

**Avon Park harebells**  
**(*Crotalaria avonensis*)**

**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**

### **Avon Park harebells/*Crotalaria avonensis***

#### **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 this plant 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 Avon Park harebells. Comments and suggestions regarding the review were received from South Florida Ecological Services Office supervisors and peer reviews from outside the Service. No part of the review was contracted to an outside party. The draft of this review document was distributed for peer review (see Appendix A) and comments received were addressed.

#### **B. Reviewers**

**Lead Region:** Southeast Region, Kelly Bibb, 404-679-7132

**Lead Field Office:** Paula Halupa, South Florida Ecological Services Office, 772-562-3909, ext. 257

#### **C. Background**

**1. FR Notice citation announcing initiation of this review:** September 27, 2006. Endangered and threatened wildlife and plants; 5-year review of 37 southeastern species. 71 FR 56545.

**2. Species status:** Decreasing, 2006 Recovery Data Call. Unprotected habitat remains at risk and threats continue. Vehicular damage from off-road vehicles on protected lands was noticeably higher than previous years.

**3. Recovery achieved:** 1 (0-25% recovery objectives achieved), 2006 Recovery Data Call.

#### **4. Listing history**

Original Listing

FR notice: 58 FR 25746

Date listed: April 27, 1993

Entity listed: Species

Classification: Endangered

#### **5. Review History:**

Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species (June 20, 1996)

South Florida Multi-Species Recovery Plan (May 18, 1999)

Recovery Data Call 2001, 2002, 2003, 2004, 2005, 2006

**6. Species' Recovery Priority Number at start of review (48 FR 43098):** 2c, Avon Park harebells had been considered as a species with a high degree of threat and high recovery potential (i.e., biological and ecological limiting factors well understood, threats to species existence well understood and easily alleviated, and intensive management not needed or techniques well documented with high probability of success) (48 FR 43098, 48 FR 51985). This species, which is dependent upon a narrow geographic range (i.e., endemic only to Lake Wales Ridge), is or may be in conflict with construction or other development projects or other forms of economic development.

**7. Recovery Plan or Outline**

Name of plan: South Florida Multi-Species Recovery Plan

Date issued: May 18, 1999

Dates of previous plans: June 20, 1996

**II. REVIEW ANALYSIS**

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

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

The Act defines species to include any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the DPS policy is not applicable to this plant species, it is not addressed further in this review.

**B. Recovery Criteria**

**1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** No

There are no recovery criteria specified in the recovery plan for downlisting or delisting. The recovery objective is to increase existing populations and prevent extinction (Service 1999). As stated in the plan, this species may be considered stabilized when existing populations, within the historic range, are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression, and sites must also be managed to support Avon Park harebells. This recovery objective is an interim goal because of the limited data on the biology, ecology, and management needs of this species (Service 1999).

Work and progress toward this recovery objective is highlighted within the 5-year review analysis below. We present the objective here only in context of the analysis of the best available information below.

## 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:** The following current summary of populations is based largely on information provided by Kris DeLaney (pers. comm. 2007), an independent botanist who co-described the species (DeLaney and Wunderlin 1989). Only two relatively small populations and one subpopulation of Avon Park harebells exist. The larger western population occurs on private, unprotected land within the Avon Park Lakes subdivision. The subpopulation occurs at The Nature Conservancy's (TNC) Saddle Blanket Scrub Preserve (conserved private). This remnant subpopulation became isolated when the central portion of the Avon Park Lakes population was removed by agribusiness development (e.g., citrus grove development and other land uses) and is now disjunct from the Avon Park Lakes population. The eastern population occurs at the Florida Fish and Wildlife Conservation Commission's (FWC) Lake Wales Ridge Wildlife Management Area (Carter Creek) (conserved public, partially acquired). Occurrences of the plant are rather localized and irregularly or thinly distributed over areas of suitable white-sand scrub habitat. No new occurrences have been found recently, and no complete censuses exist (E. Menges, Archbold Biological Station [Archbold], pers. comm. 2007).

The Avon Park Lakes population, the largest extant population, is currently at-risk as habitat is being developed and fragmented. The Florida Natural Areas Inventory (FNAI) (2006) had estimated the occurrence at Avon Park Lakes within the Lake Chilton Scrub and Avon Park Lakes survey sites to have good viability in 1998. Despite fire suppression and overgrown vegetation, several open patches remained in 1999, providing habitat for this species (TNC 1999). However, TNC has informally been tracking the Avon Park Lakes population, and a drastic reduction in habitat resulting from development in spring 2005 has occurred (B. Pace-Aldana, TNC, pers. comm. 2006). In 2005, only 125 acres (51 hectares) of undeveloped area that contained the species remained, the habitat was not contiguous, and most blocks of habitat had at least one house (B. Pace-Aldana, pers. comm. 2007). The largest remaining contiguous patch of habitat was only 25 acres (10 hectares) (B. Pace-Aldana, pers. comm. 2007). In addition to habitat loss and fragmentation, this population is being continuously degraded by off-road vehicles and other increasing human

impacts (E. Menges, pers. comm. 2007; K. DeLaney, pers. comm. 2007) (see 2.e below).

The subpopulation at Saddle Blanket is estimated as roughly hundreds (FNAI 2006); approximately 531 individuals were found in 2005-2006 (TNC 2006). Based upon field observations, DeLaney (pers. comm. 2007) believes this subpopulation appears to have declined since the site was purchased for public use; he suggests this is possibly due to disturbances and impacts associated with excessive human traffic and / or inadequate or improper management. However, TNC has been monitoring this subpopulation since 1991, and overall their data indicate it is increasing (B. Pace-Aldana, pers. comm. 2006). Monitoring at Saddle Blanket consists of permanent census plots (visited annually) and surveys (every five to six years) of all areas where this species occurs (TNC 2006). Regression analyses of census plots shows at least six of eight plots have declined overall since their inception; however, TNC suggests that the census plots are not representative of the entire subpopulation at Saddle Blanket and that the presence of this species within small areas may only be short-term due to eventual nutrient depletion or other unknown factors (TNC 2006) (e.g., possible negative impacts from anthropogenic disturbance associated with long-term plant population monitoring [K. Clanton, Florida Division of Forestry, pers. comm. 2007]). Conversely, results from survey data show large increases in occurrences of this species at Saddle Blanket; the population has increased by more than 85% from 2000 to 2006 (TNC 2006). TNC believes that fire management is the primary factor for the increase, but does not think that it has sufficient scientific evidence to support this claim due to poor pre-fire data in some areas (B. Pace-Aldana, pers. comm. 2007). Overall, however, the extinction coefficient for Avon Park harebells at Saddle Blanket is assumed to be high due to the very limited area of occupied habitat, small numbers of plants present, edge effect, potential for extensive future development adjacent to, or in close proximity to the site, and possible impacts from nearby citrus farming operations (K. DeLaney, pers. comm. 2007).

The population at Carter Creek has been impacted from road building in the mid-1990s, resulting in direct mortality and an increase in human-caused threats (Service 1996; K. DeLaney, pers. comm. 2007) (see 2.e below). However, occurrences at Carter Creek have been considered to have excellent viability (two survey sites with large populations in 1998 and 2000) and fair estimated viability (one survey site in 2000) (FNAI 2006). Since 1998 Archbold has conducted monitoring at Carter Creek North to quantify survival, growth, and reproduction (Menges and Weekly 2004, Menges et al. 2006). Menges and Weekley (2004) indicated that population at Carter Creek is fairly stable or declining slowly based upon 31 censuses over seven years. More recently, Menges et al. (2006) found that year-to-year population sizes in some sets of plots were fairly stable (e.g., plots started in 1998), but an

obvious decline occurred in the number of plants in the 2001 plots from 2001 through 2004.

