

**Key Largo Woodrat**  
*(Neotoma floridana smalli)*

**5-Year Review:**  
**Summary and Evaluation**

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

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**5-YEAR REVIEW**  
**Key Largo Woodrat / *Neotoma floridana smalli***

**I. GENERAL INFORMATION**

**A. Methodology used to complete the review:** This review is based on monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. The review was conducted by the lead recovery biologist with 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 the Key Largo woodrat (KLWR). The public notice for this review was published on April 26, 2007, with a 60 day public comment period. No comments were received from the public. Comments and suggestions regarding the review were received from peer reviews from outside the Service (see Summary of peer review section). We incorporated comments as appropriate in this review. No part of the review was contracted to an outside party.

**B. Reviewers**

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

**Lead Field Office:** South Florida Ecological Services Office, Sandra Sneckenberger, (772) 562-3909

**C. Background**

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

**2. Species status:** Declining (Recovery Data Call 2007). Subspecies status is precarious, and continues to be affected by multiple threats, such as population fragmentation, small population size, and predation (i.e., free-roaming domestic cats, Burmese pythons).

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

**4. Listing history**

Original Listing

FR notice: 49 FR 34504

Date listed: August 31, 1984

Entity listed: Subspecies

Classification: Endangered

**5. Associated rulemakings:** None.

**6. Review:** The Service conducted a five-year review for the woodrat in 1991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the woodrat's listing classification was found to be warranted.

Recovery Plan: 1999

Recovery Data Calls: 2000, 2001, 2001, 2003, 2004, 2005, 2006, 2007

**7. Species' Recovery Priority Number at start of review (48 FR 43098):** 3C. The KLWR is assigned a recovery priority of 3C because the degree of threat to its persistence is high, it is a subspecies with high level of taxonomic distinctiveness, and its potential for recovery is great if threats can be eliminated or minimized. Recovery of the KLWR is in conflict with economic activities.

**8. Recovery Plan or Outline**

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

Date issued: May 18, 1999

**II. REVIEW ANALYSIS**

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

1. **Is the species under review listed as a DPS?** No.
  2. **Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No.
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**B. Recovery Criteria**

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** No. The recovery plan (Service 1999) criteria to reclassify the KLWR from endangered to threatened provide constructive qualitative goals, but contain elements that are neither objective nor measurable. Revision of the recovery plan and recovery criteria is recommended.
2. **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.**

The criteria included in the approved recovery plan (Service 1999) to reclassify the KLWR from endangered to threatened are:

- 1) further loss, fragmentation, or degradation of suitable, occupied habitat must be prevented;
- 2) native and nonnative nuisance species must be reduced by 80 percent;
- 3) all suitable, occupied habitat on priority acquisition lists on Key Largo must be protected either through land acquisition or cooperative agreements;
- 4) tropical hardwood hammocks that form the habitat of the Key Largo woodrat must be managed on protected lands to eliminate trash and control exotics; and
- 5) stable (rate of increase equal or greater than 0.0 as a 3-year running average for 6 years) populations of the Key Largo woodrat must be distributed throughout north Key Largo and three additional, stable, populations established elsewhere within the historic range.

These criteria have not been met. Habitat degradation and loss has continued and threats from nonnative invasive species have increased. A working group has been developed to address new issues and persistent threats.

### C. Updated Information and Current Species Status

#### 1. Biology and Habitat

Information regarding KLWR biology and habitat can be found within the recovery plan (Service 1999) and the Key Largo Woodrat Captive Propagation Plan (Service 2003). A summary, with the addition of updated information, is provided below.

**a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:** While population trends are difficult to interpret from the various study designs and estimation techniques (Barbour and Humphrey 1982; Humphrey 1988; McCleery 2003; Potts et al. 2007), surveys in the last 20 to 25 years suggest a declining population, currently at very low densities (Florida Fish and Wildlife Conservation Commission [FWC] 2005; McCleery et al. 2006b; Winchester 2007). There is no appropriate estimate of population size to more precisely assess the severity of the decline. Population modeling yielded a high risk of extinction for KLWR within the next 10 years (McCleery et al. 2005; McCleery et al. 2006b).

