

**Carter's mustard**  
*(Warea carteri)*

**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**  
**Carter's mustard/*Warea carteri***

**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 an Archbold Biological Station (ABS) plant ecologist and finalized by biologists from the South Florida Ecological Services Office. Literature and documents used for this review are on file at the South Florida Ecological Services Office. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on Carter's mustard. Public notice of this review was given in the Federal Register on April 26, 2007, with a 60-day public comment period. Comments and suggestions regarding the review were received from peer reviews from outside the Service (refer to Summary of Peer review). Comments received were evaluated and addressed as appropriate.

**B. Reviewers**

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

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**C. Background**

**1. FR Notice citation announcing initiation of this review:** April 26, 2007. 72 FR 20866.

**2. Species status:** Stable (2007 Recovery Data Call). While this species has lost most of its former habitat, it is secure on the conservation lands where it occurs, assuming fire management continues. It is unlikely to persist outside of conservation lands that are specifically managed to maintain a regime of frequent prescribed fires.

**3. Recovery achieved:** 1 (0-25% recovery objectives completed) (2007 Recovery Data Call).

**4. Listing history**

Original Listing

FR notice: 52 FR 2227

Date listed: January 21, 1987

Entity listed: Species

Classification: Endangered

**5. Associated rulemakings:** N/A

**6. Review History:**

5-year review November 6, 1991 (56 FR 56882), 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 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 Carter's mustard.

Final Recovery Plan: 1999

Recovery Data Call: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007

**7. Species' Recovery Priority Number at start of review (48 FR 43098):** 2. A recovery priority number of "2" represents a high degree of threat and high recovery potential.

**8. Recovery Plan or Outline**

Name of plan: South Florida Multi-Species Recovery Plan (MSRP)

Date issued: May 18, 1999

Dates of previous revisions: Recovery Plan for nineteen central Florida scrub and high pineland plants (revised) June 20, 1996. Recovery plan for eleven Florida scrub plant species January 29, 1990.

**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 Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

**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)? No.**

**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 reclassification of Carter's mustard:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to assure 95 percent probability of persistence for 100 years.

Demographic data used to analyze population cycling in Carter's mustard have been collected from three sites (Quintana-Ascencio et al. 2008). Although these data could be used to evaluate population viability in these populations, this has not yet been done. No work has been done on other populations, and no demographic data are currently being collected (besides level 1 monitoring *sensu* Menges and Gordon [1996], which involves repeat sampling of presence or absence at defined locations, by The Nature Conservancy at Tiger Creek Preserve). This criterion addresses factor E.

2. These populations, within the historic range of Carter's mustard, are adequately protected from further habitat loss, degradation, and fire suppression.

Element occurrence records (EORs) are compiled by the Florida Natural Areas Inventory (FNAI). Each EOR represents a species occurrence that is a minimum of 1 kilometer (km) from another occurrence of the same species, thus a large site may have multiple EORs associated with it. The FNAI database lists 49 EORs for Carter's mustard. Of these, 43 are located on protected sites and 6 are on unprotected sites. Three other unprotected sites noted during the 1990s are not in the FNAI database. These unprotected areas are all in Highlands County: off of Grand Concourse Boulevard, on the east side of US 27 just south of Tobacco Barn (these patches persisted for several years), and on Van Pelt Rd. to the east of the Carter Creek South Tract of the Lake Wales Ridge National Wildlife Refuge (LWR NWR) (Menges in litt. 2008a). Fire suppression has caused habitat degradation even in some protected areas. Although the exact fire return interval that would best benefit Carter's mustard is not known, the species clearly benefits from periodic prescribed fires that are used to manage its habitat (Menges and Gordon 1996, Quintana-Ascencio et al. 2008). Exotic plant invasion, especially of cogongrass (*Imperata cylindrical*) into sandhills, is of concern. This criterion addresses factors A, D, and E.