Menges et al. (2006) have collected nine years of detailed demographic research on this species at Carter Creek. For the first time, researchers have formulated a conceptual model of the life cycle of this species and have calculated and analyzed annual survival rates (Menges et al. 2006). Overall, survival is high overall; 83-92% of plants survived each year (including plants that became dormant but later re-appeared) (Menges et al. 2006). Most surviving plants appear aboveground every year, however, 2-15% of plants enter dormancy in any given year, emerging one to several years later; most episodes of dormancy lasted longer than one year (Menges et al. 2006). Survival varied among vegetation types and was generally highest in rosemary scrub, intermediate in scrubby flatwoods, and lowest along roadsides (Menges et al. 2006).

Low fecundity is mainly attributed to low flower production (few plants flowering, few flowers per plant) and low rates of fruit initiation (generally less than 30%) (Menges et al. 2006). Although plants live for many years, reproduction is very sporadic; very few seeds ultimately mature (E. Menges, pers. comm. 2006). Fruit set requires insect visitation (Menges and Weekley 2003). Menges and Weekley (2003) reported that they observed a diversity of floral visitors (mainly bees), but “insect visits seem quite infrequent”. Fruit production is low and seedlings have rarely been encountered in the field until recently (Menges et al. 2006). Results from germination experiments suggest that this species has a persistent seed bank, however, germination rates after one year are below 1% (Menges et al. 2006). Scarification does not seem to be required for seed germination (Menges et al. 2006). Researchers are concentrating on finding and following naturally recruiting seedlings due to the difficulty in identification (Menges et al. 2006). Menges et al. (2006) indicate that Avon Park harebells is a long-lived iteroparous (reproducing repeated times in different seasons) perennial with high annual survival but considerable within-year fluctuations. DeLaney (pers. comm. 2007) suggests that the reproductive strategy of long-lived plants such as Avon Park harebells may be both dynamic and distributed over very long periods of time, with long-term peaks and lows in the numbers of populations and individuals, often including long-term local extirpations with very gradual or extremely infrequent population reestablishments.

Overall, there is enough information to evaluate the major population trends and principal risks to this species (P. Quintana Ascencio, University of Central Florida, pers. comm. 2007). Although there are no complete censuses, Avon Park harebells has been monitored across most of its limited range for several years; these studies describe general population variation and provide assessments of the relative importance of factors associated with variation in survival, growth and reproduction, and population viability (P. Quintana

Ascencio, pers. comm. 2007). More detailed research and analysis may be needed to better understand extinction risk (P. Quintana Ascencio, pers. comm. 2007). However, it is clear that land acquisition and protection are of urgent and paramount importance at the Avon Park Lakes site and would immediately accomplish increased protection and stability for the largest extant population (K. DeLaney, pers. comm. 2007). The Carter Creek population needs to be secured against unregulated activities and damaging human impacts (K. DeLaney, pers. comm. 2007; A. Cox, ecolo~G, Inc., pers. comm. 2007). The Saddle Blanket subpopulation is small and relatively secure, but may still be impacted by management and adjacent land uses.

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):** Work to further document the breeding system is underway using genetic methods (Menges and Weekley 2004). Understanding the breeding system of this species is important in designing augmentations, assessing management effects on populations, and providing insight into the limited seedling recruitment (Menges et al. 2006). In an experiment where pollinators were excluded, Menges and Weekley (2003) found that fruit production does not occur in flowers denied access to pollinators. They suggest that Avon Park harebells are either not self-compatible (i.e., there is a genetic barrier to selfing) and / or pollinators are required to move pollen among flowers within the same plant to effect selfing (Menges and Weekley 2003). Allozyme electrophoresis conducted in spring 2003 in collaboration with Dr. Rebecca Dolan of Butler University revealed no variations in banding patterns among individuals and is thus unlikely to be useful in revealing whether plants are capable of selfing (Menges and Weekley 2004).

Work using microsatellites to examine the rangewide genetics and the mating system of this species is continuing, led by Dr. Matt Gitzendanner of the Florida Museum of Natural History Genetics Lab (Menges et al. 2006). This lab has been using microsatellites to genotype seedlings from known maternal plants to determine their paternity since 2004 (Menges et al. 2006). In 2006, this lab successfully developed a DNA extraction protocol for isolating the large amounts of DNA required for the microsatellite analysis (Menges et al. 2006). The lab has developed a set of clones containing microsatellite repeats and sequenced some of the clones; sequences verify that valid microsatellite repeats are present, but the repeats are unusually long (Menges et al. 2006). These long repeats are valuable for identifying variability, but hinder sequencing through the repeat section (Menges et al. 2006). The lab has developed sequence data for one side of the repeat loci, and will be sequencing from the other direction shortly. Once sequenced, primers will be developed to amplify the loci in this species, and the samples collected from plants at Carter Creek will be genotyped (Menges et al. 2006). Research with microsatellites should result in enough information to assess loss of genetic variation and levels of inbreeding (P. Quintana Ascencio, pers. comm. 2007).

In 2005, the Service provided funding to the Cincinnati Zoo and Botanical Garden to utilize tissue culture and cryopreservation techniques to create plants of Avon Park harebells and to study the survival of plants propagated by this method in the wild. Researchers at Archbold have been working with Dr. Valerie Pence of the Zoo's Center for Conservation and Research of Endangered Wildlife (CREW) to test the feasibility of using tissue-cultured plantlets of this species to augment existing patches of plants or to start new patches in protected habitat (Menges and Weekley 2005, Menges et al. 2006). Tissue-cultured plants would allow augmentations of small existing populations and help counteract the problem of low seed production and limited seedling recruitment (Menges et al. 2006). As of 2006, shoot tips were collected from 100 individuals in each of the two targeted populations, Carter Creek and Saddle Blanket, and 68 genetic lines from Carter Creek and 64 genetic lines from Saddle Blanket are in culture at CREW (Pence et al. 2006). Current work is directed at maintaining the lines until acclimation procedures are firmly established and rooted plants can be produced to send to Archbold for acclimation; work continues on improving growth and rooting rates (Pence et al. 2006). To date, only a few genotypes have rooted in order to provide materials to establish acclimation protocols; once methods for acclimation are established rooting of all the genotypes will be attempted (Pence et al. 2006). Several attempts at acclimating plants have been made by Archbold; survival has been limited, but is improving (Pence et al. 2006). Through March 2006, survival of plants in the growth chamber has been significantly greater than plants on the veranda (54% vs. 31%) (Menges et al. 2006). Five plantlets comprising three lines were being acclimated in December 2006 outside and may be transplanted to Carter Creek in 2007 (Pence et al. 2006). The goal is to augment the Carter Creek population with tissue-cultured plants in 2007 (Menges et al. 2006).

Procedures for cryopreserving shoot tips from tissue culture lines of Avon Park harebells have been developed through previously funded work (Pence et al. 2006). As part of the current study, researchers have begun to cryopreserve the genetic lines from Carter Creek; tissues from 14 lines are frozen and banked in CREW's Frozen Garden and 11 Carter Creek lines are being prepared for cryopreservation (Pence et al. 2006, Charls et al. 2007). Approaches are being developed to deal with the large numbers of genetic lines that are in culture at CREW (Pence et al. 2006). In some cases, a very light but persistent bacterial contamination is present in the cultures, which does not appear to affect growth, but may impede survival through cryopreservation (Pence et al. 2006). Researchers have found that eliminating the bacterial infection during cryopreservation (through antibiotic treatments) is more efficient than trying to eliminate it from whole cultures before cryopreservation is attempted (Pence et al. 2006).