The distribution of KLWRs within the hammocks of North Key Largo appears to have changed over time. Since 1985, presence of KLWR during trapping events has declined steadily from 66 percent (Goodyear 1985), to less than 20 percent (McCleery 2003; Winchester 2007). Recently however, Greene (2007) trapped KLWRs at 17 of 34 random grids (50 percent). At present, it

is unclear whether the most recent field data indicate a true increase in abundance or a change in detection probabilities.

The largest decline appears to have occurred between 1986 and 1995, when no KLWR monitoring was conducted. The population appears to have continued this decline since 1995. Comparisons of population size estimated by Humphrey (1988) and more recent population estimates suggest that the population may have declined by 97 percent or more since 1986 (Service 2003). This magnitude of decline has not been recorded in other woodrat species without substantial changes in habitat characteristics that result in inhospitable conditions or outbreak of a lethal disease. There is no evidence that either of these events have occurred on Key Largo.

The combination of a measured decline in population density and trapping success, the apparent absence of nests which are a normal part of the biology of most woodrats, and the apparent reduction in distribution within contiguous habitat on Key Largo support the conclusion that the population has declined. The extremely small number of remaining KLWRs suggests that the current status of the KLWR is precarious. The subspecies may have declined to the point where extinction is likely (Frank et al. 1997), and even if limiting factors are ameliorated, it will be many generations before the population size rebounds.

Because of the continuing decline in population size, and lack of detailed knowledge of the specific mechanism(s) responsible for the decline, 6 pairs of KLWRs were brought into captivity starting in 2002, following the Service's "Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act" (65 FR 56916). There are currently two facilities (Disney Animal Kingdom and Tampa's Lowry Park Zoo) involved in the captive propagation program. The breeding program has been successful, though the facilities are approaching capacity and analyses to avoid inbreeding support few acceptable matings. Research to develop protocols for releasing captive individuals is underway (see **II.C.1.d.**)

Regarding demographic characteristics, KLWRs breed year-round with an apparent peak in reproductive activity in the summer (Hersh 1981; Sasso and Gaines 2002). Females typically have two litters a year with one to four young, with litters of two offspring the most common (Brown 1978). Young wean at about 65 days (Savage 2007) and are sexually mature at 5 months. Both male and female densities increase gradually in summer to early fall. Gender ratio estimates approximate 1.2 males to each female (Hersh 1981), however, KLWRs may be capable of assessing resource conditions and responding with various brood reduction / gender bias strategies. The life span of a KLWR is believed to be similar to the eastern woodrat – averaging less than one year, but up to 3 years; though capture of KLWRs at least two years old is not uncommon (Potts 2008b).

Beyond the severe constriction in available habitat, the threat most limiting KLWR population growth is not known. Availability of potential net sites, non-native predators, and genetic issues are suspect.

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):** Detailed information concerning present levels of genetic diversity and variation in KLWR has only recently become available. A suite of nine polymorphic microsatellite DNA markers primers have been developed and surveyed for KLWR. An initial survey of structure in the wild population described the genetic variation as fitting a pattern of isolation by distance (King 2008).

The small population size, dramatic decreasing trend, and the lack of detailed knowledge of the specific mechanism(s) responsible for the decline, prompted the implementation of a captive propagation program. The success of the captive propagation program relies, in part, on implementing a biologically sound genetic management program to determine the level of genetic diversity among the wild population and to ensure that this diversity is conserved within the captive populations. Initially, 6 pairs of KLWR were brought into captivity starting in 2002, following the Service's "Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act" (65 FR 56916). Two facilities (Disney Animal Kingdom and Tampa's Lowry Park Zoo) are currently involved in the captive propagation program. The captive populations at Lowry Park Zoo (N=16; seven individuals constitute one family) and Disney Animal Kingdom (N=14; seven of one family) are small in size and represent only 75% and 59% of the genetic diversity observed in the wild, respectively (King 2008). Recommendations for pairings of individuals based on genetic relatedness and kinship are made regularly as new captive-bred individuals are incorporated into the breeding program. This genetically-driven breeding program, which is designed to maximize the genetic diversity, has been successful, though the facilities are approaching capacity and analyses to avoid the pitfalls of inbreeding depression support few acceptable matings.