3. These sites are managed to maintain the scrubby flatwoods and turkey oak

(*Quercus laevis*) dominated high pine to support Carter's mustard.

Carter's mustard currently occurs in 13 managed areas, most of which receive at least occasional prescribed fire. However, site-specific information and associated analysis on past and planned fire regimes is not readily available. Most observers would agree that many sites are behind schedule in applying fire. Fire management at these sites should maintain scrubby flatwoods and turkey oak dominated high pine, although there is no consistent monitoring effort to evaluate whether these vegetation types are benefiting from the current management regimes. Both types of vegetation require prescribed fire, although at different intervals (Menges 2007). This criterion addresses factors A and E.

4. Monitoring programs demonstrate these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually reproducing at sufficient rates to maintain the population.

Carter's mustard no longer occurs throughout its historic range. Absent are populations in Miami-Dade and Brevard Counties, both beyond the LWR. On the LWR, a recent survey (Schultz et al. 1999) did not detect Carter's mustard at Ferndale Ridge, the northern extent of the species on the LWR.

No monitoring is now occurring at level 2 (where densities of plants are tracked over time) or level 3 (where individual plants are tracked) (Menges and Gordon 1996). Level 2 monitoring could help demonstrate whether sites support sufficient population sizes. More detailed monitoring would be necessary to provide data on sexual reproduction. This criterion addresses factor E.

Listing factors B and C are not relevant to this species.

## C. Updated Information and Current Species Status

### 1. Biology and Habitat

#### **a. Abundance, population trends, demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:**

*Ecology and Life History* - Carter's mustard is an annual plant. Most plants live 12-15 months from germination to flowering/fruitletting maturity (Weekley et al. 2007). Flowering occurs in September and October and appears to be generally greater (more flowers per plant) in open and recently burned areas (Menges in litt. 2008c). Plants are self-compatible (Evans et al. 2000). Pollinators include several generalist insect species. Because of its generalist pollinator syndrome and ability to set self seeds, reproductive output (fecundity) is not likely to be limited by small population sizes or pollinators. Seeds generally germinate in the fall/winter/spring season following production (Weekley et al. 2007). This demographic delay in germination

means that seedlings produced from a large cohort of flowering plants will themselves flower two years later. If a disturbance destroys one cohort, leaving just one remaining cohort, the demographic delay creates the opportunity for two-year population cycles (Quintana-Ascencio et al. 2008); especially following fires (Menges and Gordon 1996).

*Population Sizes and Trends* - Carter's mustard populations fluctuate widely from year to year (Menges and Gordon 1996). For burned populations especially, these fluctuations are biennial (peak every two years) and damp over time (Quintana-Ascencio et al. 2008). Fires usually initiate cycles, with the largest population sizes occurring the year following fire. These population cycles are caused by demographic delay in seed germination (Quintana-Ascencio et al. 2008). Seeds produced in the fall of one year generally enter the persistent soil seed bank, with the first (and largest) pulse of germination in the second winter following seed production. Because fires remove a cohort of plants, a single cycling post-fire cohort will create the damped two-year cycle (Quintana-Ascencio et al. 2008). Along roadsides and in other areas with recurrent disturbances, such cycling may not be evident. Because of these cycles, single-time estimates of population sizes and simple trend analyses do not provide a great deal of information on the likely future dynamics of Carter's mustard populations.

Population sizes that are noted in the FNAI EORs are mainly small, often fewer than 10 plants. The largest populations in the FNAI records were at Tiger Creek Preserve. These populations were noted as being as large as 1,000 plants, consistent with data collected there by Menges and others (Quintana-Ascencio et al. 2008).

Prior research on Carter's mustard included three populations (ABS, LWRSF – Arbuckle Tract, Tiger Creek Preserve) and seed germination experiments at Lake Placid Scrub (LWRWEA) and the LWRSF – Arbuckle Tract. Cycling populations have been documented at these sites (Menges and Gordon 1996, Quintana-Ascencio et al. 2008).