DeLaney (pers. comm. 2007) expressed concern regarding the use of tissue culture and / or cryopreservation as conservation techniques for population establishment or augmentation. DeLaney (pers. comm. 2007) considers such experiments to be highly experimental and to present the potential to reduce overall genetic diversity and fitness through a variety of mechanisms (direct and indirect, known and unknown), including negative impacts to Avon Park harebells and increased damage to the ecosystem through human-induced disturbances associated with field activities. DeLaney (pers. comm. 2007) stated that even the most minimal new acquisition would be infinitely more meaningful for the conservation of Avon Park harebells and would have the added benefits of preserving more genetic diversity. The Service believes that land acquisition and habitat protection at the Avon Park Lakes site would be the most meaningful conservation actions to ensure persistence of this species over the long-term. However, until adequate protection can be achieved we believe that research associated with preserving genetic diversity and augmenting wild populations may be important in preventing the extinction of this species.

**c. Taxonomic classification or changes in nomenclature:** None. The University of South Florida's Institute for Systematic Botany uses *Crotalaria avonensis* DeLaney and Wunderlin (Wunderlin and Hansen 2004). The Integrated Taxonomic Information System (2007) indicates that the current standing of the taxonomic status is accepted.

**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):** The current range of Avon Park harebells extends over approximately 1,280 acres (518 hectares) and includes two relatively small, distantly separated populations and one subpopulation, located in the vicinity of southeastern Polk County and northwestern Highlands County, near the City of Avon Park (K. DeLaney, pers. comm. 2007). Avon Park harebells is considered one of the most narrowly distributed and rarest of the Lake Wales Ridge endemic plants (DeLaney and Wunderlin 1989, Menges et al. 2006). The reasons for its narrow range or why it occupies so few locations within its range are not known (E. Menges, pers. comm. 2006).

Trends in spatial distribution or historic range are difficult to determine. When first described in 1989, this species was known from only two localities on the Lake Wales Ridge about 10 miles (16 kilometers) apart in Highlands County (DeLaney and Wunderlin 1989). DeLaney and Wunderlin (1989) found the species restricted to two areas of sparsely vegetated, xeric, white sand scrub that exhibited an exceedingly high diversity and density of endemic species. All populations occurred on well drained Archbold or somewhat poorly drained Satellite, deep white sand, containing extremely low clay and organic components (DeLaney and Wunderlin 1989). DeLaney and

Wunderlin (1989) noted that the species appears to be a Miocene relic that was well adapted to its xeric habitat due to a deep, buried taproot, early and short blooming period, and compact growth habit.

The type locality was contained within a defunct Sebring Highlands development that was subdivided into ~1.25-acre (0.5-hectare) tracts (DeLaney and Wunderlin 1989). The other population was confined to the east side of Avon Park Lakes development, which was subdivided into ~0.25-acre (0.1-hectare) tracts; that population was damaged due to off-road vehicle use (DeLaney and Wunderlin 1989). The Grassy Pond population was threatened by encroaching citrus farming, sod farming, and off-road vehicles (DeLaney and Wunderlin 1989). The Sebring Highlands and Grassy Pond occurrences are part of the population at Carter Creek (E. Menges, pers. comm. 2007). At the time of its discovery, the Lake Wales region was being rapidly destroyed by the expansion of the citrus industry and urban development (DeLaney and Wunderlin 1989). An estimated <10% of the original scrub vegetation remained and less than 3% of the total land of the region was protected from development (DeLaney and Wunderlin 1989).

At the time of its listing in 1993, Avon Park harebells were known from three sites, including two (Saddle Blanket and Carter Creek) that were not yet protected (58 FR 25746). The final rule indicated that this species already suffered serious loss of habitat due to agriculture (citrus groves and pastures) and residential development and that this species was threatened by future development (58 FR 25746). At the time of listing, only 27,500 acres (11,129 hectares) of the original 250,000 acres (101,172 hectares) within the Lake Wales Ridge remained (58 FR 25746).

The Saddle Blanket subpopulation and Carter Creek population have since been protected. However, off-road vehicles are a problem at Carter Creek, and while populations are fairly stable, declines have been noted along roadsides (E. Menges, pers. comm. 2007). There are plans to fence off portions of Carter Creek, but this has not been initiated yet (E. Menges, pers. comm. 2007). The Avon Park Lakes population is rapidly being developed and fragmented and is under imminent threat of complete destruction (K. DeLaney, pers. comm. 2007). Drastic habitat reduction was observed in spring 2005 due to recent and rapid development at this site (B. Pace-Aldana, pers. comm. 2006; E. Menges, pers. comm. 2006). Development, off-road vehicles, and encroachment by native shrubs and exotic grasses are problems at this site (E. Menges, pers. comm. 2007).

**e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):** Roughly 85% of the scrub and sandhills on Lake Wales Ridge have been lost to development and agriculture (Friedman et al. 1993 as cited in Turner et al. 2006). This loss of habitat has also resulted in a concomitant reduction in the frequency and extent of

wildfires (Turner et al. 2006). While public and private entities have protected 21,498 acres (8,700 hectares) of scrub and sandhill habitat over the past two decades, protected fragments are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats, and are managed by a variety of entities (Turner et al. 2006); management in general is confounded by habitat fragmentation and land ownership. Analyses by Turner et al. (2006) indicate that while conservation efforts to date have contributed greatly to protecting imperiled species on the Lake Wales Ridge, many species are likely to remain at great risk of extinction despite ongoing conservation efforts, primarily because even under the most optimistic acquisition scenarios, little more than 7% of the original habitats will be protected since most have already been destroyed. Analyses indicate that even if all of the unprotected areas targeted for protection are secured, Avon Park harebells will remain at great risk of extinction (Turner et al. 2006).

Acquisition or habitat protection is needed at Avon Park Lakes to maintain habitat suitability at its largest population. Ecosystem conditions at Avon Park Lakes have been such that a great diversity of endemic species and large numbers of Avon Park harebells have persisted, without management, but the area is rapidly becoming developed (K. DeLaney, pers. comm. 2007; B. Pace-Aldana, pers. comm. 2006; E. Menges, pers. comm. 2006). Persistence of this species is also dependent upon proper management of Carter Creek and Saddle Blanket (B. Pace-Aldana, pers. comm. 2006). Carter Creek needs to be secured to reduce the amount of unregulated activities and damaging impacts to the species and habitat at this site (K. DeLaney, pers. comm. 2007; A. Cox, pers. comm. 2007). Turner et al. (2006) found virtually all of the 36 rare and endemic Lake Wales Ridge species investigated will depend upon some form of active management (most often prescribed fire) for long-term persistence. Fragmentation of habitat and in-holdings within protected sites may limit application of fire and other management (TNC 2000).

**f. Other:** Analyses by Turner et al. (2006) identified Avon Park harebells as a species of particularly high conservation concern due to its low protection index (PI) under current and targeted scenarios. In constructing the PIs, three distributional factors associated with extinction risk were considered: number of locations, extent of occurrence, and area of occupancy (Turner et al. 2006). Avon Park harebells has a low total PI due to its small area of occupancy and limited geographical extent (Turner et al. 2006). Based upon these analyses, Avon Park harebells will likely require active management (e.g., prescribed fire) and more intensive management, possibly including propagation, translocation, and reintroduction to potentially suitable habitat, to survive (Turner et al. 2006). Additional land acquisition would likely be the most effective means of conserving this species. In addition to ongoing actions, minimizing extinction probabilities of this species will probably require augmentation of extant populations to increase population sizes and number of sites (P. Quintana Ascencio, pers. comm. 2007).

