

**U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Cicindela highlandensis*

COMMON NAME: Highlands tiger beetle

LEAD REGION: 4

INFORMATION CURRENT AS OF: May 2009

STATUS/ACTION:

☐ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

☐ New candidate

☒ Continuing candidate

☐ Non-petitioned

☒ Petitioned - Date petition received: May 11, 2004

☐ 90-day positive - FR date:

☐ 12-month warranted but precluded - FR date:

☐ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes

c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded. We find that the immediate issuance of a proposed rule and timely promulgation of a final rule for this species has been, for the preceding 12 months, and continues to be, precluded by higher priority listing actions (including candidate species with lower LPNs). During the past 12 months, almost our entire national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, meeting statutory deadlines for petition findings or listing determinations, emergency listing evaluations and determinations, and essential litigation-related, administrative, and program management tasks. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken over the past 12 months, see the discussion of "Progress on Revising the Lists," in the current CNOR which can be viewed on our Internet website (<http://endangered.fws.gov/>).

☐ Listing priority change

Former LP: ☐

New LP: ☐

Date when the species first became a Candidate (as currently defined): November 21, 1991

☐ Candidate removal: Former LP: ☐

- ___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
- ___ U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
- ___ F – Range is no longer a U.S. territory.
- ___ I – Insufficient information exists on biological vulnerability and threats to support listing.
- ___ M – Taxon mistakenly included in past notice of review.
- ___ N – Taxon does not meet the Act’s definition of “species.”
- ___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Insects, Cicindelidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.A.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Highlands and Polk Counties, U.S.A.

LAND OWNERSHIP

The Highlands tiger beetle has been documented at 40 sites in public and / or private ownership (Knisley 2005, p. 5-6). The largest counts (> 40 individuals) were found at the following locations (Knisley 2005, p. 6):

- Allen David Broussard Catfish Creek State Park Preserve, owned and managed by Florida Department of Environmental Protection
- Snell Creek, part of the Lake Wales Ridge National Wildlife Refuge (NWR)
- Flaming Arrow Boy Scout Ranch, privately owned
- Tiger Creek Preserve, owned by The Nature Conservancy (TNC)
- Carter Creek A, part of Lake Wales Ridge NWR
- Flamingo Villas, part of Lake Wales Ridge NWR
- Horse Creek Scrub, > 50% in conservation ownership
- Walk-in-the-Water Tract, part of Lake Wales Ridge State Forest, owned and managed by the Florida Division of Forestry

The beetle also occurs on the following managed areas (D. Almquist, Florida Natural Areas Inventory [FNAI], pers. comm. 2009):

- Hatchineha Ranch, owned by TNC
- Lake Wales Ridge Wildlife and Environmental Area, owned by the Florida Fish and Wildlife Conservation Commission (FWC)
- Sherwood L. Stokes Preserve / Lake Marion, owned by Polk County Environmental Services Department
- Upper Lake Marion Creek Watershed, owned by the Southwest Florida Water Management District
- Upper Lakes Basin Watershed, owned by the South Florida Water Management District.

It is difficult to determine the total amount of occupied habitat on public and private land. Many sites are less than 1 hectare (ha) (2.47 acres) in size (NatureServe 2009, p. 1). The number of

sites is not equivalent to the number of populations (see Population Estimates). Several sites are small and in close proximity to each other.

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BIOLOGICAL INFORMATION:

Species Description: The Highlands tiger beetle (*Cicindela highlandensis*) is a member of the beetle family Cicindelidae (tiger beetles), which includes more than 2,000 species worldwide, more than 100 in the United States (Pearson and Cassola 1992, p. 379, 381), and about 25 in Florida (Knisley and Hill 1992a, p.5). Adult tiger beetles are medium-sized, elongate beetles, mostly with brilliant metallic green, blue, red, and yellow coloration highlighted by stripes and spots. The Highlands tiger beetle is an exception, being mostly black. The Highlands tiger beetle is 10.5-12 millimeters long (0.4-0.5 inches) (Deyrup 1994, p. 364). Adult tiger beetles are ferocious, swift, and agile predators that seize small prey with powerful sickle-shaped jaws (Essig 1942, p. 530; Nagano 1982, p. 34; Pearson 1988, p. 124, 126-127, 132). In Florida, their prey is typically ants (Choate 1996, p. 2).

Tiger beetle larvae are also predatory. They live in small burrows from which they lunge and seize passing invertebrate prey (Essig 1926, p. 372; Essig 1942, p. 532; Pearson 1988, p. 131-132). When a prey item passes near a burrow, the larva grasps it with its strong mandibles (mouthparts), pulls it into the burrow, and feeds (Essig 1942, p. 531-532; Pearson 1988, p. 132). Tiger beetles share similar larval body forms throughout the world (Pearson and Cassola 1992, p. 377). The larvae, either white, yellowish, or dusky in coloration, are grub-like and fossorial (subterranean), with a hook-like appendage on the fifth abdominal segment that anchors the larvae inside their burrows.

Tiger beetle larvae undergo three instars (larval development stages). This period can take 1 to 4 years, with a 2-year period being the most common (Pearson 1988, p. 129). The Highlands tiger beetle has a 1-year life cycle (Knisley and Hill 1996, p. 2, 16-17, 20). Adults begin to emerge from mid- to late-May, reaching peak abundance about mid-June, then declining in numbers from mid-July onward. Only a few adults survive into late August and early September. Adults mate and begin oviposition (egg-laying) within about two weeks of emergence. First-instar larvae begin to appear in late June and reach peak abundance from late July to early August. Survivors develop to the second instar within 2 to 4 weeks. Second instars, which are at peak abundance from late August to October, require about 4 to 8 weeks to develop to the third instar. Third instars can be found from August through the following spring. This stage requires more food and lasts several months, at minimum. Many third instars may nearly complete their development by December or January, but will occasionally open their burrows until they pupate. Pupation occurs in April or early May, although some larvae of a cohort (probably less than 15 percent) will lag in their development and emerge after two years of development (Knisley and Hill 1996, p. 17).