A recent and more extensive survey of microsatellite DNA variation has resulted in unique multilocus genotypes for 133 wild captured individuals. The data did not support the hypothesis that KLWR exists as a single, panmictic (randomly mating) population. Instead, a spatially explicit model incorporating geographic coordinates of collection site and genotypic data identified a series of genetic discontinuities (i.e., barriers to gene flow) across the subspecies' 16 kilometer range resulting in five subpopulations (King 2008).

With five small, disjunct populations, the threat of losing irreplaceable genetic diversity is a concern. As a result of these most recent findings, the USFWS

and its cooperators are reevaluating the priorities of the captive breeding program and have altered the recovery strategy so as to augment gene flow among these smaller fragmented populations. Research to develop protocols for repatriating selectively-bred individuals is underway.

**c. Taxonomic classification or changes in nomenclature:** KLWRs are the southernmost subspecies of the eastern woodrat (*Neotoma floridana*) (Sherman 1955; Schwartz and Odum 1957). There have been no changes in the accepted taxonomy, which is considered valid (Integrated Taxonomic Information System 2008).

**d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):** Historically, the KLWR occurred throughout the length of Key Largo south nearly to Tavernier (i.e., Rock Harbor; Schwartz 1952). Their distribution is now patchy, congruous with the loss and fragmentation of hardwood hammock vegetation (McCleery 2003; FWC 2005). The present range of the KLWR includes the northern one-third of Key Largo where large tracts of contiguous tropical hardwood hammock occur, representing about one-half of their original distribution (Barbour and Humphrey 1982; Humphrey 1992).

Residential and commercial development is considered the cause of extirpation of KLWR south of the intersection of U.S. 1 and C.R. 905 (Brown 1978; Hersh 1981). Approximately 880 hectares (ha) of suitable KLWR habitat remains (Humphrey 1988; Service 1999; McCleery 2003; Service 2003; FWC 2005), and individuals are found almost exclusively within public lands (Crocodile Lake National Wildlife Refuge and Dagny Johnson Key Largo Hammock Botanical State Park) (FWC 2005). A few private tracts adjacent to public lands contain suitable habitat and are vulnerable to urbanization.

An initially successful translocation project was initiated on Lignumvitae Key (outside the historic range) in 1971 (Brown and Williams 1971; Barbour and Humphrey 1982). Stick nests were observed in the 1980s, but the population was considered extirpated from the key by 1990 (Duquesnel 1994). In 2008, KLWRs from the captive colonies will be released within Crocodile Lake National Wildlife Refuge and the Dagny Johnson Key Largo Hammock Botanical State Park. The focus of this effort will be the development of protocols for conducting, monitoring, and evaluating the reintroduction of the KLWR.

**e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):** Much of the original tropical hardwood hammock on Key Largo was cleared in the past for development or

agriculture, and the southern portion of Key Largo is nearly completely developed. These unnatural, patchy incidences of disturbance have resulted in a mosaic of various patch ages that together represent habitat of inferior quality to KLWRs. The only remaining large contiguous tract of tropical hardwood hammock vegetation occurs on the northern half of Key Largo. Approximately 880 ha of the remaining 1,011 ha of tropical hardwood hammock are protected within the boundaries of Crocodile Lake National Wildlife Refuge and Dagny Johnson Key Largo Hammock Botanical State Park (Service 2003). Much of the remaining (unprotected) 131 ha consists of private lands cleared several decades ago and abandoned. Successful regrowth of the hammock, and consequently the suitability of the habitat to KLWRs, varies among these sites.

Crocodile Lake National Wildlife Refuge and Dagny Johnson Key Largo Hammock Botanical State Park were acquired in 1980 and 1982, respectively. Since initial acquisition, both sites have been managed to maintain and restore the native tropical hardwood hammock vegetation on which the KLWR depends, and have continued acquisition of remaining hammock habitat on north Key Largo. Many tracts on these sites were cleared for development or agriculture earlier this century, but hammock vegetation has returned to many of these previously cleared sites. The remaining forest is now composed of a variety of successional stages of tropical hardwood hammock vegetation, reflecting the time since and extent of disturbance.