Menges and Weekley (2002) found this species to prefer, but not require open scrub, with less vegetation cover and more bare sand. Individuals resprout after being top-killed by fire (TNC 2006). TNC found 95% of the individuals resprouted within two months after the fire (TNC 2006). Based upon results from a prescribed burn experiment, Menges et al. (2006) also found that post-fire resprouting was rapid (beginning in October) and effective. Annual survival rates were similar between burn treatments (mechanically treated or not) and with fire intensity and were also similar between burned and unburned rosemary scrub patches (> 80% in all cases) (Menges et al. 2006). Fire had neither a negative nor a positive effect on survival (Menges et al. 2006). TNC found a neutral post-fire effect at Saddle Blanket as well (B. Pace-Aldana, pers. comm. 2007). Long-term fire suppression would not be beneficial to this species (E. Menges, pers. comm. 2006).

An experiment to test the effects of fire vs. mechanical treatment and fire on Avon Park harebells was conducted as part of a larger project to test the effects on rosemary-oak scrub (Menges et al. 2006). Between 2005 and 2006 survival did not differ significantly among the various treatments: burn-only quadrats (93.8% survival), gyro-trac + light burn (86.2%), gyro-trac + intense burn (81.8%), and unburned quadrats elsewhere at Carter Creek (75.2%). For unburned rosemary scrub quadrats, survival was also similar to that of burned quadrats (85.4%); all burned rosemary plots had similar survival to unburned rosemary plots (87.5%) (Menges et al. 2006). This research may be helpful in developing the best management strategies for this species. However, DeLaney (pers. comm. 2007) cautions that experimental projects involving Avon Park harebells are potentially damaging to the survival of this species, which consists of irreplaceable long-lived individuals, which may seldom reproduce in significant numbers and which may already be in decline for many other reasons.

*Ex situ* conservation efforts are underway by the following entities: Historic Bok Sanctuary (HBS) in Lake Wales, Florida; Archbold in Lake Placid, Florida; and the Cincinnati Zoo and Botanical Garden in Cincinnati, Ohio. The Service is providing funding to the CREW for tissue culture and cryopreservation work (described above); the Center for Plant Conservation and Archbold are cooperators on the project along with FWC and TNC land managers. The HBS has plants in a National Collection Bed (45 plants) and in its Endangered Plant Garden (6 plants) and plans to collect seed in 2007 at the TNC site and add propagules to the National Collection (C. Campbell, HBS, pers. comm. 2007). The HBS has propagated this species successfully from seeds and cuttings at an overall 50% success rate, but attempts to acclimatize in-vitro tissue cultured plantlets received from CREW has not been successful (C. Campbell, pers. comm. 2007). Priorities for HBS are to promote further building of the *ex situ* collection, add propagules from the

protected sites, store seed from all three sites, and work cooperatively with CREW (C. Campbell, pers. comm. 2007).

## 2. Five-Factor Analysis -

**a. Present or threatened destruction, modification or curtailment of its habitat or range:** Avon Park harebells continues to be threatened by habitat loss, modification, and fragmentation. Although some progress has been made in habitat protection through land acquisition since its listing in 1993 (i.e., Saddle Blanket is protected, Carter Creek is > 70% acquired [TNC 2000]), the Avon Park Lakes population, one of two remaining, is still at-risk to residential and agricultural development. Pace-Aldana (pers. comm. 2006) has informally tracked the population at Avon Park Lakes and observed a drastic reduction in habitat resulting from development in spring 2005. The Avon Park Lakes population is fragmented by road grids (paved and dirt), scattered houses, and numerous off-road vehicle trails (FNAI 2006). Continued building is eliminating some locations for Avon Park harebells at Avon Park Lakes (E. Menges, pers. comm. 2007). This site is being rapidly lost to residential development (P. Quintana Ascencio, pers. comm. 2007). DeLaney (pers. comm. 2007) states that the Avon Park Lakes population, the largest extant population, is rapidly being developed and fragmented and is under imminent threat of complete destruction. Development pressure in the area that supports this species is clearly increasing. As of March 2007, approximately 3,090 building permits had been issued in the previous 10-year period in the Avon Park Lakes subdivision; of these, 1,679 were new building permits on new lots (K. DeLaney, pers. comm. 2007). Within the past 10 years, the building permit rate in Avon Park Lakes has increased by a factor of 10, rising to nearly 400 new constructions per year in 2005 (K. DeLaney, pers. comm. 2007). Based upon the best data and information available, we believe that the Avon Park Lakes population is and continues to be at high and imminent risk of habitat loss and fragmentation from on-going development.

Analyses by Turner et al. (2006) show five locations for this species with 2.5 protected and 2.5 targeted for protection. Turner et al. (2006) considered: three locations at Carter Creek (partially acquired) of which 1.5 locations are protected; one location at Saddle Blanket (entirely protected); and one location on unprotected land that is targeted under the Florida Forever program, referred to as Lake Wales Ridge Ecosystem, Avon Park Lakes Addition. Based upon Turner et al. (2006), half of the locations for this species are at-risk to habitat loss. Analyses by Zwick and Carr (2006) indicate that the central Florida region is expected to experience “explosive” growth, with continuous urban development from Ocala to Sebring; virtually all of the natural systems and wildlife corridors in this region will be fragmented, if not replaced, by urban development. Increases in population growth and associated development are especially problematic for this species, due to its extremely narrow range (southeastern Polk County to northwestern Highlands

County) (see 1.d. Spatial distribution above). Polk County, with a population of 538,220 in 2005, is projected to increase to 1,029,606 by 2060 (Zwick and Carr 2006). Highlands County has experienced a 21% increase in population since 1990 (K. DeLaney, pers. comm. 2007). Highlands County, with a population of 93,625 in 2005 is projected to increase to 170,038 by 2060 (Zwick and Carr 2006).

With increases in population and human use, habitat loss, degradation, and fragmentation is expected to continue and increase. Approximately 232 acres (94 hectares) of scrub and sandhill within the Avon Park Lakes Addition remain currently unprotected, but are targeted for acquisition under the Florida Forever program (Turner et al. 2006). With continued development pressure, it may be more difficult to acquire remaining unprotected sites. Existing habitat needs to be managed to maintain populations through use of prescribed fire and preventing competition from exotic or invasive species and damage by off-road vehicles (Service 1999). A checkerboard ownership pattern of remaining acquisition parcels (Turner et al. 2006), however, is likely to make it more difficult to protect and manage land (e.g., use prescribed fire). Increased population growth and development may increase the likelihood of fire suppression. Long-term fire suppression would not be beneficial to this species (E. Menges, pers. comm. 2006).

Although the Saddle Blanket subpopulation is protected, both remaining populations (i.e., Avon Park Lakes and Carter Creek) are threatened by continued habitat loss, modification, and fragmentation. The extant populations of Avon Park harebells continue to face a significant threat of extirpation (P. Quintana Ascencio, pers. comm. 2007). Overall, we consider the magnitude of these threats to be high, and immediacy of threats to be imminent.

**b. Overutilization for commercial, recreational, scientific, or educational purposes:** Overutilization of this species for commercial or recreational purposes is not a current threat. The final listing rule stated that there was little commercial trade (58 FR 25746-25755). The Association of Florida Native Nurseries (2007) does not list any wholesale sources of Avon Park harebells, suggesting that there is little or no commercial trade for this species.