Survivorship of Highlands tiger beetle larvae from first instar through the third instar ranged from about 11 to 22 percent at the three sites that Knisley and Hill (1996, p. 17) studied for two

years. The highest mortality occurred in larvae during their first few months, August to October. Predation by ants that took over the burrows was largely restricted to first instars. Parasitism from bee flies (*Anthrax*) was a significant mortality factor for third instar larvae; most samples of larvae had parasitism rates over 15 percent, a rate similar to those found for other species of tiger beetle (Knisley 1987, p. 1192-1198; Knisley and Hill 1996, p. 18). Knisley and Hill also saw a small parasitic wasp, apparently *Methocha*. Robber flies (family Asilidae) were common at all of the study sites and appear to be the major predators of adults. During 110 hours of field observation, 22 predation attempts on adults by robber flies resulted in 5 successful attacks (Knisley and Hill 1996, p. 19).

A large body of scientific literature is devoted to tiger beetles, and a tiger beetle scientific journal, *Cicindela*, has been published since 1969. Tiger beetle species occur in many different habitats (Pearson 1988, p. 135-136, 139; Knisley and Hill 1992a, p. 4). A common habitat component appears to be open, sunny areas used for hunting and thermoregulation (adaptive behavior to use sunlight or shade to regulate body temperature) (Pearson 1988, p. 134; Knisley et al. 1990, p. 911-915; Knisley and Hill 1992a, p. 7-8).

Taxonomy: Choate (1984, p. 73-82) described the Highlands tiger beetle as a new species in a paper that also dealt with two similar species, *C. scabrosa* (the Florida scrub tiger beetle) and *C. abdominalis*. These three species constitute the “*C. abdominalis* group.” The three species are similar, very small and black (with green, blue, and purple reflections), with an orange abdomen visible from the underside. They can be distinguished by several prominent features. The elytra (leathery forewings) of *Cicindela abdominalis* are shallowly punctured; *Cicindela scabrosa* deeply punctured, and *Cicindela highlandensis* glabrous (i.e., without the punctures). The Highlands tiger beetle also lacks conspicuous white flattened hairs on both sides of the thorax and the underside of the abdomen.

NatureServe (2009, p. 1) and the FNAI (2008a, p. 13; 2008b, p. 16) use the name *C. highlandensis*. The Integrated Taxonomic Information System (2008, p. 1) uses the name *C. highlandensis* and indicates that this species’ taxonomic standing is accepted. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon.

Habitat: The Highlands tiger beetle is often associated with evergreen scrub oaks, as well as high pineland with deciduous turkey oak (*Quercus laevis*) and longleaf pines (*Pinus palustris*). High quality habitat is primarily scrub or sandhill with a high percent of open sand (greater than 50 percent) and with many natural openings, which are continuous or connected to adjacent open patches or connected by lightly disturbed trails or paths (Knisley and Hill 1996, p. 9; D. Almquist, pers. comm. 2009). Adults were not found in areas of dense scrub (except along the edges of trails) nor in areas of low shrubs (Knisley and Hill 1996, p. 11, 14-16, 21). The tiger beetle was regularly found on trails with evidence of at least moderate off-road vehicle traffic and where there was evidence of past vegetation clearing or other ground disturbance (Knisley and Hill 1992a, p. 8; 1996, p. 15, 20). This suggests that because of fire suppression, the vegetation has become artificially dense, harming the beetle. The need for prescribed burning of the vegetation or alternative methods of clearing openings, such as scraping, as Knisley and Hill (1996, p. 16, 21-22) and Knisley (2005, p. 9) suggested, and other management measures are discussed below (see Threats).

Results from surveys conducted during 2004-2005 (Knisley 2005, p. 7-8) supported previous conclusions that the Highlands tiger beetle occurs in a diversity of habitats and that there are no key plant or other specific indicators of habitat, other than open sandy areas within or adjacent to scrub or sandhill. Amount of open area was usually the primary indicator of suitable habitat (Knisley 2005, p. 5). Adults were most common along the middle and immediate edges of trails and paths; larvae were more common on the trail edges, closer to vegetation (Knisley 2005, p. 7). This suggests that adults use the open trails for thermoregulation and foraging, but move away from these areas to oviposit in more shaded microhabitats (Knisley 2005, p. 7).

Among the sites with the largest numbers of beetles were typical Lake Wales Ridge scrub with naturally open interior areas (Catfish Creek, Flaming Arrow Scout Camp), scrub sites with open sandy roads or edges caused by human disturbance (Walk-in-Water, Carter Creek sites, Flamingo Villas), and pine flatwoods and longleaf pine sites with natural or disturbed areas (Snell Creek, Catfish Creek) (Knisley 2005, p. 7). At Catfish Creek which has the largest population, adults were widespread and occasionally abundant in trails and open areas of scrub, in sandhill habitat, and on trails adjacent to wet prairie and depression marshes (Knisley 2005, p. 7-8).

