biological Station *in press*). Roughly 69,683 ac of this area is protected in refuges, parks, State forests, wildlife and environmental areas, and on private lands and therefore protected from general destruction (Turner et al. 2006).

Turner et al. (2006) indicated that bluetail mole skinks seem to be underrepresented in the reserve network of protected public lands, but the authors could not determine if their absence reflects actual exclusion or a lack of survey effort. If the former is true, then additional lands must be protected and managed in perpetuity to ensure the survival of this species (Turner et al. 2006). Over the last 20 years, a concerted effort by public and private institutions to protect the remaining undeveloped areas of the Lake Wales

Ridge has resulted in the acquisition of 21,498 acres (ac) of scrub and sandhill habitat (Turner et al. 2006). A variety of state and federal agencies and private organizations are responsible for management of these areas. All of these efforts have greatly contributed to the protection of imperiled species including skinks on the Lake Wales Ridge (Turner et al. 2006).

Another concern is whether relatively small, isolated properties are able to maintain viable populations. There is evidence of an edge effect on sand skink distribution on isolated scrub fragments bordered by non-scrub habitat (Gianopulos 2001, Mushinsky et al. 2001). Gianopulos (2001) found that on scrub fragments bordered by non-scrub habitat, sand skinks were found more frequently within the middle of the sites than along the edges bordered by non-scrub habitat, and this difference was detected as far as 50 m (164 ft) into the sites.

Between 2005 and 2060 Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million ac of undeveloped land into urban land uses (Zwick and Carr 2006). Over most of the range of the skinks in the central region of Florida from Marion County southward to northern Polk and Osceola Counties, human population growth and the conversion of previously undeveloped lands to urban use is expected to be explosive (Zwick and Carr 2006). It is predicted that Osceola County is among the counties that will experience the greatest transformation from rural to urban land over the next 50 years (Zwick and Carr 2006). This is expected to be the result of population spillover from the build-out in Orange County (Zwick and Carr 2006). Therefore, we conclude that habitat loss, degradation, fragmentation for bluetail mole skinks and sand skinks continues to be a threat.

b. Overutilization for commercial, recreational, scientific, or educational purposes: Overutilization by amateur reptile and scientific collectors was identified as a potential threat in the original listing package. At this time, we have no evidence to suggest that this is a current threat.

c. Disease or predation: Disease and predation were not identified as potential threats in the original listing package, and recent studies have provided additional information that confirms disease is not known to be a threat at this time. Analysis of blood and fecal samples obtained from 20 sand skinks in Ocala National Forest demonstrated that no blood parasites were present and only normal protistan and helminth symbiotes were observed, with no evidence of effect on survival of individuals or the population (Telford 1998). Similarly, a species of nematode (*Parapharyngodon ocalaensis* n. sp.) was collected from the intestinal tracts of 22 sand skinks (Bursey and Telford 2002). It is not known to be a threat to the species. In a subsequent paper, Telford and Bursey (2003) found 3 species of endoparasites in 45 sand skinks from Ocala National Forest. These endoparasites are also not known to be threats. Although some research has addressed potential parasitic threats, few, if any, have examined predatory threats encountered by skinks. In conjunction with his parasite studies, Telford (1998) commented that the prevalence of regenerated tails in his sample indicated sand skinks were often attacked by predators but escaped because of the autotomy of the tail. Therefore, predation is not believed to be a threat at this time.

d. Inadequacy of existing regulatory mechanisms: In addition to protections associated with the Act and existing regulations on refuges and other protected lands where skinks occur, the bluetail mole skink and sand skink are listed by the Florida Fish and Wildlife Conservation Commission as threatened (Chapter 39-27, Florida Administrative Code). This legislation prohibits take, except under permit, but does not provide any direct habitat protection. Wildlife habitat is protected on Florida Fish and Wildlife Conservation Commission wildlife management areas and wildlife environmental areas according to Florida Administrative Code 68A-15.004. Therefore, the Act provides additional protection for these species and their habitat through section 7 (interagency cooperation), as well as through the prohibitions of section 9(a)(1) and the provisions of section 4(d) and recovery planning. Although section 7 and 9(a)(1) provide some regulatory protection, these provisions do not adequately protect against habitat loss. In addition, existing regulations are not specific enough to guard against loss of genetic integrity of the species. Research has shown that it is important to preserve certain areas of the historic range to maintain genetic diversity.

e. Other natural or manmade factors affecting its continued existence: Improper habitat management and invasion by exotic plant species threaten the existence of bluetail mole skinks and sand skinks. Active management is necessary to maintain suitable habitat for skinks. Management of scrub habitat is problematic because much of the remaining habitat occurs in small fragmented areas surrounded by residential areas where prescribed burning may not be feasible. These residential areas are also often a source of exotic plants that invade native habitat. Many of the fragments are overgrown and in need of restoration.