Overutilization for scientific purposes was not considered to be a threat until recently. DeLaney (pers. comm. 2007) suggests that the species is being over-studied at the few locations where it should be protected, citing its extremely limited geographic extent and how intensively and often it has been investigated by several different entities. DeLaney (pers. comm. 2007) states that an important fact to consider when working with perennial scrub species is that they may be quite long-lived, seldom reproduce, have complex population dynamics, or even be reproductively “stalled”. DeLaney (pers. comm. 2007) suggests that damage can be unusually devastating to

populations or to species, and that long-lived species are sometimes particularly vulnerable to over-collecting and large-scale mortality (human-induced or otherwise) because their seed banks may not be adequate for recovery and their human-altered environment may no longer be suitable or capable of sustaining populations. In addition, anecdotal evidence suggests that anthropogenic disturbance associated with long-term plant monitoring projects may have a negative impact on those local populations that are not representative of the entire population (K. Clanton, pers. comm. 2007).

At this time, we do not have evidence indicating that long-term ecological studies are negatively impacting Avon Park harebells or its habitat. Overall, we believe that most of the work conducted to date has provided important information regarding this species' life history and habitat requirements, which may ultimately contribute to better management of habitat and conservation of the species. However, we recognize that overutilization for scientific purposes may also be a potential threat to the species.

**c. Disease or predation:** The final listing rule did not identify disease or predation as threats (58 FR 25746-25755). However, herbivory has since been identified as playing an important role in population dynamics (Menges and Weekley 2002). Herbivory often involved complete removal of stems, but sometimes leaves and parts of stems have been affected (Menges and Weekly 2005).

Herbivores include mammals, ants, and the larvae of the bella moth (*Utetheisa bella*; Arctiidae), a specialist on *Crotalaria* species that sequesters toxins from plant tissues and uses these chemicals to deter predators (Menges and Weekley 2005). Chemicals are donated by males to females during mating to provide the young with defenses (Menges and Weekley 2005). The caterpillar feeds preferentially on the fruits of *Crotalaria*, but will select leaves if no fruits are available (Menges and Weekley 2005). Based upon the feeding rate of a captive caterpillar, Menges and Weekley (2005) found it capable of eating entire fruits of Avon Park harebells in 1-2 days. Population densities of the bella moth have been inflated by the spread of exotic (African) species of *Crotalaria* (Menges and Weekley 2005).

Overall, herbivory rates were high in 2005, with about 17.7% of living plants affected, although much herbivory could not be attributed to a causal agent (Menges and Weekley 2005). High herbivory includes loss of developing fruits and thus, a reduction in fecundity (Menges and Weekley 2005). In 2005, Menges and Weekley (2005) found very few mature fruits, and attributed losses primarily to the bella moth caterpillars.

Studies to assess damage caused by the bella moth at monthly intervals at Carter Creek were conducted in 2005-2006; results are pending (Menges and Weekley 2005). Results from more generalized herbivore surveys in 2006

showed little herbivore damage (3.6%) compared to the extensive damage recorded in 2005 (Menges and Weekley 2005). Similarly, individuals at Saddle Blanket survive constant herbivory from caterpillars (TNC 2006). At this time, it is difficult to assess the overall magnitude and immediacy of this newly identified threat.

**d. Inadequacy of existing regulatory mechanisms:** At the time of federal listing, Avon Park harebells became a State endangered species.

The Preservation of Native Flora of Florida law, Rule Chapter 5B-40 of the Florida Administrative Code under authority from the Florida Statutes Chapter 581.185, 581.186 and 581.187 (fines defined in 581.141) provides protective measures to the Regulated Plant Index of endangered, threatened, and commercially exploited taxa. Permitting is administered by the Division of Plant Industry of the Florida Department of Agriculture and Consumer Services. It is unlawful for any person to willfully destroy or harvest Avon Park harebells (or any plant listed as an endangered plant on the Regulated Plant Index) growing on the private land of another or on any public land without first obtaining the written permission of the landowner or legal representative of the landowner and a permit from the Division of Plant Industry.

With additional State protection, regulatory mechanisms for this species have, in general, improved since its federal listing in 1993. However, despite this added protection, losses of plants on private land due to development (Avon Park Lakes) and on public land due to human-caused factors (Carter Creek) continue to occur. While the taking, transport, and sale of plants is regulated under State law, neither State nor Federal law provides adequate habitat protection. Therefore, existing regulatory mechanisms do not appear to be adequate.

Additionally, DeLaney (pers. comm. 2007) comments that the Service does not appear to have sufficiently interacted with Highlands and Polk County governments and the public at large concerning the importance of protecting Lake Wales Ridge ecosystems. DeLaney (pers. comm. 2007) cites numerous acreage tracts and thousands of building-lot-size properties supporting endangered species habitat along Lake Wales Ridge that have been destroyed during the past ten years, with relatively little local interaction or intervention from the Service, little enforcement, and few habitat conservation plans.

**e. Other natural or manmade factors affecting its continued existence:** Human activities, including off-road vehicle use, trash dumping, and inadvertent trampling during outdoor recreation activities, as identified at the time of listing (58 FR 25746-25755) continue to threaten this species. The Avon Park Lakes population is being degraded by off-road vehicles, edge effect, encroachment by native shrubs and exotic grasses, dumping, and other



increasing human impacts (E. Menges, pers. comm. 2007; K. DeLaney, pers. comm. 2007). Entire groups of plants and their habitat have been completely removed due to off-road vehicles at Avon Park Lakes; some sites have been completely denuded of vegetation, and soils have eroded away, leaving bare zones that have been quickly invaded by exotic species such as cogongrass (*Imperata cylindrical*) and pangolagrass (*Digitaria eriantha*), and other exotic species (K. DeLaney, pers. comm. 2007). Human activities are also causing substantial and widespread damage to the species and its habitat at Carter Creek (K. DeLaney, pers. comm. 2007; A. Cox, pers. comm. 2007; E. Menges, pers. comm. 2007).

Menges and Weekly (2002) found most of the quadrats in one roadside population at Carter Creek were run over by trucks that caused a massive dieback or mortality due to stem breakage and uprooting of plants. In 2006, this population continued to be affected by vehicle damage due to off-road vehicles, and traffic was noticeably higher than in previous years (Menges et al. 2006). Recovery of plants occurred in only three of 12 quadrats damaged in 2006 or past years; no plants recovered in areas damaged in 2-4 separate years (Menges et al. 2006). Off-road vehicles are a problem at this protected site, and while populations are fairly stable, declines have been noted along roadsides (E. Menges, pers. comm. 2007); off-road vehicles at Carter Creek is likely the cause for declines observed on roadsides (E. Menges, pers. comm. 2006). There are plans to fence off portions of Carter Creek, but this is a large project, which has not yet been initiated (E. Menges, pers. comm. 2007).

Other disturbances at Carter Creek included burial of dumped garbage, disturbance by abandoned cars, displacement of shotgun shells, and direct damage from small weapons (Menges and Weekley 2002). Menges and Weekley (2003) reported vandalism at a study site at Carter Creek, which had to be abandoned. Nearly all signs posted by FWC have been removed (E. Menges, pers. comm. 2007). Several wildfires at Carter Creek have been ignited by unregulated off-road recreational activities; trenching, presumably during fire suppression actions, has damaged other areas by creating disturbance that encourages exotic infestations and providing a conduit for off-road traffic into new and more remote areas of habitat (K. DeLaney, pers. comm. 2007). Avon Park harebells is also threatened by placement of shell along roads, which can alter the soil in areas that might be inhabited by the species, and by proliferation of bahia grass (*Paspalum notatum*) along those roads (Service 1996). Trash dumping is also a problem at Avon Park Lakes (FNAI 2006). DeLaney (pers. comm. 2007) indicated that the Carter Creek population sustained a devastating and permanent impact from road building in the mid-1990s, which resulting in direct mortality and increased traffic, off-road vehicle use, disturbance, exotic infestation, dumping, and poaching. Disturbance from current right-of-way clearing and road maintenance / improvements is expected to lead to increased exotic infestations and habitat decline (K. DeLaney, pers. comm. 2007).