The only current repeated monitoring of Carter's mustard is being conducted at Tiger Creek Preserve (Pace-Aldana in litt. 2008a). Sampling has shifted from the level 2 monitoring conducted from 1988 through 2003 (Quintana-Ascencio et al. 2008) to a spatially explicit level 1 monitoring. Beginning in 2005, Carter's mustard at Tiger Creek was monitored by presence/absence determinations in grids composed of contiguous cells. Each grid cell measures 10 meters by 10 meters, determined with a Global Positioning System (GPS). Grid cells were placed within known patches of Carter's mustard and adjacent to previously occupied grid cells. All grid cells are visited each September/October, except in the fall following a burn, when no Carter's mustard would likely be present. Data from 2005-2007 show a fluctuation in the number of grids with plants present from 20 (2005) to 8

(2006) to 29 (2007). The decrease in occupied grids in 2006 reflects the fact that 20 grids were burned. The number of unburned grids with no plants has stayed relatively constant (23, 26, 25 over the three years). Pace-Aldana (in litt. 2008a) also observed high water levels in 2005 affecting 18 grids. None supported Carter's mustard plants in 2006, but 11 patches that flooded in 2005 had plants in 2007.

Staff at LWRSF have been collecting GPS points on Carter's mustard occurrences since 1988. A recent report suggests a minimum of 123 individuals at this site (Clanton 2007). The report suggests an increase in numbers but a decrease in aerial extent between 1988 and 2006. However, there is not sufficient information in the report to evaluate this conclusion. Repeated visits to the same patches would be necessary to make confident statements on trends and cycles.

Broader scale quantitative surveys will be useful in the future in detecting demographic trends in Carter's mustard. A survey of rare species locations on conservation lands, used to assess soil preferences in a recent analysis (Menges et al. 2007), collected GPS data and  $\log_{10}$  density estimates from 20 species, 10 sites, 1,173 GPS points, and 2,577 species occurrences in Highlands County. These points included 63 occurrences of Carter's mustard at 5 sites (ABS, Carter Creek North, Carter Creek South, Flamingo Villas, and Lake Placid Scrub). Note that the scale for this project is considerably finer than that used by FNAI, Schultz et al. (1999), or Turner et al. (2006), leading to a higher number of occurrences. The Plant Ecology Lab at ABS plans to resample these points in 2011-2012 to provide an assessment of large-scale population trends.

In addition, ABS has initiated a population dynamics project for endemic plants to add new GPS locations, together with estimates of absolute density, for rare plants in managed sites on the LWR. Through February 2008, surveys have included 5 sites, 14 species, 402 species occurrences, and 4,541 counted individuals (Menges in litt. 2008b). These points currently do not include any locations for Carter's mustard. These points will be resurveyed periodically, especially after management actions such as prescribed burning, mowing, and roller chopping. The number of new points added and the frequency of re-sampling will depend, in part, on funding.

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):** There have been no additional studies of the genetic structure or dynamics of Carter's mustard since the work of Evans et al. (2000), which found that Carter's mustard had low genetic diversity, a relatively large proportion of genetic variation distributed among populations, and clinal variation in rangewide genetics. The large amount of variation distributed among populations suggests that more than a few

populations need protection and management to safeguard the species' genetic variation.

**c. Taxonomic classification or changes in nomenclature:** No recent changes. The Integrated Taxonomic Information System (2008) was checked while conducting this review.

**d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range:**

Continued conversion of Florida scrub and sandhill to agriculture, housing, and other developments is undoubtedly affecting the number and sizes of Carter's mustard populations. A recent analysis of land conversion on the LWR suggests that about 78% of upland habitats were lost by about 1990 (Weekley et al. 2008). By the early part of this century, about 87% of upland habitat was gone (Turner et al. 2006). Habitat losses were greatest on yellow sands and in the northern part of the LWR (Weekley et al. 2008).

