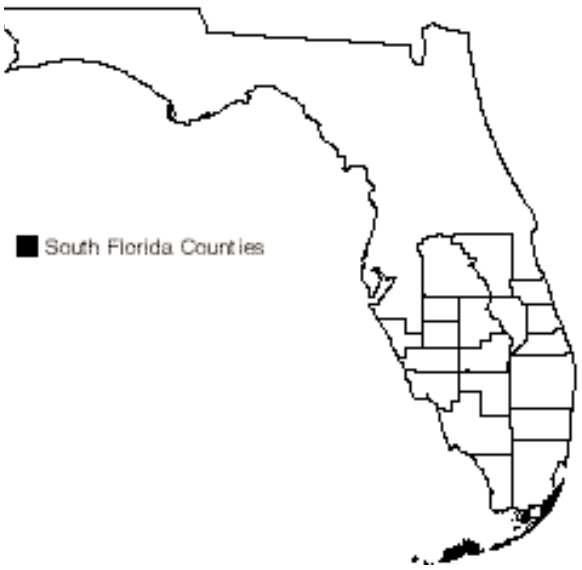
Key Largo Woodrat

Neotoma floridana smalli

Federal Status:	**Endangered (August 31, 1984)**
Critical Habitat:	**None Designated**
Florida Status:	**Endangered**
Recovery Plan Status:	**Original (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. Distribution of the Key Largo woodrat; this species is endemic only to Key Largo in the Florida Keys.



The Key Largo woodrat resides in tropical hardwood hammocks on Key Largo. This small endemic rodent once ranged throughout all of Key Largo, but today is limited to the northernmost portions. Known for its habit of building large stick houses, Key Largo woodrats depend heavily on the natural vegetation of the tropical hardwood hammocks to obtain material for constructing these houses. Although large portions of the remaining habitat are now in protection, there has been such a reduction in its total range and habitat that the future of this species remains in an endangered condition.

This account represents the range-wide recovery plan for the Key Largo woodrat.

Description

The color of the Key Largo woodrat is described as sepia or grey-brown above shading into cinnamon on the sides, with cream or white ventral coloration. The forefeet are white to the wrist and the hindfeet are primarily white to the ankles. The Key Largo woodrat has large ears, protuberant eyes, and a hairy tail. The head-and-body-length of the Key Largo woodrat ranges from 120 to 230 mm, their tail length ranges from 130 to 190 mm, and their hindfoot length ranges from 32 to 39 mm. Males, on average, weigh 258 g, while the females tend to be much smaller, weighing only 210 g (Hersh 1981).

Taxonomy

Key Largo woodrats are endemic to Key Largo, Monroe County, Florida and represent the southernmost subspecies of the eastern woodrat *(Neotoma floridana)*, which occurs widely in the eastern United States. Woodrat houses from Key Largo were first reported by Small (1932), after whom the subspecies is named, and later described in more detail

by Schwartz (1952a). The Key Largo woodrat was distinguished as a separate subspecies by Sherman (1955) and later confirmed by Schwartz and Odum (1957).

Distribution

The Key Largo woodrat is restricted to the northern one-third of Key Largo and is separated from other United States woodrat populations by the southern third of the Florida peninsula (Hersh 1981) (Figure 1). Key Largo is the first and largest of the chain of keys or islands of the Florida Keys. Woodrats formerly occurred throughout uplands on all of Key Largo, but are now restricted to tropical hardwood hammocks on north Key Largo, representing about one-half of their original distribution (Brown 1978a, 1978b; Barbour and Humphrey 1982). Key Largo woodrats were once believed to be restricted to mature hammocks, but are now known to use a variety of microhabitats within tropical hardwood hammocks. Schwartz (1952b) captured woodrats near Rock Harbor in the south portion of Key Largo; however, attempts to collect it there in recent years have been unsuccessful (Barbour and Humphrey 1982). Goodyear (1985) also trapped woodrats slightly outside the range delineated by Barbour and Humphrey, documenting the species' presence in the Garden Cove area northeast of the U.S. Highway 1-C.R. 905 intersection. A population of Key Largo woodrats was introduced and established in 1970 on Lignumvitae Key (Brown and Williams 1971, Barbour and Humphrey 1982), but that population has since been extirpated.

Habitat

The Key Largo woodrat is a resident of tropical hardwood hammocks, the climax vegetation of upland areas in the Keys. Hammocks provide a shady, humid microclimate with less wind and temperature variation than more exposed habitats. The soils are poorly developed, typically consisting of shallow humus and litter overlying the limestone substrate, but may become deep in some forested areas.

Tropical hardwood hammocks on Key Largo include a greater number of tropical plants than hammocks on the mainland. Most of these tropical species are West Indian shrubs and trees with a variety of vine species from temperate North America and the West Indies. Tropical hardwood hammock canopy ranges from 9 to 12 m in height. Canopy trees include black ironwood (*Krugiodendron ferreum*), gumbo limbo (*Bursera simaruba*), Jamaican dogwood (*Piscidia piscipula*), mahogany (*Swietenia mahagani*), pigeon plum (*Cocoloba diversifolia*), poisonwood (*Metopium toxiferum*), strangler fig (*Ficus aurea*), and wild tamarind (*Lysoloma latisiliquum*). Tropical hardwood hammock understory contains torchwood (*Amyris elemifera*), milkbark (*Drypetes diversifolia*), wild coffee (*Psychotria undata*), marlberry (*Arisia escallonioides*), stoppers (*Eugenia* spp.), soldierwood (*Colubrina elliptica*), crabwood (*Gymnanthes lucida*), and velvetseed (*Guettarda scabra*). Ground cover contains yellowroot (*Morinda royoc*) and snowberry (*Chicocca parviflora*).

Key Largo woodrat.
Original photograph by Phil Frank.

Vegetative composition and structure influence density and distribution of woodrats by affecting their ability to find food resources, nest materials, and secure cover. The two most important aspects of woodrat habitat are materials for building stick nests and ample cover (Rainey 1956). Stick nests are used for resting, feeding, and breeding, and ground cover provides travel and escape routes.