The effects of frost and drought were observed in 2006, both of which caused plants to die back (Menges et al. 2006). Freezing temperatures in mid-February and the remains of frost-killed stems and major frost damage was observed in March (Menges et al. 2006). However, 11 of 14 plants with major frost damage resprouted later in 2006 and appeared to recover rapidly (Menges et al. 2006). Researchers suggest that the plants have little trouble recovering from occasional cold temperatures, similar to their ability to vigorously resprout after herbivory or fire (Menges et al. 2006). A spring drought also caused wilting and death of some plants in April and May, and wilting was more evident in open roadside populations (Menges et al. 2006). Despite these stresses, plants dramatically rebounded in June 2006 after occasional rains resumed (Menges et al. 2006).

A limited geographic distribution, fragmentation of remaining habitat into small segments isolated from each other, and small population sizes were identified at the time of listing (58 FR 25746) as factors that exacerbated threats to Avon Park harebells. Although we do not know the sizes of the two populations and the subpopulation, we can make general characterizations about their relative statuses. The Avon Park Lakes population has experienced a drastic reduction in habitat and presumably population size and is rapidly being developed (B. Pace-Aldana, pers. comm. 2006; E. Menges, pers. comm. 2006; K. DeLaney, pers. comm. 2007). The Saddle Blanket subpopulation (roughly hundreds) is disjunct from the Avon Park Lakes population and may have declined since the site was purchased for public use (K. DeLaney, pers. comm. 2007); however, data from TNC (2006) suggests that it has increased. The Carter Creek population (excellent and fair estimated viability) has remained fairly stable or declined slowly (Menges and Weekly 2004; E. Menges, pers. comm. 2006). Therefore, we believe that small population size and problems associated with small populations are still threats to this species.

We expect the threats of restricted distribution, fragmentation of habitat, and isolation of populations to increase with further loss and degradation of habitat and increased disturbance from human activities. Overall, the magnitude of threats from natural and human-caused factors is considered high.

**D. Synthesis** - The recovery plan for this species does not contain criteria for downlisting and delisting. There are no complete censuses, so total abundance is not known. Only two populations and one subpopulation remain. The population at Avon Park Lakes (private, unprotected) is likely declining due to rapid development (B. Pace-Aldana, pers. comm. 2006; E. Menges, pers. comm. 2006; K. DeLaney, pers. comm. 2007), the subpopulation at Saddle Blanket (private conservation) may be increasing (TNC 2006), and the population at Carter Creek (partially acquired public conservation) may be fairly stable or declining slowly (Menges and Weekley 2004; E. Menges, pers. comm. 2006). Recent demographic work

suggests that survival is high, but fecundity is low (Menges et al. 2006). Work to better understand the breeding system is underway using genetic methods (Menges and Weekley 2004); this may be helpful in designing augmentations, assessing management effects on populations, and providing insight into the limited seedling recruitment (Menges et al. 2006). *Ex situ* conservation efforts are underway, but this plant has not successfully been transplanted to augment wild populations.

This species seems to prefer, but not require open scrub, with less vegetation cover and more bare sand (Menges and Weekley 2002). Endemic to Lake Wales Ridge, this species is narrowly distributed with a small area of occupancy and limited geographical extent (DeLaney and Wunderlin 1989, Menges et al. 2006, Turner et al. 2006). Although some progress has been made in habitat protection through land acquisition since its listing in 1993, Avon Park harebells remains at great risk of extinction; even under the most optimistic acquisition scenarios little more than 7% of the original habitats of Lake Wales Ridge will be protected since most have already been destroyed (Turner et al. 2006). Population growth in central Florida is expected to be explosive (Zwick and Carr 2006), so the ability to protect remaining sites or manage public lands effectively will likely diminish. The extant populations of Avon Park harebells continue to face a significant threat of extirpation (P. Quintana Ascencio, pers. comm. 2007).

Habitat loss, degradation, and fragmentation, are occurring at private and partially acquired sites, and these threats are expected to continue. Encroachment of exotic grasses and native shrubs are problems at two sites. Human disturbance are threats at two of the three sites. Effects of herbivory, frost, and drought have been only recently documented and are not fully understood (Menges and Weekley 2002, Menges et al. 2006). A limited geographic distribution and fragmented and isolated populations and habitats make the species more vulnerable. Habitat conditions at Avon Park Lakes, which supports the largest population, will likely remain suitable only with acquisition or habitat protection. Carter Creek needs to be secured to reduce the amount of unregulated activities and damaging impacts to the species and habitat at this site (K. DeLaney, pers. comm. 2007; A. Cox, pers. comm. 2007). Analyses suggest that this species will likely require intensive management to survive, possibly involving propagation, translocation, and reintroduction to potentially suitable habitat (Turner et al. 2006). Minimizing extinction probabilities of this species will probably require augmentation of extant populations to increase population sizes and sites (P. Quintana Ascencio, pers. comm. 2007). For these reasons, Avon Park harebells continues to meet the definition of endangered under the ESA.

In short, we believe Avon Park harebells is at grave risk of extinction. The few populations remaining in a restricted range are at-risk to multiple threats. Without active and concerted conservation efforts, this species may be lost. Every effort should be made to secure remaining habitat at its largest population, Avon Park Lakes, to increase the likelihood of persistence in the wild. This is the most important conservation action that needs to be taken. Threats from human activities at all sites also need to be reduced. Until habitat is secured and threats reduced, work in maintaining genetic lines and augmenting wild populations should be pursued. At this time, the recovery objective for this species is still to prevent extinction and increase existing populations.

### 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*  
 **No change is needed**

#### B. New Recovery Priority Number 5c

We are recommending a change in priority number to 5c, high degree of threat with low recovery potential and conflict (48 FR 43098-43105, 48 FR 51985). Biological and ecological limiting factors for Avon Park harebells are not completely understood. Threats to this species are pervasive and difficult to alleviate. Management for this species is needed, but there is uncertainty in the probability of success. In some cases, experimental treatments may be needed with unknown effectiveness. For example, where prescribed fire cannot be implemented, mechanical treatments may be needed with unknown effectiveness.

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

#### General recommendations:

- Secure land that supports this species (TNC 1999, Service 1999, Chafin 2000, Turner et al. 2006) where possible. Secure habitat through acquisition, landowner agreements, and conservation easements (Service 1999).
- Conduct more extensive surveys using local experts and qualified botanists and develop accurate maps for the range limits to speed the acquisition process and minimize additional future habitat loss (A. Cox, pers. comm. 2007, K. DeLaney, pers. comm. 2007). Rabbitbells (*Crotalaria rotundifolia*), the highly variable and more common species occurring in scrub habitat, is often difficult to distinguish from Avon Park harebells and may require expert taxonomic identification (A. Cox, pers. comm. 2007; K. DeLaney, pers. comm. 2007).
- Conduct a new survey of Avon Park Lakes to document remaining habitat, since this area has changed drastically since TNC's preserve design in 1999 (B. Pace-Aldana, pers. comm. 2007). Due to the small, fragmented patches within the area that support this species, acquisition and management may be challenging (B. Pace-Aldana, pers. comm. 2007).
- Survey the current CARL site at Avon Park Lakes to evaluate the potential of this area as an introduction site (B. Pace-Aldana, pers. comm. 2007). The area currently within the CARL boundary was still largely intact in 2005; however Avon Park harebells only occurred at the very northern end (B. Pace-Aldana, pers. comm. 2007). Consider redesign of the CARL boundary to include the northern section and extend north (TNC 1999).
- Use prescribed fire at managed sites to create a mosaic of successional scrub habitats where feasible and burn denser sections of scrub (Service 1999, Chafin 2000, FNAI 2006).