Most known populations occur on scrub or sandhill, with probably more than 90 percent of observations in scrub (D. Almquist, pers. comm. 2008a; B. Knisley, Randolph-Macon College, pers. comm. 2008a). This species appears to require scrub or Lake Wales Ridge sandhill that is functionally equivalent to scrub (D. Almquist, pers. comm. 2008b). Although the Highlands tiger beetle may be found in flatwoods and other habitats in the vicinity of scrub, the species would not be found in the middle of an expanse of flatwoods or other habitat without scrub in the vicinity (D. Almquist, pers. comm. 2008b).

Roughly 85 percent of the scrub and sandhills on Lake Wales Ridge has been lost to development and agriculture (Friedman et al. 1993 as cited in Turner et al. 2006, p. 3). This loss of habitat has resulted in a concomitant reduction in the frequency and extent of wildfires (Turner et al. 2006, p. 3). While public and private entities have protected 87 km² 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, p. 24); management in general is confounded by habitat fragmentation and land ownership. Analyses by Turner et al. (2006, p. i) 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 percent of the original habitats will be protected since most have already been destroyed. Habitat conditions for the tiger beetle will likely remain suitable only with active management. Fragmentation of habitat and in-holdings within protected sites may limit application of fire and other management.

Historical Range/Distribution: Because the Highlands tiger beetle has only been known since it was described in 1984, there are no records of its past distribution and abundance. It seems likely that it was common, widespread, and well established throughout the scrub and possibly high pine communities of the Lake Wales Ridge in Highlands and Polk Counties prior to the widespread destruction of these habitats over the past 50 years (Knisley and Hill 1992a, p. 8-9).

Current Range/Distribution: Knisley and Hill (1996, p. 15) found the Highlands tiger beetle at 40 sites, 25 in Polk County and 15 in Highlands County, an increase from the 23 sites reported by Knisley and Hill (1992a, p. 6), but not representing a substantial increase in geographic range. The 40 sites are all on the Lake Wales Ridge, the hilly upland along U.S. Highway 27 that is known for scrub vegetation and endemic plants and lizards. The range of the Highlands tiger beetle does not extend to the south end of the Lake Wales Ridge and the range does extend northward to near Haines City (Knisley and Hill 1996, p. 11-13). Knisley and Hill (1996, p. 6) also note that “a number of tiger beetle collectors have sought but not found this species in other areas in this vicinity in recent years” and they believe this species to be extremely rare.

The northern limit of the Highlands tiger beetle is near Snell Creek north of Lake Marion, about 4 miles east of Haines City (Knisley and Hill 1996, p. 40). This is near a unit of the Lake Wales Ridge NWR. The beetle has been found southeast of Lake Marion, in the vicinity of the Poinciana development and in the Allen David Broussard Catfish Creek Preserve east of Lake Pierce and northeast of Lake Wales. The range continues south through TNC’s Tiger Creek Preserve, the Lake Wales Ridge State Forest’s Walk-in-Water tract, Lake Weohyakapka and the west side of Lake Arbuckle (Lake Wales Ridge State Forest), and Carter Creek (Lake Wales Ridge Wildlife and Environmental Area), to the vicinity of Josephine Creek (Jack Creek tracts managed by the Southwest Florida Water Management District and the adjoining Henscratch tract of the Lake Wales Ridge Wildlife and Environmental Area).

Overall, the total range measures a little over 90 km (56 miles) in linear distance (D. Almquist, pers. comm. 2008a). The maximum width of the range, east to west, is about 10 km (6 miles), but the minimum is zero in many areas (D. Almquist, pers. comm. 2008a). The total known occupied area within this range is roughly 100 km² (39 square miles) or less (D. Almquist, pers. comm. 2008a).

This species’ narrow distribution may be in part due to its lack of dispersal. “Among tiger beetles there is a general trend of decreasing flight distance with decreasing body size (Pearson pers. comm.). *Cicindela highlandensis* is one of the smallest tiger beetles and an extremely weak flier (usually flying moving only five to ten meters) . . . Species in woodland, scrub or dune habitats seem to disperse less than water edge species, and this could further explain the apparent limited dispersal of *C. highlandensis*.” (Knisley and Hill 1996, p. 13). The thermal requirements of the Highlands tiger beetle may also limit its dispersal as adults may overheat in full sun. They prefer partially shaded habitats. Larval burrows tend to be near vegetation, where they are shaded for part of the day.

Knisley (2005, p. 8) found the range of the Highlands tiger beetle restricted to the core of the Lake Wales Ridge and nearly separate from that the Florida scrub tiger beetle, which borders the range of the former species on all sides and extends well beyond the Lake Wales Ridge. At several locations (few Lake Arbuckle sites and Henscratch), these two species were found to overlap or be contiguous (Knisley 2005, p. 8). Results of these surveys further suggest the distribution pattern of these two species may be determined by scrub height and elevation preferences; the Florida scrub tiger beetle occurs in scrub that is low in plant height and at lower elevations and the Highlands tiger beetle prefers higher scrub where more shade is available and at higher elevations (Knisley 2005, p. 8).

Population Estimates/Status: Knisley and Hill (1996, p. 7) used a mark-recapture method to

estimate population sizes and found the largest populations at Catfish Creek, where four nearby sites yielded an estimated total of 841 adults. Most of the sites had only very small to medium sized populations, evidently because the sites have very little suitable habitat due to too thick or low quality vegetation. Fortunately, small populations may be viable. Knisley and Hill (1996, p. 20-21) monitored the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), a federally listed threatened species, for nine years. Their data suggest that to be viable in the face of randomly-occurring events, populations must have at least 500 to 600 adults (Knisley and Hill 1996, p. 20-21). Arizona grassland tiger beetles typically exist at lower densities and can probably maintain themselves at smaller population sizes. In the absence of population viability studies, it seems likely that a population of about 100 adult Highlands tiger beetles in an area of 1 to 2 ha (roughly 2 to 4 acres) can persist over the long-term (Knisley and Hill 1996, p. 21).