Carter's mustard populations currently occur along the LWR in central Florida, but the species was once more widespread. Carter's mustard was once found in Miami-Dade County, having been collected 8 to 10 times between 1878 and 1942 (Bradley in litt. 2008). It has been extirpated from Miami-Dade County. Roy Woodbury reported seeing it at the DuPuis Preserve in Palm Beach County, but this sighting is not supported by a herbarium specimen (Gann et al. 2002). FNAI records show a disjunct occurrence in Brevard County, at Spessard Holland North Beach. There have been repeated efforts to re-locate plants since this EOR was sent to FNAI in 1987. According to Schmalzer and Foster (2003), this site has been destroyed by park expansion activities. The loss of former populations in Brevard and Miami-Dade Counties represents a sizeable range reduction for Carter's mustard.

Carter's mustard has occurred through the entire length of the LWR as well as on the Winter Haven Ridge (Schultz et al. 1999, Turner et al. 2006). Although the range of Carter's mustard overlaps with its endangered congener, wide-leaf warea (*Warea amplexifolia*), the two species have not been reported co-occurring at any sites (Weekley in litt. 2008).

Current FNAI records summarize 49 EORs for Carter's mustard, of which 43 are found on 12 conservation areas. These include multiple occurrences on various Lake Wales Ridge Wildlife Environmental Areas (LWRWEA), LWRSF, ABS, Tiger Creek Preserve, and Upper Lake Marion Creek Watershed. A single occurrence is listed at Crooked Lake Sandhill. FNAI lists the Brevard County occurrence which has apparently been extirpated.

A summary by Turner et al. (2006) differs slightly from the FNAI records. Both Turner et al. (2006) and FNAI include various LWRWEAs (according to



Turner et al [2006], these include Carter Creek, Henscratch 27, Lake Placid Scrub, and McJunkin), LWRSF (the Arbuckle and Walk-in-Water tracts are listed by Turner et al. [2006]), ABS, Tiger Creek Preserve, Jack Creek, Carter Creek Tract of the LWR NWR, and Upper Lake Marion Creek (Upper Lakes Basin) Watershed [including Horse Creek]. FNAI lists Crooked Lake Sandhill and the Brevard County site, which are missing from Turner et al. (2006). Turner et al. (2006) lists a Flamingo Villas (LWR NWR) occurrence of Carter's mustard (discovered in the 1990s by ABS scientists), which is included by FNAI but not indicated as a managed area in their records. Turner et al. (2006; page 80) indicate only 23 records of Carter's mustard, which may be a typographic error. They give an (overestimated; see later) extent of 9,774 kilometers<sup>2</sup>. About 26 sites are currently protected, and 30 will be protected under current conservation plans (Turner et al. 2006).

Schultz et al. (1999) summarizes 36 EORs for Carter's mustard, of which 25 (69%) occur on managed areas. In their own surveys, Schultz et al. (1999) found 7 Carter's mustard EORs in four areas: Horse Creek Scrub (2 EORs), Lake Blue (on the Winter Haven Ridge; 1 EOR), LWRSF - Walk in Water Tract (2 EORs), and Carter Creek (2 EORs) (Schultz et al. 1999). Schultz et al. (1999) were unable to re-locate Carter's mustard at an 8<sup>th</sup> EOR, at the Ferndale Ridge site in Lake County. This site was the most northerly Carter's mustard site on the LWR.

This species has been found at Lake McLeod tract of Lake Wales Ridge NWR since the publication of Turner et al. (2006). According to refuge staff, one individual was found next to a fireline. The species evidently escaped notice during previous extensive surveys of this tract (Blihovde in litt. 2008).