Behavior

The Key Largo woodrat, like other members of the genus *Neotoma*, is known for its habit of building large stick nests (Brown 1978b). Woodrats typically excavate humus at the base of a tree to build their large stick nests, which can be 1.2 m in height and 2 to 2.5 m in diameter. The woodrat constructs its nest out of sticks, twigs, and various other objects 2.5 to 7.6 cm in diameter that are piled into mounds in an irregular fashion. They frequently build their nests against a stump, fallen tree, or boulder and may also use old sheds, abandoned cars, rock piles, and machinery as nest sites. Their nests have several entrances and a single, central nest chamber. Normally, only one adult Key Largo woodrat inhabits a nest and one animal may use several nests. Eastern woodrats continually maintain and repair their stick houses, which may be used by several generations and can be enlarged over time with increased use (Rainey 1956). Goodyear (1985) found that Key Largo woodrats occupied some areas on north Key Largo without obvious stick nests, although she noted that the animals had at least a few sticks placed at the entrance to rock crevices they used for their nests. During a 1995 joint GFC and FWS survey, stick nests were absent from North Key Largo but woodrats were present. It appears they are nesting below ground in solution holes and in the root systems of large trees (Frank *et al.* 1997).

Key Largo woodrats are probably similar to eastern woodrats that interact socially with some form of social hierarchy, and they may exhibit territorial defense behaviors at individual nest sites (Kinsey 1977). Defensive behaviors are usually dependent on age, sex, season of the year, and the availability of nest sites (Kinsey 1977). During breeding periods, females actively search for nest sites and defend their nests, while the males tend to be less aggressive. Males and young woodrats are more submissive and avoid encounters with territorial woodrats. During cooler periods, males may become more aggressive and competitive in their search for nest sites.

Similar to other woodrats, Key Largo woodrats have overlapping home ranges. Hersh (1978) reported that the mean home ranges of six male and four female Key Largo woodrats were about 2,370 m^2, which is comparable to the home range of other *Neotoma floridana* populations. Following dispersal, Key Largo woodrats are believed to remain within their new home range as is the case with eastern woodrats.

Key Largo woodrats appear to reach their highest densities in mature hardwood hammocks (FWS 1973, Brown 1978b, Barbour and Humphrey 1982, Hersh 1981). The woodrats will use younger hardwood hammocks and disturbed areas adjacent to mature hammocks, but occur at lower densities (Goodyear 1985, Humphrey 1988). Younger stands of hardwood hammock have significant evidence of woodrat nesting activity. Key Largo woodrats are active climbers, spending considerable amounts of time in trees (Goodyear 1985). Key Largo woodrats also seem to have definite trails and often use fallen trees to move over the forest floor (Goodyear 1985, Hersh 1978).

Reproduction

The Key Largo woodrat is capable of reproducing all year, although seasonal peaks in winter are evident (Hersh 1981). Key Largo woodrat litter sizes range from one to four young, with two most common. Female woodrats can produce two litters a year (Brown 1978b). Sex ratio favors 1.2 : 1 male to female (Hersh 1981). Both sexes require about 5 months to reach sexual maturity (Hersh 1981). The life expectancy of the Key Largo woodrat is unknown, but is probably similar to other subspecies of *Neotoma floridana,* which may live for 3 years but probably average less than 1 year (Fitch and Rainey 1956, Goertz 1970).

An alteration in food availability can result in a higher mortality and reduced growth rate of nestlings and may produce a sexual bias in growth and mortality that favors female nestlings. McClure (1981) found this brood reduction strategy for eastern woodrats was an adaptative response to limited food resources, where Sikes (1995) did not find any sex bias behaviors, but instead found a reduction in fitness of large litters whose mothers experience limited food availability. It is likely that eastern woodrat mothers have the ability to assess resource conditions and respond in a way that maximizes their own fitness. Key Largo woodrats may be capable of responding to resource changes in a similar way.

Key Largo woodrat densities on north Key Largo have been variously estimated at 1.2 animals/ha (Brown 1978b), 2.2/ha (Barbour and Humphrey

1982), 2.5/ha (Hersh 1981), and 7.6/ha (Humphrey 1988). The large differences in the density estimates of Barbour and Humphrey (1982) and Humphrey (1988) apparently result from differences in sampling techniques. The methods used by Humphrey (1988) are statistically based and may provide the most reliable estimate of population densities. Overall, Key Largo woodrat populations occur in low densities but are highest in mature forest (Barbour and Humphrey 1982). Both male and female densities follow a similar pattern of gradual increase in late summer to early fall (Hersh 1981). Populations adjacent to housing complexes usually have much lower densities (3.1/ha), than areas removed from development (12.2/ha).

Foraging

Key Largo woodrats are nocturnal omnivores, but feed primarily on a variety of leaves, buds, seeds, and fruits (Brown 1978b). They are dependent upon the diversity of tropical hardwood fruits. Other woodrat species cache foods such as seeds and acorns for long periods of time (Post and Reichman 1991), but it is not known if Key Largo woodrats cache food items. Eastern woodrats primarily exhibit opportunistic feeding behaviors, eating any suitable food items available, although some selective foraging preferences seen may be due to palatability, nutritional quality, or perishability of food items (Post and Reichman 1991, McMurray *et al.* 1993). Eastern woodrats are able to discriminate between food items based on their perishability and decide what food items should be ingested immediately or stored for later consumption (Reichman 1988).

Relationship to Other Species

Hardwood hammocks and adjacent habitats on Key Largo support four other federally listed animals: American crocodile (*Crocodylus acutus*), eastern indigo snake (*Drymarchon corais couperi*), Key Largo cotton mouse (*Peromyscus gossypinus allapaticola*), and Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*). Similarly to the Key Largo woodrat, indigo snakes, cotton mice, and Schaus butterflies also rely on the unique habitat components of the tropical hardwood forests on Key Largo. In addition, there are at least seven state-protected animals, and 20 state-listed plants, such as the threatened white-crowned pigeon (*Columba leucocephala*) and Miami black-headed snake (*Tantilla oolitica*) and the endangered lignumvitae tree (*Guaiacum sanctum*), prickly apple (*Cereus gracilis*), tamarindillo (*Acacia choriophylla*), powdery catopsis (*Catopsis berteroniana*) and long strap fern (*Campyloneurum phyllitidus*). The Key Largo woodrat uses many of these plants for building stick nests, shelter, or foraging.

