Rice Rat

Oryzomys palustris natator

Federal Status:	**Endangered (April 30, 1991)**
Critical Habitat:	**Designated (Sept. 1993)**
Florida Status:	**Endangered**
Recovery Plan Status:	**Original (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. Distribution of the silver rice rat; this species is endemic only to the Florida Keys .

The rice rat, or silver rice rat as it is commonly called, is a small wetland rodent adapted to the unique island habitats of the Lower Keys, Florida. The silver rice rat differs from the more common marsh rice rat by its rarity, larger body size, lower fecundity, and larger home range size. Populations of these rice rats are found at extremely low densities on 12 islands in the Lower Keys and were listed as endangered primarily because their wetland habitat had been destroyed by residential and commercial construction activities. With a small population size and restricted geographic range, rice rats in the Florida Keys are greatly impacted by loss of habitat. Dredge and fill activities and other habitat alterations reduce the likelihood this species can persist.

This account represents the recovery plan for the rice rat in the Florida Keys.

Description

The rice rat in the Lower Keys, also known as the silver rice rat, was described as a full species (Spitzer and Lazell 1978) based on two specimens trapped in a freshwater marsh on Cudjoe Key in 1973.

This rice rat externally resembles other marsh rice rats in general form, being a medium-sized, semi-aquatic, generalized rat. However, the silver rice rat is distinct in having no tufts of digital bristles projecting beyond the ends of the median claws in the hind foot, by silver-gray pelage coloring laterally, and by a narrow, delicate skull with elongate nasal bones (Spitzer and Lazell 1978). Mitchell (1996) found adult weights of field-caught silver rice rats range between 14 to 136 g with males weighing generally more than females, while Forys *et al.* (1996) found weights ranging between 21 to 158 g, with the average weight of males not being statistically different than females, which is similar to findings for adult

Oryzomys palustris in Mississippi (Wolfe 1985). Adult silver rice rats tend to be larger than *Oryzomys palustris* in Virginia (Forys *et al.* 1996). External measurements (mm) of the holotype specimen (USNM 514995), an adult female, are: total length 251, tail 121, hind foot 32, ear 17 (Spitzer and Lazell 1978).

Taxonomy

Rice rats (*Oryzomys*) are New World rodents occurring from the southeastern U.S. to Mexico southward through Central America to northern South America and on some islands in the Galapagos and Caribbean. *Oryzomys* is in the order Rodentia and family Muridae with more than five subgenera and a dozen subspecies existing in North and Central America. The marsh rice rat (*Oryzomys palustris*) was first discovered by Bachman and described by Harlan in 1837, with a further taxonomic revision by Goldman in 1918 (Humphrey and Setzer 1989).

The silver rice rat was first described as a separate species by Spitzer and Lazell (1978) and named for its silvery color. The type specimen was collected in 1973 from a freshwater marsh on Cudjoe Key, Monroe County, Florida. The silver rice rat is similar to the *Oryzomys palustris* group with respect to some cranial characteristics, but is considered distinct based on its lack of digital bristle tufts projecting beyond the ends of median claws on the hind foot, large, wide sphenopalatine vacuities, long slender nasal bones, narrow skull, and silver-grey pelage (Goodyear 1991). Besides the distinct differences in skull characters and pelage, the silver rice rat is also different in morphological and color distinctions and ecological and behavioral differences (Goodyear 1991).

The taxonomic validity of this rice rat as a full species has been questioned and debated within the scientific community (Barbour and Humphrey 1982, Goodyear and Lazell 1986, Humphrey and Setzer 1989, Goodyear 1991, Humphrey 1992). The silver rice rat (*O. palustris natator* = *Oryzomys argentatus*) has been considered by some as an insular form of the more widely distributed marsh rice rat (Humphrey and Barbour 1979, Barbour and Humphrey 1982, Wolfe 1982, Humphrey and Setzer 1989, Humphrey 1992), while others view it as a separate species (Spitzer and Lazell 1978, Goodyear and Lazell 1986, Goodyear 1991). The current taxonomic status of the silver rice rat remains unresolved. For purposes of this account, however, the current FWS list of endangered and threatened wildlife and plants (50 CFR 17.11 and 17.12) considers it as *O. palustris natator*. A detailed discussion of the history of silver rice rat taxonomy and listing actions is provided in the Federal Register (FWS 1991, 1993).