Knisley (2005, p. 2) surveyed all known and additional sites (72) throughout the range of the Highlands tiger beetle in Polk (45 sites) and Highlands (27 sites) Counties in 2004 and 2005 to determine abundance, distribution, and conservation status. Population sizes were primarily estimated by visual index counts, but mark-recapture (Lincoln Index) and removal methods were also used to supplement and interpret index counts (B. Knisley, pers. comm. 2008a). A total of 1,574 adults was found at 40 sites compared with 643 adults at 31 sites in 1996, 928 adults at 31 sites in 1995, and 742 adults at 21 sites in 1993 (Knisley 2005, p. 2, 5-6). Of the 40 sites in the 2004-2005 surveys with one or more adults: 3 sites were found to have large populations of over 100 adults [Catfish Creek Preserve (493), Snell Creek South (193), Flaming Arrow Scout Camp (175)]; 3 sites had populations of 50-99 adults; 8 sites had 20-49 adults, 13 sites had 10-19 adults, and 13 sites had < 10 adults (Knisley 2005, p. 2, 6). Results from a limited removal study at four sites suggest that the actual population size at the various survey sites is likely to be as much as two times as high as indicated by the visual index counts (Knisley 2005, p. 2, 7). Knisley (2005, p. 2, 6) found that some sites with larger populations had additional habitat not previously surveyed and probably larger numbers than the survey indicated. Almquist (pers. comm. 2008a) noted that Tiger Creek Preserve may also support a large population because 50 adults were observed in one day in an unsurveyed section, and there is an estimated 3 times that much suitable habitat at this site. It is possible that additional sites and larger populations exist since some areas of suitable habitat have not been surveyed, and larger sites have not been surveyed in their entirety (D. Almquist, pers. comm. 2008a, 2008b, B. Knisley, pers. comm. 2008a).

Overall, Knisley (2005, p. 2, 8) found evidence for a significantly improved conservation status of the Highlands tiger beetle in the 2004-2005 survey compared to the 1996 survey. He attributed the improvement to the addition of several new and good quality sites, which support medium or larger populations of the tiger beetle, and the improvement of the habitat quality due to management activity at several other sites. Actual short- and long-term effects of burns and other management actions, however, are not known (B. Knisley, pers. comm. 2008b). In 2004-2005 there were five sites with A grades (a subjective grade from A to D assigned to each site based on habitat size, quality, population size, protection status, and impacts with A being the best) and seven with B grades compared to three sites with A grades and five sites with B in 1996 (Knisley 2005, p. 8). Some of these sites have been protected through acquisition. In addition, there has been a loss of only a few small or lower quality sites and no decrease in habitat quality and beetle numbers over the 10-year period (Knisley 2005, p. 8). Additional improvement in the status of the beetle could be made with even limited management at most sites, which could increase habitat quality and beetle numbers (Knisley 2005, p. 8).

Long range dispersal potential of the species is not known, but important to delineate populations and assess viability (D. Almquist, pers. comm. 2007a, 2008b; B. Knisley, pers. comm. 2008a, 2008c). While some tiger beetles are strong fliers and can make vertical flights above vegetation to disperse, the Highlands tiger beetle likely has limited dispersal ability (B. Knisley, pers. comm. 2008a, 2008c). There are significant barriers of non-habitat between many of the sites (B. Knisley, pers. comm. 2008a). NatureServe (2009, p. 5) currently uses 4 km (2.5 miles) as the separation distance cutoff between occurrences if unsuitable habitat is present, and 10 km (6.2 miles) if suitable habitat is present; these figures are somewhat arbitrary, but reasonable considering the dispersal capabilities of related species (D. Almquist, pers. comm. 2007a, 2008c; B. Knisley, pers. comm. 2008c). Thus, the 40 sites would equate to approximately 5 occurrences using NatureServe standards, but could be up to 10 populations, depending upon actual long-term separation distances (D. Almquist, pers. comm. 2008c).

The Highlands tiger beetle has a rounded global status of G1, critically imperiled because of its small range, limited habitat, small populations, and limited protection (NatureServe 2009, p. 1). While there are still many sites supporting the species, at least nine are less than 1 ha, and it is likely that fewer than five represent viable occurrences (NatureServe 2009, p. 1). Most occurrences have some degree of threat including succession, small numbers, and isolation (NatureServe 2009, p. 1). The Highlands tiger beetle is recognized in Florida's Comprehensive Wildlife Conservation Strategy as one of Florida's species of greatest conservation need; status was considered as low (measure of species abundance), trend was considered declining (FWC 2005, p. 90). The Highlands tiger beetle is not listed as endangered or threatened in Florida, and there is no wildlife management plan for this species.