Status and Trends

The Key Largo woodrat was first listed as a threatened species under the Endangered Species Conservation Act of 1969, affording the woodrat protection on Federal lands. The Key Largo woodrat was recognized as a candidate for

listing in a notice of review on July 28, 1980 (45 FR 49961). The woodrat was listed as endangered for 240 days on September 21, 1983, through an emergency listing action (48 FR 43040). The emergency listing was necessary to provide full consideration of the welfare of this species during a FWS consultation with the Rural Electrification Administration. The proposed action was construction of a residential housing project that would result in accelerated habitat loss.

The Key Largo woodrat was proposed for listing as an endangered species with critical habitat on February 9, 1984 (49 FR 4951) and was finally listed as endangered on August 31, 1984 (49 FR 34504). The proposal to designate critical habitat was withdrawn on February 18, 1986 (51 FR 5746). Effects of residential housing and commercial construction activity in tropical hardwood hammocks have been more extreme in the Upper Keys than in the Lower Keys. By 1991, 41.2 percent of the deciduous seasonal forests (1,985 ha) had been either cleared or filled to meet human needs (Strong and Bancroft 1994). Today, Key Largo has the highest concentration of platted lots (4,178), comprising 72 percent of all lots in the Upper Keys. Although much of northern Key Largo is protected, there are still areas where development could occur. An analysis of this area showed that 775 ha of vacant, dry, privately held lands with development potential remains (Monroe County 1989). South Key Largo has experienced extensive habitat destruction and fragmentation.

The Key Largo woodrat historically occurred throughout the forested uplands of Key Largo, but is currently restricted to approximately half of its historic range, now occurring only north of the U.S. Highway 1-C.R. 905 intersection. The decline in the woodrat's range and apparent extirpation of this species from Key Largo south of the U.S. 1-C.R. 905 intersection has been generally attributed to land clearing followed by residential and commercial development (Brown 1978a, b; Hersh 1981).

The primary threat to the Key Largo woodrat is habitat loss and fragmentation caused by increasing urbanization. Hammock vegetation on Key Largo has been removed or thinned by construction practices that remove all vegetation, then grade and fill the limestone substrate. In addition to land clearing practices, there are other threats to the hardwood hammock habitat resulting from human encroachment that also indirectly affect the woodrat. Increasing habitat fragmentation, combined with a decreased range, makes the Key Largo woodrat more vulnerable to genetic isolation, and to natural catastrophes such as hurricanes or fire (FWS 1993). Other threats associated with human encroachment, include predation by feral cats, dumping of trash, and competition with black rats.

Remaining hardwood hammock habitats are critical for the survival of the Key Largo woodrat. Brown (1978b) estimated that only about 120 to 160 ha of hammock suitable for woodrats remained on north Key Largo. Barbour and Humphrey (1982) estimated that 475 ha remained there, supporting an estimated 654 woodrats. Humphrey (1988) estimated that 851 ha of remaining forest supported average densities of 3.1 woodrats per ha. The numbers appear to have decreased since then, and the population may have been at high point in 1984. The Key Largo woodrat was considered to be extirpated from Lignumvitae Key by 1997 (Frank *et al.* 1997). A 1995 GFC survey shows a decline of the rat

toward the southern end of its range.

Eastern woodrats appear to be more limited by availability of shelter than by food, which may also be true for Key Largo woodrats. The destruction of hammock trees can directly affect the woodrat's ability to build its large stick nests which provide a place for shelter, nesting, feeding, and breeding. The availability of stick nest material and ground cover may be essential for the woodrat's survival. Loss of hammock trees also results in the loss of arboreal habitat used by this species. Sufficient available habitat is also necessary for the development of social interactions and systems of organization (Kinsey 1977). Where shelter is sparse and stick nests are limited, territorial and competitive behaviors are exhibited more frequently. These behaviors result in a breakdown of social organization and aggressive behaviors that may result in death or casting out of subordinate animals (Kinsey 1977, McClure 1981).

Although woodrats are omnivorous, habitat destruction or degradation directly affects food resources and the ability of woodrats to forage. Without adequate nutrition, reproductive behaviors may be impaired. Under normal conditions, some small mammal mothers expend lactation energy equally between male and female offspring, but when food resources are limited, the mothers tend to a greater bias for nursing female young over males (McClure 1981). If Key Largo woodrat mothers are faced with limited food resources, then they may respond similarly by either favoring female offspring, or reducing the fitness of large litters. Either way, a reduction in fitness in the young may be a maternal response to adverse environmental conditions (Sikes 1995).

Physical separation caused by habitat loss and fragmentation makes it increasingly difficult to locate a mate and can isolate populations. Any lack of recruitment of juveniles into the population will result in a decline of the population. Small, isolated populations are subject to inbreeding depression, which can cause populations to decline over time. An increase in urbanization also results in an increase in the need for roads that separate and fragment habitats. The woodrat requires a minimum habitat size for daily activities; habitat destruction can directly reduce home range size and disrupt movement and dispersal patterns. The hammocks on north Key Largo are already bisected by a high-speed road (C.R. 905), which disrupts the integrity of the hammocks and causes road mortality of dispersing woodrats.

Trash dumping occurs throughout the woodrat's range. Actual debris may not greatly affect Key Largo woodrats; however, dumping may encourage invasion by black rats (*Rattus rattus*). Rodent control agents used for black rats or Norway rats also pose a threat to the woodrat (FWS 1993). Hersh (1981) suggested that the introduced black rat might be a serious competitor for the Key Largo woodrat because black rats equaled or exceeded Key Largo woodrat numbers at her study site. Barbour and Humphrey (1982), however, collected only one black rat in 1,696 trap nights, while Goodyear (1985) collected only two black rats at 45 trap sites. Competition between the two species is possible, but the extent of these effects is not known.