Habitat degradation on protected and private sites continues to be a threat because vegetation restoration and management programs are costly and depend upon availability of funding. Where prescribed fire is not feasible as a management technique because of smoke management and other concerns, mechanical treatment is sometimes used. However, heavy machinery disturbs the soil more than prescribed burning, and it removes often limited nutrients from the soil (Mushinsky et al. 2001). This changes the nutrient levels in the topsoil, affecting the vegetative composition of the site, whereas fire releases nutrients (Mushinsky et al. 2001). Also, if logs are removed from a site after mechanical treatment, prey abundance (termites) may be lower than it would be after a fire (Mushinsky et al. 2001).

Another threat to skinks is the loss of genetic diversity. Branch et al. (1999, 2003) discovered genetic distinctions among sand skink populations from the Mt. Dora Ridge, the northern Lake Wales Ridge, the central Lake Wales Ridge, and the southern Lake Wales Ridge. Because each site where more than five individuals were sampled contained unique haplotypes, populations on isolated ridges should be protected to avoid the loss of genetic diversity.

D. Synthesis - The 1999 MSRP contains objective measurable criteria that reflect the best available and most up-to-date information on the biology of the species and its habitat and addresses all three of the listing factors relevant to the species. Because bluetail mole skinks and sand skinks are fossorial, they are hard to find and difficult to research. They typically live in xeric uplands with sandy soils, such as scrub, turkey oak barrens, and sandy areas of the high pine community. Except for a few locations, we have little information about the status and trends of these skinks. Of the 23 locations on which the bluetail mole skink occurs, 12.5 are protected and, as of 2004, 10 were managed. Of the 73 locations on which sand skinks are reported, 38.5 are protected and, as of 2004, 27 were managed (Turner et al. 2006). Bluetail mole skinks seem to be underrepresented in the network of protected public lands (Turner et al. 2006).

Skink populations are patchily distributed on the landscape, and distribution is clumped (Gianopulos et al. 2001). An analysis of spatial distribution of sand skinks indicates that there is an edge effect on distribution on isolated sites (Gianopulos 2001, Mushinsky et al. 2001). Microhabitat conditions including depth of loose surface sand, percent of bare sand, soil particle size, and time since fire were found to be important factors in habitat suitability and could determine local distributions (Collazos 1998, Christman 2005).

Turner et al. (2006) reported that development and agriculture have resulted in the loss of approximately 85% of the scrub and sandhill habitats on the Lake Wales Ridge, and what remains contains high concentrations of imperiled species. Over the last 20 years, more than 87 km^2 (48.9%) of the remaining 187 km^2 of these habitat types on the Lake Wales Ridge have been acquired and protected (Turner et al. 2006). Even though some skink populations occur on public lands, we believe that habitat degradation and fragmentation continue to affect the populations. Active management is necessary to maintain suitable habitat for skinks. Much of the habitat occurs in small, isolated stands surrounded by residential areas or citrus groves, making them difficult to protect and manage. Many of the fragments are overgrown and in need of restoration. We believe that habitat degradation on these sites continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding. Privately-owned sites remain at risk of being developed and destruction or habitat modification due to improper or lack of management remains a concern. For example, a biological opinion was recently issued for a project that impacted 9 ac of occupied bluetail mole skink and sand skink habitat in Osceola County.

Genetic analyses of skinks have examined diversity at the species level. Genetic distinctions were found between sand skink populations from the Mt. Dora Ridge, the northern Lake Wales Ridge, the central Lake Wales Ridge, and the southern Lake Wales Ridge. Because each site where more than five individuals were sampled contained unique haplotypes (Branch et al. 2003), populations on isolated ridges should be protected to avoid the loss of genetic diversity. Other research that has been accomplished since the completion of the MSRP includes studies on sampling efficiency, skink activity, movement, territoriality, management, and reintroduction. Typically, sand skinks were the subject of study rather than bluetail mole skinks. Additional research should be conducted on demography, genetics, dispersal, edge effects, translocation success, management and restoration techniques, density, habitat, and microhabitat conditions throughout the range of both species. Range-wide surveys and long-term demographic studies greater than 10 years are needed to assess population trends.

Habitat loss, fragmentation, and changes in land use continue to threaten these skinks. In Conversion of rural lands to urban use in central Florida where skinks occur is projected to continue over the next 50 years. Overutilization for commercial, recreational, scientific, or educational purposes is not considered to be a threat to these species. Disease and predation were not identified as potential threats in the original listing package, and recent studies have confirmed this determination. In addition, fire suppression, improper stand management, invasion by exotic plant species, and loss of genetic diversity continue to threaten the existence of the bluetail mole skink and sand skink. Due to the above continued threats, these species continue to meet the definition of threatened under the Act.