THREATS:

- A. The present or threatened destruction, modification, or curtailment of its habitat or range.
The Highlands tiger beetle depends on open, sandy areas within the Lake Wales Ridge upland vegetation. This vegetation has largely been converted to citrus groves and residential areas. Roughly 85% of the scrub and sandhills on Lake Wales Ridge has been lost to development and agriculture (Friedman et al. 1993 as cited in Turner et al. 2006, p. 3). This loss of habitat has resulted in a concomitant reduction in the frequency and extent of wildfires (Turner et al. 2006, p. 3). An estimated two-thirds of the species' habitat has been lost and much of the remaining is degraded (NatureServe 2009, p. 2). However, it is unlikely that the tiger beetle has declined by only two-thirds and it is possible that it has declined by more than 90 percent (NatureServe 2009, p. 2). Further habitat loss is a widespread threat as development and citriculture continue (NatureServe 2009, p. 3). For example, a comparison of aerial photographs of the general area of the type locality from 1970 and 2004 show that most of the suitable habitat has been developed, cleared completely, or overgrown due to fire suppression (D. Almquist, pers. comm. 2008d). Another site (i.e., near Poinciana B) is being impacted by a new development; this development will likely cause extirpation of the beetle from the entire area (D. Almquist, pers. comm. 2008e). Knisley (pers. comm. 2009) suggests that, at present, even if the species has high dispersal capabilities, there is too great a distance and significant barriers of non-habitat between some sites to allow exchange of adults. Habitat fragmentation is a serious concern (B. Knisley, pers. comm. 2009).

The threat of habitat loss, degradation, and fragmentation is expected to continue and

increase. Analyses by Zwick and Carr (2006, p. 11) 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. Highlands County, with a population of 87,366 in 2000 is projected to increase to 170,038 by 2060 (Zwick and Carr 2006, p. 20). Polk County, with a population of 483,924 in 2000, is projected to increase to 1,029,606 by 2060 (Zwick and Carr 2006, p. 21). Fortunately, much of the known high quality habitat for Highlands tiger beetle has been acquired and placed in public or other conservation ownership. Although most occupied sites are protected, the fragmented nature of these protected sites along with the influx of development around them may preclude the ability to conduct prescribed burns or other management actions essential to preserving the species. In addition, increased threats from recreational impacts on protected sites are also expected to increase with increased human population (see Factor E).

The threat of habitat loss also occurs from increasing vegetation density from ecological succession and fire suppression (NatureServe 2009, p. 3). Habitat degradation and modification due to ecological succession, fire suppression, and lack of management are major threats to this species (D. Almquist, pers. comm. 2008d). Lack of management of the remaining scrub and high pineland vegetation may constitute a threat as serious as habitat loss (Knisley and Hill 1992a, p. 9; 1992b, p. 133-140; 1996, p. 20-22). The vegetation in which the beetle occurs is subject to fire, ranging from relatively frequent and low-intensity in high pineland to infrequent and high intensity in some scrub (Myers 1990, p. 151-154). Years of fire suppression in most upland habitats of the Lake Wales Ridge led to the vegetation becoming much thicker, with few patches of bare ground. One indicator of ecological problems caused by fire suppression is that small scrub plants (herbs and smaller shrubs) are now typically most abundant in artificially disturbed areas such as firebreaks.

Implementing burning schedules should create more open habitat and benefit the species (Knisley 2005, p. 8-9). However, it is uncertain if the method or time of burning has had negative effects on the beetle. Knisley (2005, p. 9) suggest that burning conducted during the period of adult activity, mid-May through July, in areas with adults would likely cause some mortality to adults that cannot escape (by flying) from fire. In addition, fire and post-fire effects might also make the habitat unsuitable for larval recruitment because of adult mortality and, perhaps more importantly, the disturbance to oviposition from burning activities (Knisley 2005, p. 9). Knisley (2005, p. 9) suggests that larvae, which live in burrows, may not be affected by burning. The negative impacts from burning would probably be countered by improved habitat conditions within 1-2 years and an increase in the populations (Knisley 2005, p. 9).

The Highlands tiger beetle is largely restricted to artificially disturbed areas. Knisley and Hill (1992a, p. 9) noted that “our surveys for this species revealed that most sites we checked were very densely vegetated, a feature which we believe contributes to the low numbers of *C. highlandensis* we typically found. We have recently documented how this type of habitat change from ecological succession can cause the decline and local extirpation of tiger beetle species (Knisley and Hill 1992[b]). One example we present is the extirpation of *C. abdominalis* (the species to which *highlandensis* is most closely related) at a Virginia pine barrens site in the 1930's from encroaching vegetation from succession and fire suppression.” Knisley (2005, p. 9) suggests that scraping or cutting of trails or open areas will cause some

mortality to adults and especially larvae, but that the population would probably recover and increase in numbers within a few years of this disturbance.

While trails for fire management or recreational purposes (all-terrain vehicles or four-wheeling) may provide needed open habitat for the Highlands tiger beetle (Knisley and Hill 1992a, p. 7), vehicular activity has harmed beach-dwelling tiger beetles in the northeastern U.S. Larvae live in burrows near the ground surface and may be harmed by off-road vehicle traffic (NatureServe 2009, p. 3) (see Factor E).

Invasion by non-native species is a lesser threat, but one that appears to be increasing. Many conservation land managers work to control the spread and prevent additional invasions of exotics on a continual basis.

In summary, land acquisition by the State of Florida, the Service, and others has placed most of the remaining good quality Highlands tiger beetle habitat in public or other conservation ownership. Habitat loss, while serious, has been partially addressed, especially by the State in cooperation with local government. State land managers are implementing prescribed fire programs, exotic plant control, and visitor management, which should benefit this species. Significant progress has been made by the State and other entities toward reducing these threats through acquisition and management at some sites. However, habitat loss, conversion, degradation, and fragmentation are expected to continue and increase, affecting any populations on private lands as well as those on protected lands that depend on management actions (i.e., fire) that could be precluded by surrounding development.