Eastern woodrats are believed to be highly susceptible to predation because of their moderate size and terrestrial mode of life (Rainey 1956). Key Largo woodrats are vulnerable to predation for the same reasons from such

potential predators as red-shouldered hawks (*Buteo lineatus*), bobcats (*Lynx rufus*), corn snakes (*Elaphe guttata*), diamondback rattlesnakes (*Crotalus adamanteus*), eastern indigo snakes (*Drymarchon corais couperi*), Florida black racers (*Coluber constrictor priapus)*, Keys rat snakes (*Elaphe obsoleta deckerti*), barn owls (*Tyto alba)*, raccoons (*Procyon lotor*) and feral and domestic cats. Natural and increased levels of predation pose a major threat to the survival of these rodents. The drastic decline of Allegheny woodrats in Pennsylvania was attributed primarily to predation by great horned owls and exposure to raccoon roundworms (Balcom and Yahner 1996). Key Largo woodrats may also be susceptible to raccoon roundworms.

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. On August 1992, Hurricane Andrew hit Elliott Key, a few miles north of north Key Largo. The northern one-third of Key Largo suffered the most extensive damage, with about 240 to 280 ha affected. The area of greatest impact, comprising about 80 ha, suffered 70 percent canopy loss. Damage included windshear, uprooting of large trees, understory damage, and significant soil disturbance.

Recent surveys of woodrats on Northern Key Largo have been discouraging. In 1997 and 1998, only 6 and 7 animals were trapped, respectively, after 1500 trap nights of effort (S. Klett, FWS, personal communication 1998). It is expected that the results of habitat fragmentation, combined with other threats, and the effects of Hurricane Andrew and Hurricane Georges may have reduced the population below a minimum threshold needed to rebound.

Management

In an attempt to curtail the decline of the Key Largo woodrat population, 19 Key Largo woodrats were introduced to Lignumvitae Key in 1970 (Brown and Williams 1971). Although woodrats are not native to Lignumvitae Key, the hammock habitats of this key are similar to those of Key Largo. The woodrat population on Lignumvitae Key apparently remained at low levels at least until 1977, when Hersh (1978) found only six stick nests. Barbour and Humphrey (1982), however, estimated that 476 stick nests and 85 woodrats were present on Lignumvitae Key in 1979. In the late 1980s, woodrats appeared to decline, and by the spring and early summer of 1990, no woodrats were taken in approximately 400 trap-nights. Little or no sign of woodrats could be found, and it appeared that the woodrat population must be at a very low level or even extirpated.

The FWS issued two Biological Opinions, pursuant to section 7 of the ESA, with regard to Federal activities on north Key Largo that had a considerable impact on the future of development. The first opinion addressed Farmers Home Administration's financing of the Florida Keys Aqueduct Authority pipeline improvements in the Keys. The species of concern on north Key Largo were the American crocodile (C*rocodylus acutus*) and the Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*); the Key Largo woodrat and cotton mouse

were not federally listed at that time (May 1980). The Biological Opinion concluded that the crocodile and Schaus swallowtail would be jeopardized by development made possible by the greatly increased water supply to north Key Largo. As an alternative, the Farmers Home Administration chose to exclude certain areas from water delivery. These loan conditions were subsequently accepted by the Florida Keys Aqueduct Authority.

The second Biological Opinion was issued by the FWS in October, 1983. This opinion addressed the crocodile, Schaus swallowtail, and the Key Largo woodrat and cotton mouse, and found that these species would be jeopardized by the Rural Electrification Administration funding for increased electrical capacity by the Florida Keys Electric Cooperative. The FWS's concern was that increased electrical delivery capacity would facilitate development in the hammocks of north Key Largo. No new electrical hookups have subsequently been made to any of the exclusionary areas described in the Biological Opinion.

In 1984, several landowners became interested in developing a Habitat Conservation Plan for the Key Largo woodrat, pursuant to section 10(a)(B)(1) of the ESA, to allow for residential and commercial development on north Key Largo, while conserving federally listed species in the area. The planning process was initiated, involving representatives of landowners, conservation groups, and State agencies. Density and distribution studies of the Key Largo woodrat were conducted (Humphrey 1988). Subsequent public land acquisition largely precluded the need for an overall habitat conservation plan. At least two incidental take permits have been issued to subdivisions for the authorized take of Key Largo woodrats.

The most important effort to conserve the Key Largo woodrat has been public land acquisition on north Key Largo. Most undeveloped land west of C.R. 905 has been acquired by the FWS as part of the Crocodile Lake NWR, while the undeveloped land on the east side of the road has been acquired by Florida DEP's Key Largo Hammocks State Botanical Preserve. Generally, these areas have limited public access and are managed for trash removal and exotic vegetation control.

In April 1996, the FWS Multi-Species Recovery Team met to discuss the listed species in the Keys and ways to improve their status. The team determined several priority actions necessary to protect and conserve the Key Largo woodrat, including the stabilization of existing woodrat populations, protection and restoration of habitat, monitoring of existing populations and re-evaluation of its status in 5 years, secondary evaluation and minimization of impacts (cats, black rats, fire ants), and development reclassification and delisting criteria (FWS 1996).

Recently, the FWS consulted on how the administration of the National Flood Insurance Program (NFIP) by the Federal Emergency Management Agency (FEMA) affects threatened and endangered species in Monroe County. The Key Largo woodrat was one of 10 species that was determined to be affected by FEMA's actions. Prior to this consultation, FEMA did not address

listed species issues as required by section 7 of the ESA. FEMA's responsibilities to consult arise from a sequence of events that begins before a structure is designed and ends with habitat destruction or modification for the construction of residential or commercial structures. Although FEMA is not the only entity involved in this sequence of events, it still has the obligation, as a Federal agency, to ensure its actions do not jeopardize the continued existence of a listed species, like the woodrat. The FWS concluded that the continued administration of the National Flood Insurance Program by FEMA in the Keys, with its attendant effects on land-use planning and zoning and incentives for landowners, is likely to jeopardize the continued existence of the Key Largo woodrat. As a reasonable and prudent alternative to alleviate jeopardy, FEMA committed to implement procedures to ensure their actions do not jeopardize the woodrat.