Investigate the most effective land management practices using prescribed fire (A. Cox, pers. comm. 2007).

- Prevent soil disturbance, trash dumping, off-road vehicle use, and rock or shell fill along roadsides near known populations and control exotic plant species (Service 1999, Chafin 2000, Menges et al. 2006, FNAI 2006). Eliminate or reduce disturbance from off-road vehicles at the Carter Creek and Avon Park Lakes sites (Menges et al. 2006; FNAI 2006; E. Menges, pers. comm. 2007; K. DeLaney, pers. comm. 2007). Focus on eliminating the causes of exotic plant infestation (e.g., human impacts and other artificial disturbances) (K. DeLaney, pers. comm. 2007). Clean up existing trash piles at Avon Park Lakes site (FNAI 2006).
- Work closely with Highlands and Polk County to achieve effective enforcement of the ESA (K. DeLaney, pers. comm. 2007). Use State, Federal, and local regulations to protect this species from damage from off-road vehicle use and overcollection; regulations should also be used to protect xeric vegetative communities where this species is found (Service 1999).
- Restore areas to suitable habitat. Native habitats that have been disturbed and have the appropriate soils may be prime candidate sites for restoration (Service 1999).
- Conduct a complete census.
- Develop population viability and risk assessment. Demographic information should be used to develop models to evaluate spatial distribution and population size necessary to ensure persistence of the species (Service 1999). More detailed research and analysis is needed for a better understanding of extinction risks (P. Quintana Ascencio, pers. comm. 2007). Because of the nature of ecological data, further studies, large sample sizes, and long-term data are needed to reduce uncertainties of the population viability of Avon Park harebells (P. Quintana Ascencio, pers. comm. 2007).
- Continue work to understand the breeding system using genetic methods; this will be helpful in designing augmentations, assessing management effects on populations, and providing insight into the limited seedling recruitment (Menges et al. 2006).
- Continue to conduct and expand *ex situ* conservation work. Such work may be helpful in augmenting small wild populations on protected sites or possibly establishing new populations on suitable habitat within its historic range (C. Campell, pers. comm. 2007). Develop a propagation plan that is consistent with the Service's policy.
- Continue research on land management strategies and alternatives (mechanical, prescribed fire). Evaluate management practices (e.g., prescribed burning, mowing, exotic plant control) for their effects on this species and provide the results to land managers (Service 1999). Examine the immediate and long-term effects of fire and refine fire management (TNC 2000).
- Investigate the effects of anthropogenic disturbance associated with long-term plant population monitoring projects (K. Clanton, pers. comm. 2007). Anecdotal evidence suggests that such disturbance may have a negative impact on local populations that are not representative of the entire population (K. Clanton, pers. comm. 2007).
- Ensure that integrated management planning and adequate management protocols are in place soon (Turner et al. 2006). Propagation, translocation, and reintroduction to potentially suitable habitat may be needed for this species to survive (Turner et al. 2006). Collaboration among researchers, land managers, and agencies is needed to determine and implement actions. Additional information is needed about the seed germination, growth, and

establishment in native habitats; future research should focus on *in situ* studies in scrub habitat (A. Cox, pers. comm. 2007).

- Closely scrutinize research projects involving the species or its habitat, due to the potential threat of overutilization for scientific purposes (see 2.b. above).
- Continue to conduct scrub education efforts (TNC 1999, Service 1999, FNAI 2006). Develop and implement an interpretive plan for Avon Park Lakes residents about the presence and importance of this species (TNC 1999).
- Update the recovery plan to provide criteria for reclassification and delisting.

Site-specific recommendations:

- Avon Park Lakes – Acquire all properties possible (K. DeLaney, pers. comm. 2007; A. Cox, pers. comm. 2007); develop and initiate a site management plan for the scrub and listed species; initiate and conduct prescribed fire in spring or summer to maintain scrub habitat; eradicate exotic species (A. Cox, pers. comm. 2007).
- Saddle Blanket – Continue monitoring; provide prescribed fire in spring or fall as appropriate to maintain scrub habitat; maintain habitat free of exotic species (A. Cox, pers. comm. 2007). Develop a generalized management plan for this site that incorporates the concerns of the scientific community (K. DeLaney, pers. comm. 2007).
- Carter Creek – Immediately and tightly secure the site against unregulated activities and damaging impacts (K. DeLaney, pers. comm. 2007). Purchase adjacent property; fence the property and establish fence lines for security and fire lanes along perimeter; initiate security measures (e.g., on-site law enforcement or land manager); conduct research, but limit research to portion of site to allow reestablishment in areas degraded by off-road vehicles; initiate in-situ plantings to establish additional populations, obtain information on germination, growth and establishment in native habitat; continue with prescribed fire in spring or summer as appropriate to maintain scrub; eradicate exotic species (A. Cox, pers. comm. 2007).

## V. REFERENCES -

Association of Florida Native Nurseries. 2007. [http://www.afnn.org/search\\_afnn.asp?n=22](http://www.afnn.org/search_afnn.asp?n=22)  
Checked January 11, 2007.

Chafin, L.G. 2000. Field guide to the rare plants of Florida. Florida Natural Areas Inventory, Tallahassee, FL.

Charls, S., V. Pence, E. Menges, and G. Clarke. 2007. Summary of work from 10/28/06 – 1/28/07 for the project: tissue culture propagation of *Crotalaria avonensis*. Cincinnati Zoo & Botanical Garden and Archbold Biological Station. Cincinnati, OH.

Clanton, K. 2007. Comments on draft 5-year review form as official peer reviewer. Email to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated April 27, 2007. Florida Division of Forestry. Frostproof, FL.

- Cox, A. Comments on draft 5-year review form as unofficial peer reviewer. Email and letter to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated April 26, 2007. ecolo~G, Inc. Jupiter, FL.
- DeLaney, K.R. 2007. Comments and recommendations on draft 5-year review form as official peer reviewer. Email to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated May 3, 2007. Avon Park, FL.
- DeLaney, K.R., and R.P. Wunderlin. 1989. A new species of *Crotalaria* (Fabaceae) from the Florida Central Ridge. *Sida* 13(3):315-324.
- Florida Natural Areas Inventory. 2006. Element occurrence polygon data layer. fleo\_py\_200609. Tallahassee, FL.
- Integrated Taxonomic Information System. 2007. <http://www.itis.usda.gov/index.html>  
Checked January 4, 2007.
- Menges, E. 2007. Comments on draft 5-year review form as unofficial peer reviewer. Email to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated April 17, 2007. Archbold Biological Station. Lake Placid, FL.
- Menges, E.S., and C.W. Weekley. 2002. Demographic research on four State-listed Lake Wales Ridge endemic plants. Final report to Endangered and Threatened Plant Conservation Grants Program. Division of Plant Industry, FDACS Contract 006464. Archbold Biological Station, Lake Placid, FL.
- Menges, E.S., and C.W. Weekley. 2003. Continuation of demographic research on four State-listed Lake Wales Ridge endemic plants. Final report to Endangered and Threatened Plant Conservation Grants Program. Division of Plant Industry, FDACS Contract 006464. Archbold Biological Station, Lake Placid, FL.
- Menges, E.S., and C.W. Weekley. 2004. Further demographic research on four State-listed Lake Wales Ridge endemic plants. Final report to Endangered and Threatened Plant Conservation Grants Program. Division of Plant Industry, FDACS Contract 007998. Archbold Biological Station, Lake Placid, FL.
- Menges, E.S., and C.W. Weekley. 2005. Further demographic research on four State-listed Lake Wales Ridge endemic plants. Final report to Division of Plant Industry. Archbold Biological Station, Lake Placid, FL.
- Menges, E.S., C.W. Weekley, M.A. Rickey, and G.L. Clarke. 2006. Further demographic research on five State-listed Lake Wales Ridge endemic plants. Final report to Endangered and Threatened Plant Conservation Grants Program. Division of Plant Industry, Florida Department of Agriculture and Consumer Services. Archbold Biological Station, Lake Placid, FL.