- B. Overutilization for commercial, recreational, scientific, or educational purposes. Members of the genus *Cicindela* may be the subject of more intense collecting and study than any other single beetle group (Knisley and Hill (1992a, p.9). Knisley and Hill (1992a, p. 9) stated that overcollecting of the Highlands tiger beetle may be of “some importance” and suggested that overcollecting may have been partly responsible for the extirpation of the species from the site where Choate had first collected it (i.e., the type locality). Knisley and Hill (1992a, p. 10) estimated that 500-1,000 adults had been collected at this site during a several year period after its initial discovery. More recently, Almquist (pers. comm. 2007b, 2008a) stated that the Highlands tiger beetle has not been extirpated from its type locality. The discrepancy may be because the type series was taken from the east side of the road by Choate; this site was subsequently converted to citrus and no beetles were found in the surrounding marginal habitat (B. Knisley, pers. comm. 2008a). The beetle can still be found on the west side of the road; since close habitat patches can be interpreted as being part of the same site, the west side of the road could be considered as part of the type locality (B. Knisley, pers. comm. 2008a).

Many tiger beetle enthusiasts in general have little regard for conservation; some have little regard for rarity and collect early in the season before oviposition, which can negatively affect populations (B. Knisley, pers. comm. 2008a). For the Highlands tiger beetle, however, Knisley (pers. comm. 2008a) does not believe that collecting has caused a significant reduction in populations; most collectors take from sites with larger numbers, and thus are unlikely to cause a major impact. Knisley and Hill (1992a, p. 9) indicated that they know personally or indirectly at least 30 individuals who regularly or actively collect tiger beetles. More recently, Knisley (pers. comm. 2008a) stated that he is aware of 5-10 collectors who

have collected several hundred or more of this species in the past 5-8 years. Overall, collection is a threat, especially if taken before oviposition or from small sites. However, for most sites, impacts from collecting may not be as severe as habitat loss, degradation, and modification (see Factor A) (B. Knisley pers. comm. 2008a).

NatureServe (2009, p. 2) considers collecting to be a significant threat to the Highlands tiger beetle. However, the impact of this threat is being revised by NatureServe (D. Almquist, pers. comm. 2008a). Almquist (pers. comm. 2008a) indicates that there is no evidence that collecting has negatively impacted any populations of this species, but suggests that it is possible that collecting could be a factor in small, isolated, and poor-quality patches of habitat. Almquist (pers. comm. 2009) also suggests that the species may be somewhat resilient to collection. Since occurrences are not being regularly monitored and collecting activities would likely be unannounced, it is not possible to assess the actual impacts of collection on any population.

In summary, collection is documented and currently occurring. Due to the species' vulnerability, collection is considered a threat, especially if adults are taken prior to oviposition or from small, isolated, or poor-quality sites. It is not possible to assess actual impacts to the population since most occurrences are not regularly monitored. Most collectors appear to be taking beetles from larger sites. Overall, we believe the current threat level is moderate at this time.

- C. Disease or predation. No diseases are known to threaten the Highlands tiger beetle. It is likely that the beetle experiences the limiting effects from natural enemies and generally low survivorship that are seen for other tiger beetle species (Knisley and Hill 1996, p. 5, 20). In general, parasites are considered to have greater effects on tiger beetles than predators (Nagano 1982, p. 34; Pearson 1988, p. 136-138). While predators and parasites play important roles in the natural dynamics of tiger beetle populations, the small sizes of Highlands tiger beetle populations may render them vulnerable to predation and parasitism that would otherwise constitute a normal part of their environment.

The main natural enemies of adult tiger beetles are robber flies (Family Asilidae) and birds. Parasitoid wasps (Family Tiphidae, genus *Methocha*) and bombyliid flies (genus *Anthrax*) are the main predators of larvae (Knisley and Hill 1989, p. 18-20; Hill and Knisley 1991, p. 42-43). Ants may sometimes affect larvae, especially during first instar (a stage in the life of an arthropod between two successive molts) (Knisley 1987, p. 1196). Most tiger beetle species that have been intensely studied experienced relatively high levels of larval parasitism (10 to over 40 percent) (Knisley and Hill 1992a, p. 10). At this time, the overall threat of predation and parasitism is not known.

- D. The inadequacy of existing regulatory mechanisms. Regulatory mechanisms currently in effect do not adequately protect the Highlands tiger beetle and its habitat. The FWC has not listed this insect, nor are there other State or local regulatory mechanisms. Because the beetle is not listed at the State or Federal levels, nothing prohibits importing, exporting, sale, or trade of the species.
- E. Other natural or manmade factors affecting its continued existence. The Highlands tiger

beetle is vulnerable to a wide array of natural and human factors. Populations are small and isolated and appear to occupy relatively small patches of habitat. Of the 40 sites supporting the species (Knisley 2005, p. 2, 5-6), at least nine are less than 1 ha in size, and it is likely that fewer than five represent viable occurrences (NatureServe 2009, p. 1). Because increased extinction rates are directly correlated with reduction of available habitat area and increased distances between small populations (Gilpin 1987, p. 135-138), the small, isolated populations may be vulnerable to local extinction from normal fluctuations in population size, genetic problems from small population size, or environmental catastrophes. In the absence of population viability studies, it seems likely that a population of about 100 adult Highlands tiger beetles in an area of 1 to 2 ha (roughly 2 to 4 acres) can persist over the long-term (Knisley and Hill 1996, p. 21). However, population sizes have not been studied in detail and metapopulation viability studies have not been conducted. The small sizes of occupied habitat also reduce the ability of the habitats to buffer against edge effects and other influences from adjacent developed areas, such as pesticide drift.