In conjunction with the GFC, the FWS recently produced Geographic Information System (GIS) maps of suitable Key Largo woodrat habitat to assist in making better management decisions. Areas in private ownership that are either occupied or unoccupied by woodrats are the most vulnerable to loss. Based on our GIS analyses, only 4,877 ha of habitat remain for the Key Largo woodrat. Of this total, 4,445 ha (91 percent) are protected and 432 ha are vulnerable to urbanization. Most of this unprotected acreage occurs in the golf course of the Harbor Course residential area on north Key Largo, with a small fragment south of the marina on the western edge of the residential area (west of Gateway Road). The FWS believes all remaining occupied and unoccupied suitable habitat should be protected in order to ensure the continued existence of the Key Largo woodrat. In addition, the FWS also recommends that a 500-m buffer zone around these areas be put in place since adjacent areas are vulnerable to urbanization as well. The necessity for a protected buffer is based on the likelihood that human influences encroach upon and impact the woodrat. The distance of 500 m is based on the use of upland areas by this species and the estimated range of domestic cats. Upland and wetland buffers are important habitat because they provide connectivity between subpopulations and minimize secondary impacts such as road and cat mortality. Protection of the remaining tropical hardwood hammock areas on north Key Largo from further development is critical to the survival and recovery of the Key Largo woodrat. The National Audubon Society *et al.* (1990) identified areas of tropical hardwood hammocks throughout Key Largo for proposed acquisition by the State that would preserve the biological diversity of the hammock ecosystem. The FWS believes that protection, conservation, and management of these additional areas is critical to future actions, such as reintroduction, to recover the Key Largo woodrat.

The FWS, GFC, and the University of Miami are currently conducting a status survey of the woodrat that will provide information on the population density, population fluctuations, survival, reproduction, and movements of this species on north Key Largo (Quarterly Progress Report, FWS Research Work

Order No. 123). Other current research for the woodrat includes studies on territoriality (University of Florida) and analysis of genetic variations (University of Miami).

The FWS has placed a refuge manager at the Crocodile Lake NWR to increase the level of law enforcement, restore habitat, and protect and monitor woodrats and other species. In addition, a Student Conservation Association intern volunteer has been assisting with these duties and removing exotic

Literature Cited

vegetation at the refuge.

Balcom, B.J. and R.H. Yahner. 1996. Microhabitat and landscape characteristics associated with the threatened Allegheny woodrat. Conservation Biology 10(2): 515-525.

Barbour, D.B. and S.R. Humphrey. 1982. Status and habitat of the Key Largo woodrat and cotton mouse (*Neotoma floridana smalli* and *Peromyscus gossypinus allapaticola*). Journal of Mammalogy 63(1): 144-148.

Brown, L.N. 1978a. Key Largo cotton mouse. Pages 10-11 *in* J.N. Layne, ed. Mammals. University Press of Florida; Gainesville, Florida.

Brown, L.N. 1978b. Key Largo woodrat. Pages 11-12 *in* J.N. Layne, ed. Rare and endangered biota of Florida. Mammals. University Press of Florida; Gainesville, Florida.

Brown, L.N. and R.L. Williams. 1971. The Key Largo woodrat (*Neotoma floridana smalli*) and cotton mouse (*Peromyscus gossypinus allapaticola*) on Lignum Vitae Key, Florida. Florida Naturalist 44: 95-96.

Fitch, H.S. and D.G. Rainey. 1956. Ecological observations on the woodrat, *Neotoma floridana*. University of Kansas publications, Museum of Natural History 8: 499-533.

Frank P., F. Percival, and K. Britt. 1997. A status survey for the Key Largo woodrat (*Neotoma floridana smallii*) and Key Largo cotton mouse (*Peromyscus gossypinus allapaticola*) on north Key Largo, Monroe County, Florida. Florida Game and Fresh Water Fish Commission Final Report to the FWS, Jacksonville, Florida.

Goertz, J.W. 1970. An ecological study of *Neotoma floridana* in Oklahoma. Journal of Mammalogy 51: 94-104.

Goodyear, N.C. 1985. Results of a study of Key Largo woodrats and cotton mice: Phase I, spring and summer 1985. Unpublished report to North Key Largo Study Committee.

Hersh, S.L. 1978. Ecology of the Key Largo woodrat. M.S. thesis, University of Miami; Coral Gables, Florida.

Hersh, S.L. 1981. Ecology of the Key Largo woodrat (*Neotoma floridana smalli*). Journal of Mammalogy 62(1): 201-206.

Humphrey, S.R. 1988. Density estimates of the endangered Key Largo woodrat and cotton mouse (*Neotoma floridana smalli* and *Peromyscus gossypinus allapaticola*), using the nested-grid approach. Journal of Mammalogy 69(3): 524-531.

Kinsey, K.P. Agonistic behavior and social organization in a reproductive population of Allegheny woodrats, *Neotoma floridana magister.* Journal of Mammalogy 58(3): 417-419.

Klett, S. 1998. Telephone conversation. October 1998.

McClure, P.A. 1981. Sex-biased litter reduction in food-restricted woodrats (*Neotoma floridana*). Science 211(4486): 1058-1060.

McMurray, S.T., R.L. Lochmiller, J.F. Boggs, D.M. Leslie, Jr., and D.M. Engle. 1993. Opportunistic foraging of eastern woodrats (*Neotoma floridana*) in manipulated habitats. American Midland Naturalist 130(2): 325-337.

Monroe County. 1989. North Key Largo Habitat Conservation Plan. Growth

Management Division; Monroe County, Florida.