III. RESULTS

A. Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X__ **No change is needed**

B. New Recovery Priority Number: Bluetail mole skink: 3C (upon name change)
Sand skink: 2C (upon name change)

The Recovery Priority Number for the bluetail mole skink should be changed from 3 to 3C because the current and projected development in central Florida conflicts with the recovery of the species. Despite pending taxonomic changes, it remains a subspecies within a non-monotypic genus, and, therefore no other changes are needed to the Recovery Priority Number classification. After the Service officially adopts the change in nomenclature for the two species, the Recovery Priority Number for the sand skink should be changed from 1 to 2C because of taxonomic changes that will place the species in a non-monotypic genus, *Plestiodon*. Like the bluetail mole skink, current and projected development in central Florida conflicts with the recovery of the species. Both sand skinks and bluetail mole skinks still fall within the category of high threats with high recovery potential.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Nomenclatural changes should be made to officially designate the names of the subspecies/species as *Plestiodon egregius lividus* and *Plestiodon reynoldsi.*
- Revisions to the recovery plan should be considered for both skink species.
- Scrub preserves should be effectively designed and managed using a multi-species approach to address the needs of each imperiled species, based upon dispersal abilities, spatial requirements, and habitat needs of the species of concern (Hokit et al. 1999).
- Additional surveys for bluetail mole skinks should be conducted on a year-round basis over an adequate number of years to assess the effect of variation in rainfall (Telford 2007 in litt.).
- Land should be acquired or conservation agreements established if bluetail mole skinks are underrepresented in the reserve network (Turner et al. 2006).
- Demographic and genetic studies should be undertaken to learn more about the biology of bluetail mole skinks.
- Additional studies should be conducted on density, habitat, and microhabitat conditions throughout the range of both species, and long-term demographic studies greater than 10 years are needed to discuss population trends (Malatesta 2007 in litt.).
- Additional studies should be conducted on natural history such as skink dispersal, edge effect, and translocation success (Malatesta 2007 in litt.).
- A range-wide survey of sand and bluetail mole skinks should be completed to compare with the last one conducted in the early 1990s.
- A sampling design should be developed that can be used to monitor and assess skink population trends throughout their range on an annual basis.
- Genetic distinctions among skink populations throughout their range should be considered when conducting section 7 consultations, Habitat Conservation Plans, and recovery efforts and when planning reserve designs to maintain the genetic diversity of the species.
- As many of the sites where skinks occur are highly fragmented and isolated and may suffer from an edge effect, future land acquisitions should be prioritized to purchase habitat congruent with existing protected and managed areas and to connect managed lands in order to obtain the best conservation value of the land for the species.

- Long-term studies should be undertaken on the effects of mechanical treatment and other management techniques (Malatesta 2007 in litt.).
- Habitat restoration and proper management techniques should be implemented on scrub and sandhill habitat.
- Partnerships should be promoted to share information, conduct collaborative research on scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota.
- Exotic species removal should be continued, and prescribed burns in scrub habitat should be reinstated and/or continued.
- Variability in the fire regime, including both seasonality and the fire return interval, should be considered and applied to management of the species and its habitat.
- Acquisition, protection, and management of additional undeveloped scrub habitat, especially along the middle and southern central ridge of Florida, will be needed to effectively protect both species (Telford 2007 in litt.).
- Land acquisition should be prioritized to purchase habitat congruent with existing protected and managed areas in order to obtain the best conservation value of the land for the species. This should be accomplished in coordination with acquisition of property in each of the areas that have genetically distinct populations.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Bluetail mole skink (*Eumeces egregius lividus*)
and Sand skink (*Neoseps reynoldsi*)

Current Classification
Bluetail mole skink: Threatened
Sand skink: Threatened

Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable ____

Review Conducted By Marilyn Knight

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve [signature] Date 6-22-07

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve Noreen E. Walsh Date 8/2/07

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

APPENDIX A: Summary of peer review for the 5-year review of bluetail mole skink (*Eumeces egregius lividus*) and sand skink (*Neoseps reynoldsi*)