Integrating these four data sources, there appear to be 15 managed areas currently supporting Carter's mustard (ABS, Upper Lakes Basin [including Horse Creek Scrub], LWRSF - Arbuckle Tract, LWRSF - Walk in Water Tract, Tiger Creek Preserve, Crooked Lake, Lake Blue, Henscratch 27, Carter Creek North, Carter Creek South, Jack Creek, Flamingo Villas, Lake McLeod, Lake Placid Scrub, and McJunkin).

More so than other plant species, Carter's mustard distributional information may be incomplete, with occupied sites unknown and formerly known sites now lacking the species. Its fluctuating population sizes, inconspicuous nature when not flowering, and annual habit make assessment of its distribution and conservation status more difficult than is the case for perennial herbs or shrubs.

A recent analysis of Florida scrub conservation progress (Turner et al. 2006) included Carter's mustard among the 36 rare species of the LWR. This analysis confirmed that 21 of 23 of occurrences were on the LWR. The others included the Brevard County occurrence and an outlying, unprotected

occurrence west of the LWR in Polk County. Turner et al. (2006) calculated protection indices for each species and for three time periods (past, present, future) based on number of locations, extent of occurrence, and area of occupancy. The overall protection index of < 2 flagged Carter's mustard as of high conservation concern. The protection index for Carter's mustard would have been lower if Turner et al. (2006) had not included the outlying (and apparently extirpated) population in Brevard County, which increased the aerial extent in a polygon that included a huge area of inhospitable wetland habitat (see map on page 80 in Turner et al. [2006]).

**e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):** Carter's mustard is found almost exclusively in upland areas and is a soil generalist, being found on yellow, gray, or white sands (Menges et al. 2007). It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. This is also true for sites at Tiger Creek Preserve, a site in the central part of its range, which supports the greatest number of plants. At this site, the species is found in both high quality, frequently burned sandhill, as well as in overgrown sandhill that could also be termed xeric hammock (Menges in litt. 2008d). Near the south end of its range (e.g., ABS), Carter's mustard is found primarily in scrubby flatwoods, often just downhill from a ridge of yellow sand (Menges in litt. 2008e).

These habitats have a range of fire return intervals from 2-15 years (Menges 2007). Although Carter's mustard has large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire (Menges in litt. 2008f). Although preferring post-fire or disturbed sites, Carter's mustard is not a gap specialist. Plants often grow among dense shrubs in scrubby flatwoods or shrubby sandhill sites.

Like many LWR endemic plants, Carter's mustard also grows in disturbed areas such as sandy roadsides and trails. Population dynamics in these roadsides often do not show a pronounced two-year cycle found in burned habitats, presumably because recurrent disturbances allow release of multiple annual cohorts of plants from the seed bank without killing all plants of one cohort.

**f. Other:** Carter's mustard responds well to fire, but its response to other habitat manipulations such as roller chopping and mowing, are not known. Although several research projects are examining these effects on sandhill and Florida scrub, Carter's mustard is not abundant enough at these sites to test its responses to treatments.

## 2. Five-Factor Analysis

- a. **Present or threatened destruction, modification or curtailment of its habitat or range:** Forty-three EORs of Carter's mustard and one additional occurrence not in the FNAI database are protected within 15 managed areas but at least six EORs are on unprotected sites and could be in imminent danger of extirpation. Three additional occurrences not in the FNAI database are also unprotected. Information on Carter's mustard distribution is incomplete. The species likely occurred in additional undocumented locations in the past, even at the time of listing. Many former occurrences are on land that has been altered by development. The most recent estimate of loss of xeric upland habitat on the LWR is 87% (Turner et al. 2006). Suitable habitat for Carter's mustard continues to be developed for agriculture, housing, and other uses. We believe this is reducing the number and size of populations on unprotected lands.