Theories regarding the habitat preference of KLWR appear to conflict. Once believed to reach highest densities in mature hardwood hammocks (Service 1973; Brown 1978; Hersh 1981; Barbour and Humphrey 1982), KLWRs are now known to use a variety of successional habitat conditions (Goodyear 1985), possibly preferring young hardwood hammock (McCleery 2003). As these habitat types differ mainly in species composition, their physiognomies (i.e., life form, architecture of canopy layers) being comparable, the conflicting assessments of preferred habitat may be a result of differing uses of habitat nomenclature. Furthermore, hammock age classes are confounded with disturbance and the presence of artificial structures, making habitat preference associations with trapping data problematic (Winchester 2007).

Crucial components of KLWR habitat include materials for building stick nests and ample cover (Rainey 1956). More recently, however, KLWRs have been found to occupy areas without obvious stick nests, instead using rock crevices, solution holes, abandoned cars, refuse, or rock piles for the basis of their nests (Goodyear 1985; Service 1999). Over 150 supplemental nest structures (constructed of rock, wood, and recycled materials) have been placed within Crocodile Lake National Wildlife Refuge, with approximately 33 percent of these in use (Potts 2008a).



## 2. Five-Factor Analysis

### a. Present or threatened destruction, modification or curtailment of its habitat or range:

*Habitat loss, fragmentation, degradation.* The KLWR is inseparably linked to its hardwood hammock habitat. This unique community, characterized by thin soils, relatively low rainfall, and dense, impenetrable vegetation, is the dominant forest type in the Florida Keys. The hardwood hammock provides food, vegetative cover, material for nest sites, and other biotic and abiotic resources upon which the KLWR depend.

Historically, areas where KLWRs were extirpated would be recolonized as population densities increased and dispersal occurred from adjacent populated areas. As agriculture and urbanization has fragmented the landscape, KLWRs can no longer recolonize these areas as they did in the past. The KLWR requires a minimum habitat size for daily activities; barriers caused by habitat loss and fragmentation compromise their ability to disperse, obtain food and nest site resources, locate a mate, and carry out natural life history behaviors. The ease with which resources can be attained directly affects survival rates, fecundity, juvenile recruitment, and ultimately, population growth rate.

Isolation of small populations also reduces or precludes gene flow between populations and can result in the loss of genetic diversity. Demographic factors such as predation, diseases, and competition are intensified in small, isolated populations which may be rapidly extirpated by these pressures. Especially when coupled with events such as tropical storms, reduced food availability, and/or reduced reproductive success, isolated populations may experience severe declines or extirpation (Caughley and Gunn 1996).

The scope and severity of this threat are high. This threat also increases the severity of all other threats addressed subsequently.

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*Availability of nest sites.* Like eastern woodrats, KLWRs may be more limited by the availability of nest sites than by food (Service 1999). The destruction of hammock trees or the energy cost and predation risk involved with construction may be affecting the woodrats' ability to build its large stick nests. While an estimated 20 percent of KLWR nests occur in fallen logs or root systems, free-standing stick nests appear to be absent from north Key Largo (McCleery 2006a, Winchester 2007).

The scope and severity of this threat are not known. As artificial substrate (rock and debris piles) may be selected over natural nest material because it provides more protection from predators, this threat is coupled with the threat of increased predation pressure (II.C.2.c. Disease and predation).

*Invasive exotic plants (IEP).* Significant resources have been applied to IEP

control in the Keys. The Service carries out an IEP control program throughout Crocodile Lake National Wildlife Refuge. Dagny Johnson Key Largo Hammock Botanical State Park is a member of the Florida Keys Regional Working Group that has developed a control plan for IEP on public lands including the state park. The Nature Conservancy and the Florida Keys Invasive Exotics Task Force also conduct complementary programs on other public and private lands. IEP currently do not appear to be a significant threat to KLWR habitat, and the severity of this threat is low.