- Pace-Aldana, B. 2007. Comments on draft 5-year review form as official peer reviewer. Facsimile to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated April 20, 2007. The Nature Conservancy. Babson Park, FL.
- Pence, V., S. Charls, E.S. Menges, and G. Clarke. 2006. Summary of work from 10/28/05 – 10/28/06 for the project: tissue culture propagation of *Crotalaria avonensis*. Cincinnati Zoo & Botanical Garden and Archbold Biological Station, Cincinnati, OH.
- Quintana-Ascencio, P.F. 2007. Comments on draft 5-year review form as official peer reviewer. Email and letter to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated April 13, 2007. University of Central Florida. Orlando, FL.
- The Nature Conservancy. 1999. Conservation plan for *Crotalaria avonensis*. Interim report. FDACS Contract 4759. Florida Department of Agriculture and Consumer Affairs, Florida Division of Forestry. The Nature Conservancy, Lake Wales Ridge Program, Lake Wales, FL.
- The Nature Conservancy. 2000. *Crotalaria avonensis* survey of Saddleblanket Preserve. Final report. FDACS Contract 4759. Florida Department of Agriculture and Consumer Affairs, Florida Division of Forestry. The Nature Conservancy, Lake Wales Ridge Program, Lake Wales, FL.
- The Nature Conservancy. 2006. Annual Report. *Crotalaria avonensis* (Avon Park harebells) Monitoring at The Nature Conservancy's Saddle Blanket Scrub Preserve. Babson Park, FL.
- Turner, W.R., D.S. Wilcove, and H.M. Swain. 2006. State of the scrub: conservation progress, management responsibilities, and land acquisition priorities for imperiled species of Florida's Lake Wales Ridge. Archbold Biological Station, Lake Placid, FL.
- U.S. Fish and Wildlife Service. 1996. Recovery plan for nineteen Florida scrub and high pineland plant species. U.S. Fish and Wildlife Service, Atlanta, GA.
- U.S. Fish and Wildlife Service. 1999. South Florida multi-species recovery plan. U.S. Fish and Wildlife Service, Atlanta, GA.
- Wunderlin, R.P., and B. F. Hansen. 2004. Atlas of Florida vascular plants (<http://www.plantatlas.usf.edu/>). Institute for Systematic Botany, University of South Florida, Tampa, FL.
- Zwick, P.D., and M.H. Carr. 2006. Florida 2060. A population distribution scenario for the State of Florida. A research project prepared for 1000 Friends of Florida. Prepared by the Geoplan Center at the University of Florida, Gainesville, FL.



U.S. FISH AND WILDLIFE SERVICE  
5-YEAR REVIEW of  
Avon Park harebells (*Crotalaria avonensis*)

Current Classification Endangered  
Recommendation resulting from the 5-Year Review

- Downlist to Threatened  
 Uplist to Endangered  
 Delist  
 No change is needed

Review Conducted By Paula J. Halupa

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve [Signature] Date 5/21/07

*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.*

*for* Lead Regional Director, Fish and Wildlife Service

Approve [Signature] Date 7/13/07

*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 Avon Park harebells (*Crotalaria avonensis*)**

**A. Peer Review Method:** The Service conducted an influential level of peer review. Recommendations for peer reviewers were solicited from the Florida Department of Agriculture and Consumer Services, Florida Division of Forestry and Florida Division of Forestry, Plant Conservation Program; Polk County Natural Resource Division; and Highlands County Department of Planning. Additionally, two peer reviewers were selected by the Service. Individual responses were requested from six peer reviewers and one additional technical reviewer. Responses were received from all seven reviewers.

**B. Peer Review Charge:** See attached guidance.

**C. Summary of Peer Review Comments/Report:** Peer review comments provided insights that were beneficial in conducting this review. Although there were a variety of substantive comments, they predominantly addressed degrees of emphasis as opposed to points of contention or entirely new subject matter. Comments and concerns covered a variety of topics including the following: continued loss, fragmentation, and degradation of habitat; the need for habitat acquisition at Avon Park Lakes; threats associated with unregulated human activities on public and private lands, and disturbance caused by off-road vehicles in particular; the need to secure the Carter Creek site due to human-caused threats; the need for extensive surveys using local experts to assist in acquisition efforts; the possible need to augment extant populations to increase population sizes and sites; the need for further study to better understand population viability and extinction risk; the need to conduct *in situ* research and to investigate the most effective land management practices using prescribed fire; overutilization for scientific purposes as a threat; site-specific recommendations for three remaining occurrences; clarification of breeding system and genetic methods; objections to and concerns regarding *ex situ* conservation efforts, experiments to test the effects of fire vs. mechanical treatment, and non-essential research; the need to form an “open” forum public committee to function as a clearinghouse for proposed research; and, the need to administer regular and effective enforcement of the ESA in Highlands County.

**D. Response to Peer Review:** The Service was in agreement with the vast majority of comments and concerns received from peer reviewers. Comments were largely incorporated into the 5-year review form. Where the Service disagreed with a specific concern, the comment and Service’s position were both incorporated into the form wherever possible. One reviewer provided 53 pages of comments. Although not all of these comments were incorporated directly into the form, each concern was thoughtfully considered. There were two substantial areas of concern, which the Service did not completely share. K. DeLaney (pers. comm. 2007) objected to *ex situ* conservation efforts (e.g., cryopreservation, tissue culture) and population augmentation due to scientific, economic, ethical, and political reasons. Although we agree that habitat acquisition and protection are the most crucial actions needed to preserve Avon Park harebells, we believe that *ex situ* conservation efforts and population augmentation may also be needed, especially in light of limited acquisition capabilities on the part of ourselves and our partners. Closer scrutiny of projects and greater independent scientific review of proposals would help ensure that these efforts are not detrimental to the species or its habitat. K. DeLaney

(pers. comm. 2007) also objected to monitoring and demographic work, use of experimental mechanical treatments, and other non-essential research due to the potential for direct and ancillary physical impacts resulting from intensive field investigations and the magnitude of the resources consumed. Although we agree that intensive, intrusive, or improper research can negatively impact the species and its habitat, we believe that on-going monitoring and demographic work by qualified researchers is providing valuable data and information, which may ultimately be important to the conservation of the species. To our knowledge, research is not detracting from acquisition efforts in terms of funding or resource allocation.

## **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](mailto:Cindy_Schulz@fws.gov).