Distribution

The silver rice rat is known to occur on 12 islands (Figure 1) in the Lower Keys: Little Pine, Howe, Water, Middle Torch, Big Torch, Summerland, Raccoon, Johnston, Cudjoe, Upper Sugarloaf, Lower Sugarloaf, and

Rice rat. *Original photograph by Beth Forys.*

Saddlebunch Keys (Vessey *et al.* 1976, Goodyear 1984, 1987; Wolfe 1986, 1987 Goodyear 1992, Forys *et al.* 1996, Mitchell 1996). Populations are widely distributed and occur at extremely low densities. Based on the availability of suitable habitat and proximity to existing populations, the silver rice rat may also occur on several other islands in the Lower Keys, including but not limited to Big Pine, No Name, Cudjoe, Little Torch, Ramrod, and Boca Chica Keys, although recent survey efforts have failed to detect their presence (Forys *et al.* 1996, Mitchell 1996).

Rice rats were not found on Big Pine Key and Boca Chica Key despite the availability of large areas of apparently suitable habitat (Goodyear 1987, Wolfe 1987). Because of the semi-aquatic habits of the silver rice rat, the extensive areas it traverses, and fluctuations in small mammal populations, it is reasonable to assume that Boca Chica Key and Big Pine Key could be colonized from existing populations on adjacent islands, and that they may support populations of silver rice rats at least periodically. Black rats and raccoons on both Boca Chica Key and Big Pine Key could be factors in the absence of silver rice rats from these islands (Goodyear 1983). Islands such as the Contents, Muds, Sawyer, and the Snipe Keys are large pristine islands but do not contain the three vegetative communities used by rice rats nor sufficient freshwater sources (Goodyear 1987, Forys *et al.* 1996, Mitchell 1996). Silver rice rats are not found in the Middle or Upper Keys presumably because of the lack of suitable habitat (Goodyear 1987).

Habitat

The first two silver rice rats captured on Cudjoe Key were in a freshwater marsh vegetated mainly with sawgrass and cattails (Spitzer and Lazell 1978). Since those original captures, however, silver rice rats were not found again in freshwater marshes until 1996 (Mitchell 1996), but instead were only found in salt marsh

habitats (Goodyear 1987). In a recent radio telemetry and capture study, silver rice rats were found using freshwater wetlands (freshwater marsh, hardwoods, and pinelands) that are adjacent to saltmarshes on Cudjoe and Big Torch Key (Mitchell 1996). Freshwater marshes are primarily a Lower Keys habitat found in depressions in the interior of only a few islands and are dominated by sawgrass (*Cladium jamiacense*), seashore dropseed (*Sporobolus virginicus*), and cordgrass (*Spartina* spp.). During the wet season these areas can accumulate standing water. Silver rice rats depend on both freshwater wetlands and saline wetland habitat, especially large areas of adjacent or contiguous habitat.

Silver rice rats typically use three zones that are delineated by their salinity and topography: (1) low intertidal areas, (2) salt marsh flooded by spring or storm tides, and (3) buttonwood transitional areas that are slightly more elevated and only flooded by storm tides (Goodyear 1987). The low intertidal area is comprised primarily of red and black mangroves with white mangroves, buttonwoods, woody glasswort, saltwort, and Key grass found on higher elevated areas. These areas are used by silver rice rats mainly during nocturnal activity periods and also for foraging, moving between habitats, and nesting. The low salt marsh area consists of the grasses *Distichilis* and *Sporobolus*, interspersed with sea ox-eye, white and black mangrove, and buttonwood, in addition to depression areas that contain saltwort, black mangrove, and glasswort. Silver rice rats use this zone mainly for foraging and nesting. The buttonwood transitional salt marsh area is at a higher elevation than other salt marsh habitats, contains a denser coverage of *Distichilis*, *Sporobolus*, and sea ox-eye, and is used for foraging and nesting (Goodyear 1987).