**b. Overutilization for commercial, recreational, scientific, or educational purposes:** Not known as a threat. Although scientific research does involve trapping and taking genetic samples (i.e., removal of tail tips to obtain a blood sample), only two KLWRs are known to have died as a result of scientific research (Greene 2008).

**c. Disease or predation:**

*Disease.* Raccoon roundworm (*Baylisascaris procyonis*), while a concern for other woodrat subspecies, has not been reported in south Florida (Forrester 1992). Surveillance for the raccoon roundworm was initiated on Key Largo in 2002, and there is no evidence that this parasite is present within the range of the KLWR (McCleery et al. 2005). As this roundworm is a common parasite of raccoons throughout much of North America and usually results in death in woodrat species (Logiudice 2001), the severity of this threat is high, while the scope remains low.

There are a wide variety of other diseases and parasites that might infect the KLWR, but we lack evidence of the presence of such diseases or parasites. Additional parasite and disease surveillance effort is necessary to evaluate this potential threat.

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*Predation.* KLWRs have a number of natural predators: raptors, corn snakes (*Elaphe guttata*), diamondback rattlesnakes (*Crotalus adamanteus*), Florida black racers (*Coluber constrictor priapus*), Keys rat snakes (*Elaphe obsoleta deckerti*), owls, and raccoons (*Procyon lotor*). Nonnative predators include free-roaming domestic cats (*Felis catus*), fire ants (*Solenopsis invicta*), and Burmese pythons (*Python molurus bivittatus*).

One of the largest feral cat colonies is operated adjacent to the Dagny Johnson Key Largo Hammocks State Botanical Site, yet there have not been comprehensive or continuous free-roaming cat control efforts in place within the range of the KLWR. Limited cat control has been undertaken in the past on Crocodile Lake National Wildlife Refuge and Dagny Johnson Key Largo Hammocks State Botanical Site. However, it was usually instituted on a small scale, and only targeted a few individual cats. To aid recovery efforts of both KLWR and Key Largo cotton mice, the Service funded a successful larger-scale control effort that was conducted in the winter of 2004 (USDA 2004).

Raccoons, while a natural predator, are attracted to areas with feral cat colonies due to regular feedings. This factor, in addition to the general attraction of raccoons to garbage, has likely led to elevated densities of raccoons in North Key Largo (USDA 2004).

Seven non-native Burmese pythons have been captured in Key Largo since April 2007, and predation of KLWRs by Burmese pythons was documented in 2007 (Snow 2008). An eradication program for this non-native predator is in place, but largely relies on reports from the public. Intra-agency partnerships have developed to assess ecological risks, encourage responsible pet ownership, organize exotic pet amnesty days and media campaigns, and form a rapid response team. To specifically protect the KLWR, the Service has funded a USGS project that includes a multi-faceted effort to detect and control Burmese pythons on Key Largo using visual surveys and several types of experimental traps to capture pythons.

Predation of KLWRs where recruitment is sufficient and suitable habitat is available is not a concern. Conversely, increased predation pressure on isolated populations from natural and non-native predators can have a substantial impact. The drastic decline of Allegheny woodrats (*N. magister*) in Pennsylvania was attributed primarily to predation by great horned owls (*Bubo virginianus*) and exposure to raccoon roundworms (Balcom and Yahner 1996). In addition, due to their moderate size and mostly terrestrial mode of life, KLWRs may be particularly vulnerable to predation. In light of the increased level of native predators (USDA 2004), the addition of non-native predators, and the direct relation of this threat to mortality, the severity and scope of this threat are high.

**d. Inadequacy of existing regulatory mechanisms:** Information regarding past significant regulatory activities involving KLWR can be found within the recovery plan (Service 1999). A summary, with the addition of updated information, is provided below.