National Audubon Society, Florida Natural Areas Inventory, and The Nature Conservancy. 1990. Tropical Flyways, A Proposal to: Conservation and Recreational Lands (CARL), State of Florida Department of Natural Resources.

Post, D.S. and O.J. Reichman. 1991. Effects of food perishability, distance, and competitors on caching behavior by eastern woodrats. Journal of Mammalogy 72(3): 513-517.

Rainey, D.G. 1956. Eastern woodrat, *Neotoma floridana*: life history and ecology. University of Kansas Publications, Natural Museum of History 8: 535-646.

Reichman, O.J. 1988. Caching behavior by eastern woodrats, *Neotoma floridana*, in relation to food perishability. Animal Behavior 36(5): 1525-1532.

Schwartz, A. 1952a. Three new mammals from southern Florida. Journal of Mammalogy 33(3): 381-385.

Schwartz, A. 1952b. The land mammals of southern Florida and the upper Florida Keys. Ph.D. dissertation, University of Michigan; Ann Arbor, Michigan.

Schwartz, A. and E.P. Odum. 1957. The woodrats of the eastern United States. Journal of Mammalogy 38: 197-206.

Sherman, H.B. 1955. Description of a new race of woodrat from Key Largo, Florida. Journal of Mammalogy 36(1): 113-120.

Sikes, R.S. 1995. Maternal response to resource limitations in eastern woodrats. Animal Behavior 49(6): 1551-1558.

Strong, A.M. and G.T. Bancroft. 1994. Patterns of deforestation and fragmentation of mangrove and deciduous seasonal forests in the Upper Florida Keys. Bulletin of Marine Science 54(3): 795-804.

U.S. Fish and Wildlife Service [FWS]. 1996. Multi-species Recovery Team/Keys Group meeting, April 1996.

U.S. Fish and Wildlife Service. 1973. Threatened wildlife of the United States. Resource Publications, Washington, D.C.

U.S. Fish and Wildlife Service. 1984. Endangered and threatened wildlife and plants; determination of endangered status for the Key Largo woodrat and Key Largo cotton mouse. Federal Register 49(171): 34504-34510.

U.S. Fish and Wildlife Service. 1993. Technical/agency draft recovery plan for the Key Largo woodrat and the Key Largo cotton mouse. Atlanta, Georgia.

Recovery for the Key Largo Woodrat

Neotoma floridana smalli

Recovery Objective: RECLASSIFY to threatened.

Recovery Criteria

A recent GIS analysis of tropical hardwood hammock habitat on Key Largo suggests that the Key Largo woodrat has lost more than 50 percent of its habitat to urbanization; much of the remaining habitat has been fragmented or degraded, and the nature of the habitat loss provides extremely limited potential for habitat restoration or rehabilitation. Consequently, the objective is to reclassify the Key Largo woodrat from endangered to threatened by protecting and managing its habitat on Key Largo, restoring potential habitat, and increasing the size of its population. This objective will be achieved when: further loss, fragmentation, or degradation of suitable, occupied habitat on Key Largo has been prevented; when native and non-native nuisance species have been reduced by 80 percent; when all suitable, occupied habitat on priority acquisition lists on Key Largo is protected either through land acquisition or cooperative agreements; when the tropical hardwood hammocks that form the habitat for the Key Largo woodrat are managed on protected lands to eliminate trash and control exotics; when potential habitat on these protected lands is restored or rehabilitated for the Key Largo woodrat; when stable populations of the Key Largo woodrat are distributed throughout north Key Largo and three, additional, stable populations have been established elsewhere within the historic range. These populations will be considered demographically stable when they exhibit a stable age structure and have a rate of increase (r) equal to or greater than 0.0 as a 3-year running average for 6 years.

Species-level Recovery Actions

S1. Determine the distribution and status of the Key Largo woodrat. Key Largo woodrats formerly occurred throughout uplands of Key Largo but are now restricted to hammocks on the northern one-third of Key Largo.

S1.1. Conduct presence/absence surveys on north Key Largo to determine the status of woodrats. Survey the southern part of north Key Largo along the ecotone of human habitation and hardwood hammock. Evaluate the status of woodrats here as compared to more contiguous, remote areas.

S1.2. Survey suitable areas in other parts of Key Largo. Woodrats were historically found in southern Key Largo (Schwartz 1952b), but recent surveys have been un-successful (Barbour and Humphrey 1982.) Survey suitable habitat in other areas.

S1.3. Determine the status of woodrats north of Key Largo. Survey habitat on Palo Alto, Pumpkin, Swan, Little Totten, and Old Rhodes keys. These areas contain suitable habitat, but have not been surveyed in detail.

S1.4. **Survey woodrat habitat.** Determine habitat characterization and use by woodrats. Determine why woodrats are absent in areas with suitable habitat. Assess the condition of occupied habitat and potential habitat. Compare presence of woodrats in areas of contiguous versus fragmented habitat.

S1.5. **Survey for the presence/absence of black rats simultaneously with woodrat surveys.** Black rats may compete against woodrats, with black rats having larger populations than woodrats in some areas (Hersh 1981). Determine the prevalence of habitat use and overlap between woodrats and black rats.

S1.6. **Maintain and improve the GIS database for woodrats information.** Compile additional survey information into the FWS' existing GIS database.

S2. **Protect and enhance existing populations.**

S2.1. **Utilize Federal regulatory mechanisms for protection.** Conduct section 7 consultations on Federal activities that may affect the woodrat and determine a jeopardy threshold. Coordinate with law enforcement to improve and increase enforcement of section 9 of the ESA, which prohibits the taking of any listed species like the woodrat. Obtain evidence that shows habitat modification or degradation and secondary impacts (*e.g.*, black rats) have an adverse impact on the woodrat's ability to survive or recover and thus constitute take.

S2.2. **Provide woodrat information to Federal, State, county, and city agencies, including GIS information regarding the presence of woodrats, their protection under the ESA, and ways to minimize impacts.** Non-Federal agencies that may influence the woodrat include DEP, DCA, GFC, DACS and Monroe County Mosquito Control, Florida Keys Aqueduct Authority, and Monroe County Government.