The difficulty of dispersal between suitable patches of habitat may also result in local extirpations. Knisley and Hill (1992a, p. 11) noted that “tiger beetles, like many other insects, experience extreme year-to-year fluctuations in abundance such that small or moderate populations may be subject to natural extinctions. Our studies with *C. dorsalis* (and *C. puritana*), two Federally Listed species, indicate that 2-3 fold differences in abundance are common and that local extinctions and colonization of new sites occur. The presence of numerous populations within an area is important for the survival of this species by providing for repeated immigration, dispersal, and colonization sites critical for the population dynamics of this species (Hill and Knisley 1992). The extirpation of both of these species from most of their ranges in the Northeast seems to have been the result of gradual reductions and fragmentation of habitats which eventually prevented successful recolonization and supplementation of the few surviving populations. Populations of *C. highlandensis* already appear to be highly fragmented in scattered areas of small habitat patches . . . and subject to genetic decline and other related problems for small, isolated populations.” The Highlands tiger beetle is one of the smallest tiger beetles and appears to be a weak flier, meaning it probably only disperses over short distances.

No assessment has been made of possible threats to Highlands tiger beetle from maintenance of fire lanes, recreational use of off-road vehicles, and pedestrian traffic. Vehicle and pedestrian traffic is a problem for tiger beetles on Florida beaches (Choate 1996, p. 1-3). Populations of a tiger beetle species in the northeastern United States, *Cicindela dorsalis dorsalis*, were extirpated in several localities that were subjected to heavy recreational use (i.e., heavy pedestrian foot traffic and vehicular use), but survived at sites that received little or no recreational disturbance (Knisley and Hill 1992b, p. 138). Nagano (1982, p. 35) stated that off-road vehicles are a significant threat to tiger beetles in general; larval burrows are easily collapsed and larvae crushed. Since larvae of the Highlands tiger beetle live in burrows near the ground surface, this species may be harmed by local off-road vehicle traffic (NatureServe 2009, p. 3). With increased human population, occupied habitat may be at placed at greater risk of degradation due to increased demand for recreational uses, especially on public lands.

Pesticides may be a potential threat to the Highlands tiger beetle. The effects of insecticides on other tiger beetle species are summarized by Nagano (1982, p. 35). NatureServe (2009, p.

3) states that “mosquito spraying may well be or become a serious threat at some or most sites.” However, pesticides used for mosquito control may not be of great concern for the Highlands tiger beetle, compared to other tiger beetles, because this species is restricted to xeric habitats where aerial adulticide applications may be minimal (D. Almquist, pers. comm. 2008a; R. Frakes, Service, pers. comm. 2009). Drift from pesticides applied to nearby citrus or other agriculture are more likely a concern (D. Almquist, pers. comm. 2008a, 2008d; B. Knisley, pers. comm. 2008a). As urban development and agriculture increase near or in Highlands tiger beetle habitat, negative impacts from pesticides may become a greater threat.

Highlands tiger beetle populations are on a variety of sites, ranging from large, contiguous tracts of conservation lands to conservation lands with numerous in-holdings, to privately owned sites. Illicit waste dumping is a documented problem at several sites, including the Flamingo Villas tract of the Lake Wales Ridge NWR, where boundary fencing has been installed to discourage unauthorized access.

In summary, the beetle is vulnerable to a wide array of natural and human factors, including: low population sizes, restricted range, small and isolated habitat patches, and difficulty dispersing between suitable habitats. Potential threats include: off-road vehicle and pedestrian traffic, fire break maintenance, pesticide use, and illicit waste dumping.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

The State of Florida has acquired a number of sites occupied by the Highlands tiger beetle, including those listed above. The Service is continuing with acquisition of conservation lands on a lot-by-lot basis at Carter Creek and Flamingo Villas of the Lake Wales Ridge NWR. This area has been fenced to provide protection from unauthorized access. Other areas are targeted for acquisition: 7.76 km² in Carter Creek A, part of Lake Wales Ridge NWR; 0.52 km² in Flamingo Villas, part of Lake Wales Ridge NWR; 2.79 km² in Horse Creek Scrub; roughly 13.40 km² in The Walk-in-the-Water Tract, owned and managed by the Florida Division of Forestry. Efforts by the Service, the State, and other entities have the potential to secure habitat for the beetle. Continued acquisition and land management remain the greatest need for accomplishing the long-term protection and recovery of this species on the Lake Wales Ridge.

Land managers in the Lake Wales Ridge area have begun to conduct more prescribed burning to enhance or restore scrub habitat. Prescribed burning on private and public conservation lands has likely improved habitat for this species and may provide improved habitat conditions in the future.