*FEMA flood insurance consultation.* On August 25, 1994, the United States District Court for the Southern District of Florida directed the Federal Emergency Management Agency (FEMA) to consult with the Service to determine whether implementation of the National Flood Insurance Program in Monroe County was likely to jeopardize the continued existence of federally listed species (Case No. 90-10037-CIV-MOORE). In 2003, the Service issued a jeopardy biological opinion with reasonable and prudent alternatives that required Monroe County to consult with the Service before issuing building permits in suitable habitat for listed species. Thus, in recent years, the Service provided technical assistance on pertinent projects (virtually all building applications on private parcels throughout the range of the KLWR, excluding Coastal Barrier Resource Act zones). On September 9, 2005, the Court ordered an injunction against FEMA issuing flood insurance

on any new developments in suitable habitat of federally listed species, and required the Service to submit a revised biological opinion within nine months (deadline later extended to August 9, 2006). Because the Court ruled that the 2003 reasonable and prudent alternatives were invalid, Monroe County was no longer required to consult with the Service before issuing building permits in suitable habitat and the Service suspended technical assistance on building permit applications.

The Service finalized its reanalysis of the National Flood Insurance Program in Monroe County, and provided a biological opinion to the Court on August 8, 2006 (Service 2006). The biological opinion provides a revised strategy for implementing regulatory actions pertaining to threatened and endangered species. This strategy includes clarification of FEMA's oversight role and a more comprehensive strategy of evaluating potential impacts. The latter incorporates a lot-by-lot assessment of potential impacts that takes into account the limitations on development imposed by the County's Rate of Growth Ordinance (ROGO) system with its new designations of geographical tiers. In the biological opinion, the Service concluded that continued administration of the National Flood Insurance Program in the Keys was not likely to jeopardize the continued existence of the KLWR. The Court will determine whether to accept the biological opinion and whether to lift the prohibition on FEMA's issuance of flood insurance in Monroe County.

*State and county regulations.* The KLWR is listed by the FWC as endangered (Chapter 39-27, Florida Administrative Code). This legislation prohibits take, except under permit, but does not provide any direct habitat protection. Wildlife habitat is protected on FWC wildlife management areas and wildlife environmental areas according to Florida Administrative Code 68A-15.004. Florida Park Service regulations prohibit take of specimens and destruction of vegetation (i.e., habitat) on park property without a permit.

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The State of Florida has compelled the Monroe County Board of Commissioners to strengthen controls on land use since at least 1975 when the Keys were designated an Area of Critical State Concern. A critical regulatory factor is the level of service on U.S. Highway 1 as it relates to hurricane evacuation time. The County developed a (ROGO) that, as of March 2006, incorporated a land tier system that specifically designates areas of native habitat for listed species, including the KLWR. The process made it more costly to destroy habitat and now discourages development in unfragmented habitat, steers available permit allocations to disturbed areas that are poor habitat for native fauna, and implements a land acquisition program for areas with native vegetation, including KLWR habitat.

Monroe County's Comprehensive Land Use Plan (March 2007) states that development within hammock "shall be reviewed to ensure the functional integrity of the entire hammock" and development proposals within this

habitat type “shall identify the extent to which the area is habitat for threatened or endangered species” and adverse impacts to “the functional integrity of the hammock or pineland in which development is to be undertaken, the developer shall provide for mitigation in an amount greater than the area disturbed in the form of replanting disturbed areas with native species or by the acquisition and preservation, including donations, of land containing comparable quality and character of vegetation as the area disturbed.”

Pressure to develop remaining residential and commercial land within the range of the KLWR continues. However, development is subject to regulatory oversight by Monroe County (e.g., the ROGO), the State (e.g., designated an Area of Critical State Concern), and the Service (e.g., ESA consultation, presumably including continued consultation with FEMA regarding administration of the National Flood Insurance Program). Regulatory mechanisms have reduced the threat of further habitat loss in north Key Largo.

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

*Competitors.* The presence of competitors, particularly non-native species, is a significant influence on habitat suitability. Trash dumping occurs throughout the KLWR’s range and attracts human commensals. In the past, black rats (*Rattus rattus*) were captured at equal or greater numbers as KLWRs on hammock study sites (Hersh 1981) and thought to be a serious competitor, but subsequent trapping sessions have yielded very few captures of black or Norway rats (*Rattus norvegicus*) (Barbour and Humphrey 1982; Goodyear 1985). Gambian giant pouch rats (*Cricetomys gambianus*), the largest murids, were unintentionally released in Marathon, Florida in 1999. Possible sightings on Key Largo have not been confirmed with trapping (Engeman et al. 2006), but due to their large size, high fecundity, and similar food and nest site requirements, their impact on KLWR would be extensive. An eradication program initiated in Marathon appears to have been successful, though the pouch rats could emigrate by several means (Engeman et al. 2006). Furthermore, the hurricanes of 2005 may have assisted in their dispersal to nearby islands. The severity of this threat is high, while the scope remains moderate.