In general, rice rats use mangrove habitats primarily for foraging, while higher-elevation salt marshes are used for nesting and foraging (Forys *et al.* 1996). Silver rice rats tend to use various vegetation zones during different seasons: during the dry season (March-April and December-January) they use low marsh more, while in the wet season, mid- and higher-elevation salt marsh habitats are used more (Forys *et al.* 1996). *Oryzomys palustris* in the Everglades displays a fugitive behavior of moving from one patch of habitat to another in response to seasonal fluctuations in water levels (Smith and Vrieze 1979). Silver rice rats may also exhibit such an adaptive behavior in response to seasonal changes in water levels or food availability. Silver rice rats occur at comparable densities in both scrub and fringe mangrove communities, although microhabitat data suggests that this species spends most of its time in red and black mangroves (Forys *et al.* 1996).

The rice rat requires large, contiguous areas of mangrove and salt marsh habitats to sustain viable populations. Forys *et al.* (1996) trapped individual rice rats in areas of very sparse residential development, and suggested that marshes in proximity to human impacts are still capable of supporting silver rice rats. However, development in or immediately adjacent to silver rice rat habitat could adversely affect the survival and recovery of the species. These areas include all mangrove habitat within 1 km of known silver rice rat habitat. The 1 km distance would serve as a buffer from the majority of adverse effects resulting from residential and commercial construction projects.

The amount of silver rice rat habitat available is based on the vegetation type included. There are approximately 3,575 ha of fringe and scrub mangrove habitat with silver rice rats present, with a total amount of 5,542 ha of habitat available (occupied and unoccupied) (Forys *et al.* 1996). When other vegetation types (*e.g.*, freshwater marsh, hardwoods, pinelands and saltmarsh) used by the silver rice rat are included, the amount of occupied habitat is 5,644 ha (Mitchell 1996).

Critical Habitat

Critical habitat for the silver rice rat includes areas containing contiguous mangrove swamps, salt marsh flats, and buttonwood transition vegetation. These vegetational types, as well as cattail marshes, contain the primary constituent elements in critical habitat types (50 CFR 17.95).

The major constituent elements of this critical habitat that require special management considerations or protection are: mangrove swamps containing red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*); salt marshes, swales, and adjacent transitional wetlands containing saltwort (*Batis maritima*), perennial glasswort (*Salicornia virginica*), saltgrass (*Distichlis spicata*), sea ox-eye (*Borrichia frutescens*), Key grass (*Monanthochloe littoralis*), and coastal dropseed (*Sporobolus virginicus*); and freshwater marshes containing cattails (*Typha domingensis*), sawgrass (*Cladium jamaicense*), and cordgrass (*Spartina* spp.).

The original critical habitat proposal included nine keys totaling 4,075 ha on the following islands: Little Pine Key, Water Keys (north of Big Torch, but not the Water Key west of Little Pine Key), Big Torch Key, Middle Torch Key, Raccoon Key, Summerland Key north of U.S. Highway 1, Cudjoe Key, Johnston Key, and the Saddlebunch Keys south of U.S. Highway 1, but not including lands in Township 67S, Range 27E, Section 8, and the northern 1/5 of Section 17. All lands and waters above mean low tide are included in this designation. Approximately 2,026 ha of the proposed critical habitat was within NWR boundaries. After a scientific and economic analysis, the FWS concluded there was no justification for excluding areas from the proposed critical habitat based on economic reasons, although two areas should be excluded from critical habitat designation because they no longer supported significant silver rice rat habitat. These two areas included 418 ha with 186 ha on Summerland Key and 232 ha on Cudjoe Key. Both areas are located south of U.S. Highway 1, are extensively urbanized, and hence have little remaining suitable habitat left for the silver rice rat.

Behavior

Silver rice rats are primarily nocturnal and have large home ranges. Spitzer (1983) estimated the home range of a male silver rice rat on Summerland Key to be 23 ha. This animal regularly traveled long distances during a single activity; in one night it traveled 1 km. Forys *et al.* (1996) observed rice rats undertaking movements of 325 m in one day. In a recent telemetry study, Mitchell (1996) found home ranges of 2.0 to 8.5 ha for females and 3.4 to 11.0

ha for males, which is much larger than *O. palustris* ranges of 0.33 for females and 0.25 ha for males in the Everglades (Birkenholz 1963). Overall, there is no estimate on the average dispersal distance for silver rice rats; however, their home range size is estimated to be much larger than is known for other rice rats by 5 to 10 times as large (Spitzer 1983, Mitchell 1996). The need for a large home range may be a behavioral response to a limited supply of food or freshwater resources (Forys *et al.* 1996).