Carter's mustard is threatened by habitat modification due to fire suppression. Fire suppression has caused habitat degradation even in some protected areas. Although the exact fire return interval that would best benefit Carter's mustard is not known, the species clearly benefits from periodic prescribed fires that are used to manage its habitat (Menges and Gordon 1996, Quintana-Ascencio et al. 2008). The effect of mechanical surrogates or pre-treatments for fire, which are widely used by land managers on the LWR, is not known for Carter's mustard. We believe that the inadequate application of fire in these habitats is a primary threat to existing populations of Carter's mustard.

- b. **Overutilization for commercial, recreational, scientific, or educational purposes:** Overutilization for commercial, recreational, scientific, or educational purposes was not identified as a potential threat in the original listing package. Since listing, no evidence of overutilization has been found.

- c. **Disease or predation:** Disease and predation were not identified as potential threats in the original listing package. In greenhouse culture, Carter's mustard was quite susceptible to fungal rotting and insect predation (Bissett 1987). At this time, there is not enough evidence to conclude that herbivory or disease is a threat to wild populations of Carter's mustard.

- d. **Inadequacy of existing regulatory mechanisms:** Carter's mustard is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. Property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations.

Existing federal and state regulations prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. The Act only protects populations from disturbances on federal lands or when a federal nexus is involved.

In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. Existing regulatory mechanisms are inadequate to protect this species.

**e. Other natural or manmade factors affecting its continued existence:**

Factors affecting the existence of Carter's mustard include lack of fire, exotic species invasion of its habitats, off-road vehicle (ORV) damage, pedestrian trampling, and its specialized and endemic distribution. Lack of fire will limit germination from the soil seed bank, and remaining seeds in the soil seed bank will not live forever. Therefore, long-term lack of fire could cause local extirpation. Invasion of exotic species, such as cogongrass, is a concern in sandhill and scrub, although there is no specific information on how Carter's mustard would be affected. Damage to habitat and plants by ORVs and pedestrian trampling could be important at some sites. Carter's mustard stems are fragile and easily broken by such disturbances. However, germination from soil seed banks may be increased by a certain level of physical disturbance. Seedling survival rates are low (3.5%-12% annually among years; lower for late season recruits than early season recruits) (Weekley et al. 2007). Finally, any factors that cause individual populations to disappear are of great concern because Carter's mustard is currently found only in a small geographic area on the LWR, and then again only in a subset of upland soils (being generally absent from xeric white sands; Menges et al. [2007]).

**D. Synthesis** - Although much is known about the general biology of Carter's mustard, field constraints and volatile population dynamics make this a difficult species for which to quantify conservation criteria or management strategies. Demographic data have been collected from three populations and integrated into an analysis of population cycling (Quintana-Ascencio et al. 2008). However, no analysis predicting probability of persistence for individual populations has been done. In addition, no higher level (metapopulation) level analysis has been attempted. Such an analysis would be required to predict the probability of persistence of the species as a whole. Distributions have been updated by Schultz et al. (1999) and others, although no recent range-wide field survey has been conducted.

Further loss of unprotected populations is likely as development continues on the LWR. Carter's mustard is protected on 15 managed areas but at least six known unprotected populations could be in imminent danger of extirpation. There are likely to be other LWR populations on private sites with undocumented patches of Carter's mustard. Some of these may remain extant for years, but some are likely to be destroyed by land development.

Within managed areas, lack of fire remains a threat. Fire management on protected sites may not be adequate to support viable populations. While it is difficult to detect long-term declines in the wide-cycling populations of Carter's mustard, it is clear that without fire, populations will decline over time (Menges and Gordon 1996, Quintana-Ascencio et al. 2008). Managed areas on the LWR vary widely in their successful application of fire, although in general, more frequent fire management is necessary across LWR conservation sites (Pace-Aldana, in litt. 2008b). Additional threats that could affect Carter's mustard

include competition from exotic plant species, and damage from ORV traffic or pedestrian trampling. Because of this plant's narrow range and restriction to certain soil types, loss of individual populations is a threat to this species.

Due to the lack of key data and continued threats of habitat loss and degradation due to fire suppression, Carter's mustard continues to meet the definition of endangered under the Act.