A. Peer Review Method: The Service conducted a standard level of peer review. Recommendations for peer reviewers were solicited from the Florida Fish and Wildlife Conservation Commission and Polk County Natural Resource Division. Additionally, peer reviewers were selected by the Service. Five peer reviewers were asked to participate in this review. Individual responses were requested and received from each of the peer reviewers.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments/Report: Peer review comments were substantial and provided insights that were beneficial in conducting this review. Comments and concerns covered a variety of topics including the thoroughness of the review and questions concerning the validity of occurrence data used in the review. New documentation of sand skink occurrence in Putnam County was brought to our attention, as was a concern regarding the number and need for verification of skink locations reported beyond the Lake Wales Ridge. Methods used by different land managers to collect skink data varied considerably and should be scrutinized carefully when analyzing data. The disparity noted between the relative abundance of the two skink species may have been due to small sample sizes as a result of seasonal variability in activity cycles and movements, but there is concern that overall populations of both skink species are declining. It is possible to obtain a crude estimate of the total number of sand skinks on protected lands on the Lake Wales Ridge based upon data that we currently have using the mean number of skinks per acre and the number of acres of potentially suitable habitat protected on the Lake Wales Ridge. However, this estimate must be interpreted with caution due to the lack of comprehensive data and provided that some assumptions are made (e.g., that density estimates are consistent among populations throughout the range).

Other significant comments included the concern that researchers may not be able to obtain solid density estimates, behavioral biology, and home range extent of any fossorial species, and the data that are available may not be adequate to confirm skink distribution.
Other areas where we lack comprehensive data on these species include research on natural nesting sites, distribution, abundance, population trends, and microhabitat conditions by scrub "type" for both skink species. It was suggested that a stochastic event may be capable of decreasing bluetail mole skink populations to levels of concern before much needed studies can be completed. Additional biological information or clarification provided by reviewers included skink preference as to sand particle size, the suggestion of founder effect versus genetic drift on the Mt. Dora Ridge, the need for additional analyses for proposing taxonomic changes, age at sexual maturity of sand skinks, and new information reported this year on clutch sizes of sand skinks.

Other comments and concerns included the amount of land that has already been acquired to benefit the sand skink in the last two decades, the effects of lack of habitat management and habitat succession on skink populations, the need for additional protection of suitable habitat for skinks, and the establishment of reserves. It was suggested that the under-representation of bluetail mole skinks in the reserve network of protected public lands may be due to either a lack of survey effort or actual exclusion, and inadequate results, especially related to the bluetail mole skink, may have implications on the scientific conclusions that are drawn from the data. There was concern about using limited edge effect data to try to determine the minimum size of conservation reserves because some sand skinks have the ability to persist on areas less than an acre in size. Also addressed was the assumption that declines in skink populations as reported by Pike et al. (2006 abstract) on an experimental conservation reserve were the result of hydrologic changes caused by development rather than by site preparation via prescribed burning. The amount of time since fire has been shown to be an important variable affecting skink populations, and the use of mechanical treatments on skinks in lieu of prescribed fire as a management technique is a concern. Effective protection of both skink species may depend upon additional acquisition of scrub habitat along the central and southern portions of the Lake Wales Ridge.

Suggestions for future actions included: sample on a year-round basis for a period of years adequate to minimize the effect of annual variation in rainfall on skink activity; conduct long-term demographic studies, greater than 10 years in duration, to understand the biology and population trends of both skink species; conduct additional and more detailed genetic analyses to understand the natural history of the species; implement studies to examine skink distributions and microhabitat conditions; conduct range-wide surveys on both public and private lands and examine their response to certain mechanical treatments and their preference for certain microhabitat conditions; implement additional studies on skink dispersal, translocation success, and edge effect to obtain information that can be used to make decisions on adequate preserve sizes; acquire more undeveloped scrub habitat along the central and southern portions of the Lake Wales Ridge to provide additional protection for the two skink species; quantify how effective public land managers are in managing scrub habitat for skinks; and determine an efficient way to track skink populations on public lands.

D. Response to Peer Review: The Service was in agreement with the vast majority of comments and concerns received from peer reviewers, and comments were largely incorporated into the 5-year review form. There were two areas of concern, which the Service did not completely share. One reviewer suggested that soil compaction changes on a daily basis depending upon weather conditions and that such microhabitat features may influence skink distribution. Although soil compaction may change due to weather conditions (e.g., rainfall), the Service believes that physical properties of soil that do not change (e.g., soil type and particle size) are more of a general determinant in skink distribution. However, the Service does agree with the suggestion that additional research needs to be conducted on microhabitat conditions and skink distribution. Regarding the other concern, a reviewer suggested that we should determine a crude estimate of the total number of sand skinks on the Lake Wales Ridge based upon density estimates and their estimated area of occupancy on protected lands along this ridge. However, we did not have enough confidence in these estimates to add this to the review.

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, South Florida Ecological Services Office

February 20, 2007

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Cindy Schulz, Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 305, email: Cindy_Schulz@fws.gov.