Five types of locomotory movements are evident in silver rice rats: walking, running, swimming, climbing, and jumping (Spitzer 1983). Silver rice rats frequently climb through vegetation and use their tails for additional support when climbing, but rarely do they climb higher than one meter above the ground (Spitzer 1983, Mitchell 1996). Silver rice rats dive and swim on the surface and underwater and swim more frequently and faster than cotton rats (*Sigmodon hispidus*). Self-grooming behaviors to maintain the water repellent nature of their pelage are displayed by *Oryzomys palustris* (Wolfe 1982) and are believed to be done by silver rice rats as well.

Reproduction

Silver rice rats are found at extremely low densities throughout their range: 2.29/ha for silver rice rat compared to 18.07/ha for *O. palustris* in the Everglades and are significantly lower than for marsh rice rats elsewhere (Smith and Vrieze 1979, Wolfe 1985, Forys *et al*. 1996). The largest populations of silver rice rats occur on Big Torch, Cudjoe, and Raccoon Keys (Forys *et al*. 1996, Mitchell 1996). Population variations between years were evident in *O. palustris* in Mississippi (Wolfe 1985), but not in Everglades rice rat populations (Smith and Vrieze 1979). Yearly population trends are not known for the silver rice rat, but populations of *O. palustris* have been found to be lower in the early spring (2 to 5 per ha) with a gradual increase to peak levels in late autumn and early winter (13 to 25 per ha) (Wolfe 1985). Silver rice rats appear to have a fairly high survivorship as compared to *O. palustris* (Forys *et al*. 1996).

Like some *O. palustris* in lower latitudes, reproduction in silver rice rats can occur throughout the year and is influenced by a variety of ecological factors (Wolfe 1982). Climatic conditions and photoperiod in the Lower Keys are less variable than in higher latitudes and may not restrict rice rats to one litter a year. Rather, the milder conditions may allow rice rats to produce several litters each year (Edmonds and Stetson 1993). A reproductive peak in silver rice rats occurs after the wet season, from September to October (Forys *et al*. 1996), although Spitzer (1983) trapped a pregnant female silver rice rat during winter. Similar to *O. palustris*, the gestation period for silver rice rats is 21 to 28 days, with litter size ranging three to five. The number of litters produced each year is not known for silver rice rats.

Forys *et al*. (1996) found that juvenile rice rats comprised only 14 percent of the total number of individuals captured in their study. This number is significantly lower than results from studies of *O. palustris* in Mississippi and Louisiana (Negus *et al*. 1961, Wolfe 1985). The number of juveniles present in the population is usually higher where higher numbers of females are present (Mitchell 1996). Although survivorship of silver rice rats in the Florida Keys

was found to be relatively high, the low proportion of juveniles in this population is indicative of a low reproductive rate which may in turn, be limited by the availability of food and freshwater resources (Forys *et al*. 1996).

A sex ratio at weaning of 1:1 has been reported for *O. palustris* (Wolfe 1982). Other studies have documented a ratio of 272 males:215 females in Mississippi (Wolfe 1985) and 23 males:16 females in a central Florida population (Birkenholz 1963). Wolfe (1985) attributed the higher number of males to a lower survival rate for females or decreased trappability of adult females, especially when they are pregnant or caring for their young. Forys *et al*. (1996) documented a ratio of 66 males:19 females in silver rice rat populations caught during grid trapping, as did Mitchell (1996) during line trappings (68 percent were male). Social behavior is not apparent, but copulatory behavior of the silver rice rat is similar to *O. palustris*.

Silver rice rats construct simple spherical nests that are 15 cm in diameter consisting primarily of *Distichilis* or *Sporobolus* grasses, although other materials such as buttonwood, mangrove, or saltwort may also be used in nest construction (Spitzer 1983). Nests are usually built on the ground or slightly elevated in grasses. Spitzer (1983) found that a single male silver rice rat on Summerland Key alternately used 16 different nest sites, often quite distant from each other, over a one-month period.