SUMMARY OF THREATS

Habitat loss, degradation, and fragmentation have destroyed a substantial portion of the Highlands tiger beetle’s historical range; these threats are continuing and are expected to increase. Although most of the largest populations occur on conservation lands, the specific habitat requirements of the beetle make its continued persistence uncertain. Increasing vegetation density from ecological succession and fire suppression is a threat. The species is inherently vulnerable to extinction due to its low population sizes, restricted range, small and isolated habitat patches, and difficulty in dispersing between suitable habitats. Potential threats include off-road vehicle and pedestrian traffic, fire break maintenance, pesticide use, and illicit waste dumping at some sites. In addition, collection of the Highlands tiger beetle is documented and currently occurring. Due to the species’ vulnerability, collection is considered a threat,

especially if adults are taken prior to oviposition or from small, isolated, or poor-quality sites. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

___ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES

- Continue acquisition and protection of habitat by private, County, State, and Federal entities (Knisley 2005, p. 8).
- Continue monitoring and surveying known sites, especially unsurveyed nearby areas with suitable habitat, and search for new sites (D. Almquist, pers. comm. 2008a, B. Knisley, pers. comm. 2008a, 2008b).
- Implement burning schedules as part of land management practices on conservation lands to create and maintain more open habitat. However, the method and timing of burns may have negative effects. For example, burns conducted during the period of adult activity (mid-May through July) in areas with adults may cause some mortality (Knisley 2005, p. 8-9).
- Cut or scrape new trails and / or open areas throughout sites to create more open habitat (Knisley 2005, p. 9), especially on lands on which it is difficult to burn appropriately.
- Conduct studies of the effects of burning and other management approaches through experimental comparative studies (preferred) or annual monitoring over a number of years at sites with and without management (B. Knisley, pers. comm. 2008b).
- Limit pesticide use in and around Highlands tiger beetle habitat.
- Limit off-road vehicle use in and around Highlands tiger beetle habitat to protect larvae.
- Minimize trash dumping in Highlands tiger beetle habitat through regulations, increased fines, and / or posting of signs marking boundaries of conservation lands.
- Determine long range dispersal potential to help delineate populations and assess viability (D. Almquist, pers. comm. 2007a).
- Conduct annual monitoring over a number of years to obtain information on population size and fluctuations such that a population viability model can be developed (B. Knisley, pers. comm. 2008b).

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5*

		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The Highlands tiger beetle is narrowly distributed and threatened by habitat loss, degradation, and fragmentation from residential development and the citrus industry. The central Florida region where this species occurs is expected to undergo explosive population growth in the next few decades, further contributing to this threat. Ecological succession, fire suppression, and lack of management also threaten persistence at many sites. The fragmented nature of protected sites along with the influx of development around them may preclude the ability to conduct prescribed burns or other management actions. Populations are small and isolated and appear to occupy relatively small patches of habitat. Difficulty in dispersing between suitable patches of habitat may result in local extirpations. Due to the species' vulnerability, collection is considered a threat, especially if adults are taken prior to oviposition or from small, isolated, or poor-quality sites. Loss of larvae and destruction of burrows by off-road vehicles on public and private sites is a concern. Other potential threats include fire break maintenance, pedestrian traffic, pesticide use, and illicit waste dumping at some sites. Overall, we find the magnitude of threats to be high.

Imminence: Although habitat loss, degradation, and fragmentation are continuing, acquisition of suitable habitat for State conservation lands, the Lake Wales Ridge NWR, and other private preserves have helped reduce these threats. Habitat management at some sites may be forestalling the threat of vegetation encroaching into bare sand areas needed by the beetle. The species is inherently vulnerable to extinction due to its low population sizes, restricted range, small and isolated habitat patches, and difficulty in dispersal between suitable habitats. How immediate these threats are is unknown. Collection is currently occurring, but there is no evidence to suggest that it is negatively impacting any populations. Potential threats include off-road vehicle and pedestrian traffic, fire break maintenance, pesticide use, and illicit waste dumping at some sites. Overall, sufficient conservation efforts are being made, and threats are considered to be non-imminent.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. A status survey completed in October 2005 suggests that the status of the Highlands tiger beetle has improved (Knisley 2005, p. 8).

DESCRIPTION OF MONITORING

The Service funded a rangewide survey for the Highlands tiger beetle by Dr. Barry Knisley in 2004. The survey was completed in October 2005 and provides the most recent information. Results of the 2004-2005 study suggest that the status of the beetle improved since the last

survey in 1996 (Knisley 2005, p. 8). No additional monitoring has been conducted since that time.

The Service participates as a member of the Lake Wales Ridge Ecosystem Working Group, a cooperative group comprised of private, local, State, and Federal entities interested in identifying and addressing sources of concern and threats to the health of the Lake Wales Ridge Ecosystem. The Lake Wales Ridge Working Group and its subgroups (Listed Species, Fire, Exotics, and Education) focus on restoration and management of lands throughout the Lake Wales Ridge Ecosystem. Although this group includes managers of all conservation lands within the range of the Highlands tiger beetle, monitoring specifically for this species was not reported during the year by any members of this group.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: The Service requested new information (observations, data, reports) regarding the status of this species and any new information regarding threats to this species from: Florida Department of Agriculture and Consumer Services, Florida Department of Environmental Protection, FWC, National Park Service, Service (Ecological Services and National Wildlife Refuges), FNAI, Archbold Biological Station, The Institute for Regional Conservation, University of Florida, Randolph-Macon College, and other entities. In total, the previous assessment was sent to 109 individuals.

The Highlands tiger beetle is recognized in Florida's Wildlife Action Plan, Florida's Comprehensive Wildlife Conservation Strategy, as one of Florida's species of greatest conservation need (FWC 2005, p. 90).

Indicate which State(s) did not provide any information or comments: Florida.

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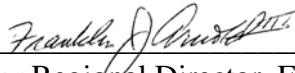
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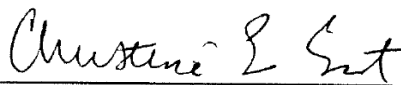
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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  May 27, 2009
for Regional Director, Fish and Wildlife Service Date


Acting
Director, Fish and Wildlife Service
Concur: Date October 29, 2009

Do not concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: May 15, 2009
Conducted by: Paula Halupa, South Florida Ecological Services Office