S2.3. **Minimize and eliminate disturbance or mortality to the woodrat.** The level of woodrat mortality has not been characterized, although sources of mortality are documented. Implement management actions that reduce mortality.

S2.3.1. **Remove nuisance predators.** Feral dogs and cats, black rats, raccoons, and fire ants can increase woodrats' mortality. Eliminate food sources and home sites for raccoons and black rats, control free-roaming feral cats and dogs, and destroy fire ant colonies near and in woodrat habitat. Enforce deed restrictions of cat control in Ocean Reef Club and other areas.

S2.3.2. **Minimize the effects of pesticides and other biocides.** Mosquito spraying may impact the availability of food species. Rodent control agents used for black rats pose a threat to the woodrat (FWS 1993). Investigate the effects of these biocides and eliminate any adverse effects on the woodrat.

S2.3.3. **Control blatant killing and poisoning.** Woodrats may be killed by humans in an effort to get rid of nuisance black rats. Educate homeowners on the protection of woodrats and ways to minimize impacts. Develop methods to prevent woodrat poisoning.

S2.3.4. **Reduce the effects of road mortality**. Investigate the effects of road mortality on the woodrat. Implement appropriate management actions to reduce impacts of road mortality.

S2.3.5. Minimize the effects of contaminants. Investigate the effects of contaminants around the old missile site on the refuge, the firing range at Harbor Course, and illegal dumpsites. Remove contaminants that pose an adverse threat to the woodrat.

S2.4. Conduct woodrat reintroductions if the population reaches numbers conducive to reintroduction and translocation.

S2.4.1. Develop a standard protocol for conducting, monitoring, and evaluating all reintroduction, translocation, and supplementation efforts of woodrats using the IUCN/SSC Guidelines for Reintroductions. Develop criteria that determine the type of release to be conducted, evaluation and selection of release site, source and health of release stock, development and monitoring of short and long-term success indicators, and policy on intervention. Ensure release sites are free of threats prior to any release of woodrats.

S2.4.2. Identify potential release sites. Prioritize relocation sites based on population needs and habitat suitability. Ensure habitat is of sufficient size, is within historic range, contains suitable vegetation, and has long-term protection. Ensure site has sufficient carrying capacity to sustain growth of the reintroduced population for a minimum of 25 years.

S2.4.3. Restore or improve habitat where possible to ensure sites are suitable for augmentation/reintroductions.

S2.4.4. Identify suitable release stock. Identify donor populations and determine size and health of these populations. Determine the effects of translocation on the donor population.

S2.4.5. Obtain stock for translocation. Select the number, ages, and sex ratios of woodrats to be translocated, and the timing of the translocation. Select animals from existing stable populations in a way that does not negatively impact the donor population.

S2.4.6. Release woodrats into new sites. First, augment populations in habitat on north Key Largo that has been restored. Second, reintroduce woodrats in habitat on the periphery of the range. Third, establish new populations in other suitable areas within the historic range.

S2.4.7. Monitor introduced populations to determine survival, growth, and reproductive success.

S2.5. Investigate captive propagation options. Captive propagation may be necessary in the near future if results of population studies do not begin to show signs of a rebound. Captive propagation guidelines will need to be developed that follow DOI guidelines.

S3. Conduct research on the biology and life history of the woodrat. Conduct studies on the basic biology of the woodrat. Investigate reproductive success, productivity, longevity, population size, movements, and dispersal.

S3.1. Determine if the total population size is large enough to prevent functional extinction and genetic extinction. Determine the effective population size necessary

for survival and recovery. Conduct population modeling *(e.g.*, PVA, risk assessment) to predict the persistence of this species.

S3.2. Determine the number of sub-populations necessary to constitute a stable or increasing population.

S3.2.1. Identify subpopulations vulnerable to extinction. Identify subpopulations vulnerable to fragmentation, lost corridors, and reduced dispersal. Populations adjacent to housing complexes tend to have lower densities than those in more remote areas (Hersh 1981). Investigate whether populations on the periphery or near human habitation are more vulnerable to extinction.

S3.2.2. Determine the necessary number of subpopulations and level of exchange that will enable the woodrat to persist for 100 years.

S3.3. Determine a stable age structure, sex ratio, and group size for the woodrat.

S3.4. Examine factors that affect the abundance and distribution of the woodrat. Determine what aspects of this species' ecology make it most vulnerable to extinction (*e.g.,* predation, lack of food, lack of nesting materials, inability to find a mate).

S3.5. Conduct an experimental woodrat augmentation/reintroduction and evaluate its effectiveness in increasing the woodrat's persistence. Determine if augmentation is effective in establishing stable populations throughout the woodrat's range. Investigate the exchange rate to be used between donor and re-established populations to retain genetic integrity and similarity of both.

S4. Monitor the status of the woodrat (and its habitat). Due to the short life span and normal population fluctuation, population declines could go unnoticed unless a continuous monitoring program is established and implemented.

S4.1. Develop methods to monitor demographic parameters. Develop methods to monitor sex ratios, age class structure, survivorship, home range size, age of dispersal, and dispersal distance of the woodrat.

S4.2. Conduct long-term monitoring of the woodrat. Monitor presence/absence and degree of abundance semi-annually until the woodrat is recovered.

S5. Increase public awareness and stewardship. Develop educational materials and host public workshops to increase awareness about woodrats and instill a sense of stewardship for the protection of this endangered species.

S5.1. Prepare informational material for the general public. Distribute materials at visitor information centers and local chambers of commerce.

S5.2. Develop and implement a cat, black rat, fire ant, and raccoon control program. Conduct workshops to educate residents about the necessity to control cat and raccoon predation on woodrats and to reduce the effects of black rats and fire ants.

S6. Establish reclassification criteria. Develop measurable reclassification criteria based on what factors constitute a stable population, including total population size, number of subpopulations, sex ratio, age structure, habitat condition and availability, and level of threats. Evaluate and monitor the woodrat's status in relation to reclassification criteria.