Foraging

The congener, *O. palustris* is predominantly omnivorous, but preferably carnivorous, feeding mainly on insects, snails, and crabs, and occasionally on clams, fishes, baby turtles, carcasses of muskrats, deer mice, sparrows, and eggs and young of marsh wrens (Negus *et al.* 1961, see Wolfe 1982 for review). These marsh rice rats also eat seeds and parts from plants such as *Spartina* spp., *Tripsacum* spp. and *Elymus* spp. (Wolfe 1982).

Similarly, silver rice rats prefer to eat animal material but in general, they are omnivorous (Spitzer 1983, Goodyear 1992). Silver rice rats forage along the edges of flooded areas or in recently flooded areas on a variety of animal and plant material, including invertebrates such as isopods (*Ligia* sp.), snails (*Melampus* sp. and *Cerithidea* sp.), and crabs (*Uca* sp.) and seeds of saltwort, coconut palm (*Cocos nucifera*), and buttonwood, *Rhizophora propagules*, and germinating *Avicennia* seedlings (Spitzer 1983). Silver rice rats do not appear to hoard food, but food has been found in their nests suggesting they may carry the food back to eat in their nest (Wolfe 1982, Spitzer 1983).

Seasonal variation in food consumption has not been documented for the silver rice rat, but is evident in the foraging habits of *O. palustris* (Negus *et al*. 1961); the dietary habits of silver rice rats are not expected to be affected as much since seasonal changes are not as dramatic in the Lower Keys as they are in higher latitudes. The availability of freshwater is important to the survival of silver rice rats since they cannot effectively concentrate urine to meet their metabolic needs (Dunson and Lazell 1982, Goodyear 1987). They depend on several sources of fresh water including freshwater lenses, water droplets on vegetation, and pools of water collected in tree holes (Spitzer 1983, Goodyear 1987).

Relationship To Other Species

Species that live in island habitats like the silver rice rat are more susceptible to the negative effects of habitat loss, predation, competition, diseases, and natural catastrophes and therefore are more vulnerable to extinction (MacArthur and Wilson 1963, 1967). The integrity of the silver rice rat's habitat is important to its continued existence and to the other species that share its habitat. A balance between the needs of these species is essential for maintaining the relationships of these species and ensuring the survival of the silver rice rat. The Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) and silver rice rat utilize similar vegetation in salt marshes (*e.g*. *Sporobolus virginicus*), transitional areas *(e.g., Conocarpus erectus*), and freshwater marshes (*e.g*., *Cladium jamaicense*). Silver rice rats also use many of the same habitats as the endangered Key deer (*Odocoileus virginianus clavium*).

Silver rice rats coexist with several other small mammals, which may be potential competitors, such as the black rat (*Rattus rattus*) and Key cotton rat (*Sigmodon hispidus exsputus*). The abundance of these rodents may influence the relative abundance of the silver rice rat (Kincaid and Cameron 1982, Wolfe 1982, Forys *et al.* 1996, Mitchell 1996). Both the silver rice rat and black rat have similar food items and habitat preferences. *Oryzomys palustris* diet overlaps with sympatric populations of hispid cotton rat (*Sigmodon hispidus*) and fulvous harvest mouse (*Reithrodontomys fulvescens*). There is evidence of habitat distinction between these species because each species uses different subhabitats to feed in during different times of the year (Kincaid and Cameron 1982, Goodyear 1992).

Rhesus monkeys or macaques (*Cercopithecus mulattus*) on Raccoon Key heavily forage on the vegetation (especially mangrove foliage) and degrade silver rice rat habitat. Owls, hawks, snakes, raccoons, and foxes are known predators on *O. palustris* (Wolfe 1982), and are also believed to be predators of the silver rice rat (Spitzer 1983). Feral cats and red fire ants (*Solenopsis invicta*) are also considered to be a threat to the silver rice rat (Forys *et al.* 1996).

Several parasites, such as trematodes, mites, helminths, and ticks have been reported on the congener *O. palustris* (Layne 1967, Kinsella 1974, Wolfe 1982) and probably occur on the silver rice rat as well. The effects of these parasites on their host is not well known, but is believed to be minimal, except during high periods of environmental stress where they may negatively influence the host more.