### III. RESULTS

#### A. Recommended Classification:

  X   No change is needed

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Detailed demographic data from three sites (Quintana-Ascencio et al. 2008) could be used as the basis of a population viability analysis that addressed questions such as how Carter's mustard responds to different fire regimes and what is the prognosis for populations of different sizes. They could also be used to make specific predictions for populations where there were estimates of population sizes.
- For some or all managed sites, additional data need to be collected on population sizes (level 2 monitoring). We suggest using a protocol used by ABS in its project on "Population Dynamics of Endemic Plants". GPS units are used to mark the centers of 5 meter radius circular plots (located randomly as well as in crucial patches of listed plants). Careful counts of the numbers of plants are made in these plots. Plots are periodically revisited, especially after management activities. Simple accumulations of GPS points cannot substitute for level 2 data in providing data on population sizes and population trends. For Carter's mustard, level 2 monitoring will have to be concentrated in September and October, when plants are visible and more easily counted.
- Data on management activities (e.g., fire, mechanical treatments) should be gathered in management units where level 2 monitoring is being done. These can serve to link information specific to those units (including population size and trends) with detailed demographic models that are keyed to management (e.g., fire).
- More data need to be collected on the response of Carter's mustard to management activities such as roller chopping, mowing, gyro-tracking, logging, and chain-saw felling. To the extent that responses are dissimilar to post-fire responses, fire-based population viability models will need to be adjusted.
- If significant unprotected populations of Carter's mustard are discovered, these populations should be protected by land purchase or management agreements.
- Better land management is needed to ensure that protected populations remain extant. Periodic burning is recommended as a way to ensure that aboveground populations are replenished before seed banks decline. There is little data to suggest a fire return interval currently, but adaptive management can be used based on data collected on Carter's mustard responses to various fire regimes.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Carter's mustard (*Warea carteri*)**

Current Classification Endangered  
Recommendation resulting from the 5-Year Review

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

Appropriate Listing/Reclassification Priority Number, if applicable \_\_\_\_\_

Review Conducted By Dr. Eric Menges, Archbold Biological Station

**FIELD OFFICE APPROVAL:**

Lead Field Supervisor, Fish and Wildlife Service

Approve [Signature] Date 7-8-08

*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.*

<sup>for</sup> Lead Regional Director, Fish and Wildlife Service

Approve [Signature] Date 9/15/08

*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.*

Cooperating Regional Director, Fish and Wildlife Service

Concur  Do Not Concur

Signature \_\_\_\_\_ Date \_\_\_\_\_

## **Summary of peer review for the 5-year review of Carter's mustard (*Warea carteri*)**

**A. Peer Review Method:** The Service conducted peer review. Three peer reviewers were selected by the Service. 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:** The reviewers felt the five-year review was thorough and all agreed with the conclusions of the review. One peer reviewer pointed out some confusing statistics regarding the number of populations protected on managed areas. Another reviewer questioned whether current demographic data would be sufficient to conduct a population viability analysis and provided edits on a confusing section describing that reviewer's own methods in level 1 monitoring for this species. That reviewer asked for the conservation implications of past genetics results. Finally, that reviewer commented on a discrepancy in the numbers that we used to describe Carter's mustard distribution in sites searched by Schultz et al. (1999). The final reviewer provided information on the susceptibility of Carter's mustard to fungal pathogens and insects, along with a citation for this work.

**D. Response to Peer Review:** In response to peer review, the information in source documents was checked regarding the managed areas supporting Carter's mustard. New sentences and edits make clear that there are 15 managed areas known to protect populations of Carter's mustard at this time. Edits were made to state explicitly that there are sufficient data to conduct a PVA, implications of genetic results are described, the discrepancy in Schultz et al. (1999) cleared up, and suggested minor edits were made. The information on susceptibility to fungal pathogens and insects was added.

## **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).