*Hurricanes.* Hurricanes influence vegetational succession in the Florida Keys. Undisturbed hammocks are presumably more resistant to storms than hammocks that have been fragmented or have had surrounding mangrove and transitional vegetation removed. Damage to habitat from past hurricanes has included windshear, significant canopy loss, uprooting of large trees, understory damage, and significant soil disturbance. Extensive damage represents habitat loss to KLWR, but some disturbance serves to open habitat and allow for greater plant diversity. The severity and scope of this threat are variable and stochastic.

*Sea level rise.* Sea level rise has been shown to affect conversions of upland communities with low soil and moisture salinities to communities comprised of more salt tolerant plant species and higher soil and groundwater salinities (Ross et al. 1994). This phenomenon may potentially result in the loss of suitable KLWR habitat through inundation or vegetative species composition changes. The general effects of sea level rise within the range of the KLWR will depend upon the rate of rise and landform topography. However, the specific effects across the landscape will be affected by complex interactions between geomorphology, tides, and fluctuations in energy and matter. These effects have yet to be simulated and projected for the range of the KLWR. The imminence of this threat is low, but the severity remains unknown.

**D. Synthesis** - No change is recommended to the listing classification of the endangered KLWR. The degree of threat to its persistence remains high. It is a subspecies with high level of taxonomic distinctness, and its potential for recovery is considerable if threats can be eliminated or minimized.

Impacts and potential threats to the KLWR and its habitat have increased in the recent past from non-native predators and competitors. With these additional stresses, KLWR habitat is in poor condition and populations are currently fragile. Specifically, about 880 ha of KLWR habitat is protected on north Key Largo. Trends from trapping data suggest a population decline for the last 20 to 25 years (FWC 2005; McCleery et al. 2006b; Winchester 2007). A consistent reduction in the distribution of KLWRs on North Key Largo is occurring as well.

Regulatory mechanisms are in place to track impacts to KLWR habitat and aid in minimizing impacts from development on public lands. However, the subspecies' minimum requirements for habitat connectivity, food and nest site resources, and other factors may already be underprovided. Free-roaming cat control programs have occasionally been in place on public lands since 2002, and non-native predators continue to pose a major threat.

Through several years of research and continuous monitoring, researchers have identified a suite of possible causes for the continuous decline in the KLWR population. Beyond the severe constriction in available habitat, the threat most limiting KLWR population growth is not known. Availability of potential nest sites, non-native predators, and genetic issues are suspect. Remedial measures, including captive propagation, have been developed for the subspecies, but the decline continues and new threats have emerged.

### III. RESULTS

#### A. Recommended Classification:

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

#### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Old and abandoned roads bisecting hammock habitat should be restored to native vegetation. Research may be warranted to develop restoration techniques effective in this unique environment.
- The 1999 Recovery Plan should be revised and updated to reflect the current status and threats to the KLWR, and recovery criteria, objectives, and tasks should be developed or revised.
- Genetic analyses should be conducted to provide further insight into the current KLWR population. Information on the genetic diversity of the population and the genetic makeup of individual KLWRs will provide insight into the current status of the population.
- Opportunities to convey the importance of hammock habitat to the public should be sought and pursued. Interpretive signs could be designed and distributed to public land managers on North Key Largo. In addition, an outreach/education program focused on the threats free-roaming cats and exotic pets pose to wildlife should also be developed.
- Appropriate parcels for land acquisition should be identified using current knowledge of KLWR movements and habitat use.
- Captive propagation and reintroduction efforts should continue to develop techniques and methods appropriate for KLWRs.
- Further examination of nest sites potentially limiting the KLWR may be warranted. Natural nest materials may be provided in areas occupied by KLWRs to aid in natural nest construction. Ex situ research may be appropriate to determine possible causes for nest site selection.
- Information concerning the diet of KLWR would aid in habitat restoration, land acquisition, and captive propagation efforts. Identifying foraging patterns may allow for better assessment of KLWR's perception and response to predation risk and provide detailed movement information. Data from previous research could be reanalyzed to provide insights into habitat use. In addition, vegetation surveys measuring several habitat parameters may be important to determine factors influencing habitat use.
- Additional information is required concerning potential disease agents and health problems that may afflict KLWRs. Rodents from Key Largo should be screened for a variety of diseases, when considered appropriate. Tentative agreements with the University of Florida - College of Veterinary Medicine, Gainesville, Florida and with the National Wildlife Health Center, Madison, Wisconsin, would allow for such investigations.
- Research focused on determining the relative abundance of KLWR predators, their influence on KLWR behavior, and their effect on survival and recruitment rates is warranted. Predator management strategies and/or more comprehensive predator control should be investigated if appropriate.