Status and Trends

Federal protection for the silver rice rat first became an issue in 1980, when the FWS was petitioned by the Center for Action on Endangered Species to list this species as endangered and provide it full protection under the Endangered Species Act. Between 1982 and 1988, the FWS published annual reports stating that a listing proposal for the silver rice rat was "warranted but precluded" by other listing actions of higher priority. During this time, the FWS considered the

silver rice rat a full species. In 1988, the FWS announced it was no longer considering the silver rice rat for protection under the ESA based on a 1986 report that rebutted the animal's identity as a separate species. In response to that, the Sierra Club Legal Defense Fund, Inc., filed a lawsuit challenging the FWS's decision not to proceed with listing the silver rice rat and stated the FWS did not consider listing the silver rice rat as a "distinct vertebrate population." The silver rice rat was then placed in the "warranted but precluded" category and a review period for listing this species as a vertebrate population was announced. After additional review and research, the FWS announced its proposal to list the silver rice rat as an endangered species in 1990.

The silver rice rat was listed as an endangered species on April 30, 1991 (56 Federal Register 19814). At that time, the silver rice rat was extirpated from one key where it formerly occurred and was believed to be extirpated from two additional keys. The silver rice rat was listed as endangered because its wetland habitat had been destroyed by residential and commercial construction; because of predation, competition, and habitat modification from various introduced mammals and because its low populations make it more susceptible to reduced genetic variability. In the final rule listing the silver rice rat as an endangered species, the FWS determined that critical habitat designation was not prudent. A reexamination of potential threats to the silver rice rat led the FWS to conclude the illicit takings arising from publication of critical habitat would not be so serious as to render designation of critical habitat imprudent. Critical habitat was then designated on September 30, 1993. Some areas have been excluded from critical habitat designation based on comments received on the proposed rule.

The silver rice rat has a narrow geographic range and a small local population size, both of which make it more vulnerable to extinction. After its discovery, surveys conducted the following 5 years failed to find any additional specimens in freshwater wetlands--the type locality. Surveys conducted in 1978-79 also failed to find any silver rice rats and this species was believed to be extirpated in the type locality and on nearby islands (Barbour and Humphrey 1982). Shortly after that study was completed, the identity of specimens collected in 1976 on Raccoon Key was examined and confirmed to be silver rice rats (Barbour and Humphrey 1982, Wolfe 1987), indicating this species was not extinct and occurred on islands not previously recorded. At the time of their Federal listing in 1991, silver rice rats were known to exist on eight islands including Little Pine, Water, Big Torch, Middle Torch, Raccoon, Summerland, Johnston, and Saddlebunch Keys. During 1987-88, Goodyear (1993) captured rice rats on Big Torch, Middle Torch, Saddlebunch, and Summerland Keys. In addition to the original eight islands, the most recent status reports from 1996 report four other islands also support populations of silver rice rats including Howe, Cudjoe, Upper Sugarloaf, and Lower Sugarloaf Keys (Forys *et al.* 1996, Mitchell 1996). It was not until 1996 that silver rice rats were located again in the type locality of freshwater marshes. Both adults and

juveniles were surveyed in freshwater marshes on Cudjoe and Big Torch keys (Mitchell 1996). Silver rice rats have not been found on No Name, Big Pine or Ramrod keys although suitable habitat is present (Forys *et al.* 1996, Mitchell 1996).

In general, islands located on the periphery of the silver rice rat's range do not support populations although suitable habitat is present, whereas islands in the middle or interior of the range all support populations (Forys *et al.* 1996). Populations on the periphery of a species' range are considered more susceptible to perturbations because they are less stable and also tend to have lower numbers.

Considering the limited range, habitat specificity, and low population density of the silver rice rat, it is unlikely that this species or its habitat was ever extremely abundant in the Lower keys, at least in recent times. Silver rice rats occur at extremely low densities on most islands sampled, with the exceptions of Raccoon and Johnston Keys, where populations occur at densities more typical of rice rats from mainland locations. Population trends can only be inferred from the limited trapping data available from Raccoon, Saddlebunch, Middle Torch, Big Torch, and Summerland keys collected by various researchers over the years (Vessey *et al.* 1976; Goodyear 1987, 1993; Wolfe 1986, 1987). Based on these surveys, silver rice rat population levels remained at low numbers throughout the period 1981-1987 on those islands where repeat trapping was conducted.