Habitat-related Recovery Actions

H1. Prevent degradation of existing habitat. The primary threat to the Key Largo woodrat is habitat loss and fragmentation caused by increasing urbanization. The range of the Key Largo woodrat has declined by more than 50 percent and remaining habitat is restricted to the northern portion of this Key.

H1.1. Acquire all occupied habitat first, then unoccupied. Identify priority areas for acquisition. Acquire all occupied suitable habitat first (Priority 1), then unoccupied (Priority 2). Unoccupied, but suitable habitat is important for future reintroduction activity. Inholding areas are also high priority.

H1.1.1. Continue Federal acquisition efforts. Continue acquisition efforts within the Crocodile Lake NWR. The Crocodile Lake NWR is developing a priority acquisition and restoration list.

H1.1.2. Support State, local, and non-governmental organizations including acquisition efforts. Support efforts of entities to acquire woodrat habitat including state conservation easements, CARL, Monroe County Land Authority, Florida Community Trust, Florida Keys Land Trust, and The Nature Conservancy. Support the acquisition of lands to be incorporated into the Key Largo State Botanical Site.

H1.2. Protect and manage woodrat habitat.

H1.2.1. Protect woodrats on public lands. Develop a habitat management plan that outlines priority habitat for acquisition and methods to protect, restore, and minimize impacts on woodrats and their habitat.

H1.2.2. Protect woodrats on private lands. Protect woodrat populations on private land through acquisition, conservation easements or agreements, and education of landowners. Develop agreements (*e.g.,* Memorandum of Agreement) between the FWS and private landowners to minimize impacts such as feral cats and exotics.

H1.2.3. Coordinate with Federal, State and Monroe County agencies and private entities to develop management actions to protect woodrat habitat. Coordinate with all Federal agencies to ensure Federal actions do not impact woodrat habitat. Coordinate with these entities to ensure proposed construction activities that result in land clearing or alteration do not impact the woodrat and its habitat. Coordinate with the Audubon Society to develop a management plan for Parcel 22. Coordinate with the landowner to protect and manage habitat and minimize impacts to the woodrat (*e.g.*, trash, feral cats, *etc.*).

H1.2.4. Avoid clearing or disturbing hammocks. Prevent direct clearing of hardwood hammocks. Direct construction activities toward already cleared areas.

H1.2.5. Restrict access to woodrat habitat. Restrict access to remote habitat areas to prevent damage caused by campers, homesteaders, trash

dumpers, and vehicular traffic.

H1.2.6. Establish and protect 500-m buffers around Priority 1 habitat. The necessity for 500-m protection buffer zones is based on the likelihood that human influences encroach and impact the woodrat.

H1.2.7. Prevent fires in woodrat habitat. Uncontrolled wildfires can quickly destroy large areas of hardwood hammocks. Develop effective fire control plans. Prohibit fires and smoking in or near hardwood hammocks.

H1.2.8. Eliminate exotic vegetation. Remove exotic vegetation in woodrat habitat and in adjacent upland buffers. Use deed restrictions, covenants, or other means to minimize the likelihood that exotic plants will invade hardwood hammocks. Remove exotic vegetation in refuge boundaries. Support the removal of exotics in other woodrat habitat, including Port Bougainvillaea and Ocean Forest Tract (ocean side of Harrison Tract).

H2. Restore both suitable occupied and unoccupied woodrat habitat or create habitat. Several areas are suitable for restoration. Restoration efforts will benefit the hammock habitat, existing woodrat populations, and future-released populations. Conduct and support restoration activities in woodrat habitat.

H2.1. Prepare a hardwood hammock restoration plan for north Key Largo. Several large-scale restoration efforts are underway in South Florida, and it will be advantageous to have a plan to link into funding and implementation opportunities.

H2.2. Restore woodrat habitat on refuge property. Restore habitat near the missile site, borrow pit, gun range, the cockfighting ring, and radio tower.

H2.3. Restore old 905 Road to promote woodrat habitat.

H2.4. Remove trash and debris. Several old roads in the Crocodile Lake NWR are littered with trash and debris. Remove trash and debris from these and other areas in woodrat habitat.

H2.5. Improve hydrology and water quality in woodrat habitat. Restore hydrology of Dispatch Slough and other areas in need.

H2.6. Improve habitat by planting or encouraging native plant species. Plant native vegetation in areas that have been scarified or degraded.

H2.7. Create habitat by refilling and recreating areas that have been dredged or altered.

H3. Conduct research to determine habitat needs for the woodrat.

H3.1. Investigate how woodrats utilize different habitat components for survival (*e.g.*, for food, shelter, nesting, traveling). Woodrats rely heavily on the availability of materials to construct their stick nests. Eastern woodrats may be more limited by availability of shelter than by food, which may also be true for Key Largo woodrats.

H3.1.1. Investigate stable home range and minimum area requirements. Key Largo woodrats have overlapping home ranges (about 2,370 m^2).

H3.1.2. Investigate the effect of habitat change. Determine how the woodrat's distribution and abundance is affected by habitat degradation and other

human factors.

H3.2. Determine an index of habitat fragmentation.

H3.2.1. Investigate movement patterns and the spatial use of habitat to identify important core areas and corridors.

H3.2.2. Determine if the amount and configuration of habitat is sufficient to support a stable or increasing population of woodrats.

H4. Monitor the status of woodrat habitat and examine ecological processes. Conduct yearly monitoring evaluations of the status of the woodrat's habitat. including what patches are being altered or lost each year. Use GIS to map locations and quality of habitat. Monitor the availability of woodrat habitat by updating the loss or change of habitat due to residential or commercial construction.

H5. Increase public awareness of woodrat habitat and instill stewardship. Conduct workshops with the public to educate private landowners on appropriate management practices to preserve woodrat habitat. Encourage private landowners to remove exotics, maintain natural waterflow, refrain from destroying woodrat habitat, and restore disturbed areas. Prepare literature to provide information regarding the woodrat's habitat and ways to protect and conserve it.