## V. REFERENCES

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW OF THE KEY LARGO WOODRAT (*Neotoma floridana smalli*)**

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 Sandra Sneckenberger

**FIELD OFFICE APPROVAL:**

Lead Field Supervisor, Fish and Wildlife Service

Approve [Signature] Date 7-21-08

*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.*

**Lead Regional Director, Fish and Wildlife Service**

Approve [Signature] Date 9/25/08

*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 Key Largo Woodrat (*Neotoma floridana smalli*)**

**A. Peer Review Method:** Recommendations for peer reviewers were solicited from the Florida Fish and Wildlife Conservation Commission, the U.S. Forest Service, a nonprofit environmental center, and a private consultant. Four peer reviewers were asked to participate in this review. Individual responses were requested and received from two of the four peer reviewers.

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

### **C. Summary of Peer Review Comments/Report**

One reviewer noted that since woodrats have been captured where nests were not found, reporting a “complete absence of nests” may be a mischaracterization.

One reviewer felt the discussion of remaining and potential habitat was unclear. Specifically, the reviewer felt it was confusing as to whether the habitat was suitable but unoccupied or unsuitable and unoccupied. Also, the reviewer felt the statement should have a citation.

One reviewer suggested the inclusion of language to reflect Florida State Park regulations.

One reviewer felt that more studies focused on the related eastern woodrat could be incorporated into the review, particularly in terms of habitat use, denning habitat, food habitats, and conservation genetics.

One reviewer felt that the trapping success presented (i.e., number of grids with captures and percentage of grids with captures) appears to be an abstraction and more specifics should be provided in the review.

One reviewer suggested examining data from previous studies using an Euclidean distance approach to assess habitat use and requirements. This reviewer also suggested comparative vegetation studies to investigate habitat preferences or factors influencing habitat use.

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One reviewer supported the basic premise that habitat loss and overabundant predators are likely responsible for the subspecies’ decline.

One reviewer noted that the use or preference for hammock age is unclear in the literature and noted in the status review. This reviewer finds habitat use/ preference constitutes the greatest scientific uncertainty with respect to KLWR other than population size.

One reviewer questioned whether a more comprehensive predator control program should be considered.

### **D. Response to Peer Review:**

The discussion of nest abundance was modified to reflect the fact that nests were likely present (perhaps at low densities) and not observed.

After reviewing the section of the review pertaining to habitat (II.C.e.), the text appears unambiguous; other than providing a citation, no modifications were made to the text.

Language was added regarding Florida State Park regulations.

As this is a thorough, but not exhaustive, review of the status of the KLWR, this document did not address all topics or include all information pertinent to KLWR. KLWR studies were used to address the focused sections of the review. If KLWR research or information is not available, studies of the related eastern woodrat were used if deemed applicable. Use of eastern woodrat information versus KLWR data was clearly denoted within the document.

As stated in the review, population trends are difficult to interpret from the various study designs and estimation techniques. The intention of the inclusion of such trapping information was to loosely establish the declining trend. Discussion of the study designs of the research project cited is beyond the scope of this status review.

Suggested future research topics regarding habitat use and predator management were incorporated into the recommendations section.

## **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.
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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).