Populations have decreased at four of five saline wetland sites originally surveyed in the 1980s: Johnston, Middle Torch, Saddlebunch, and Summerland keys (Mitchell 1996). In 1984, Johnston Key had 0.83 individuals per ha and by 1996 the population declined to zero. Estimated population sizes for silver rice rats from nine islands range from 0 to 16 individuals present, with an average of approximately five per island (Mitchell 1996).

Threats

Residential and commercial activities, recent habitat loss, and the introduction or increase of non-native predators and competitors have been the contributing factors to the endangered status of the rice rat (Forys *et al*. 1996). Limited food or freshwater resources may also be contributing to the rarity of the rice rat. Rice rats have very large home ranges, which may indicate a low supply of food or water and the need to travel further distances to find these important resources. As a result of limited resources, silver rice rats are believed to have a low reproductive rate as evident from the low number of juveniles in population studies (Forys *et al*. 1996).

The main threat to the silver rice rat is degradation and loss of habitat due to urbanization. Construction activities typically result in the direct loss of habitat as well as secondary effects that extend into surrounding habitats. Related secondary effects include habitat fragmentation and an increase in the densities of black rats and domestic cats. Cats are predators of silver rice rats and there is evidence of interspecific competition between silver rice rats and black rats (Goodyear 1992, Forys *et al*. 1996).

Secondary threats resulting from human encroachment on silver rice rat habitat have been difficult to quantify because of the low population densities

of this species throughout the Lower Keys. These threats include predation and competition from domestic and exotic animals, contaminants, and dumping. Domestic cats are abundant throughout the Lower Keys, and forage in the higher-elevation salt marsh habitats also used by the silver rice rat. Because rodents are often the most abundant items in a domestic cat's diet (Eberhard 1954, Churcher and Lawton 1989), the potential for domestic cats to prey upon silver rice rats is high. Given the low densities of silver rice rats throughout the Lower Keys, any increase in cat predation would pose a direct effect on the species' survival.

Human habitation and solid waste accumulation encourages establishment of black rats. Goodyear (1993) has shown that silver rice rats and black rats exhibit extensive niche overlap, and that islands with high densities of black rats support few silver rice rats. Goodyear's data suggest that black rats may outcompete silver rice rats for food and habitat resources; in areas of suitable habitat, the occurrence of black rats may preclude the survival of silver rice rats. Black rats may also prey upon newborn silver rice rats. Pesticides used to control black rats also pose a threat to the silver rice rat (FWS 1993). Exotic fire ants have been documented to cause declines in populations of small mammals in Texas (Killion *et al*. 1990, Killion and Grant 1993) and may cause direct mortality of juvenile silver rice rats.

In some areas, the natural hydrologic cycles of silver rice rat wetland habitat has been altered by the construction of fill roads, borrow pits, and mosquito ditches. As a result, the vegetative communities change and disrupt behaviors such as nesting, movement, and foraging. These alterations also encourage invasion by exotic vegetation, which may reduce habitat quality.

The small, isolated, and widely distributed populations of silver rice rats are also vulnerable to extinction through random demographic fluctuations, loss of genetic variability caused by small population size, and stochastic environmental events (*e.g.,* hurricanes).

Management

The types of habitat (primarily salt marsh and mangrove wetlands) silver rice rats use require Federal, State, and Monroe County permits in order to conduct residential or commercial construction. Although Federal and State regulations provide for the consideration of impacts of dredge and fill operations on endangered species, permits nevertheless are issued for construction in silver rice rat habitat on a regular basis. Additional protection for this species is provided through the designation and preservation of critical habitat. Critical habitat only affects Federal agency actions and does not apply to private, local, or State government activities that are not subject to Federal authorization or funding.

Federal agencies affected by the designation of silver rice rat critical habitat include the FWS' National Key Deer Refuge (NKDR), COE, and FEMA (58 FR 46031). Seven of the nine keys in designated critical habitat are within the NKDR boundaries. Although the NKDR is primarily managed for Key deer, the habitat requirements and biological needs of the species do not conflict. Silver rice rat habitat on NKDR and Great White Heron NWR is being managed by refuge staff.

In addition, the two tracts on Sugarloaf Key where the species occurs is in the process of being transferred to the NKDR to provide additional protection. Both the permitting program of the COE and the administration of flood insurance by FEMA are affected by the silver rice rat's critical habitat designation. All Federal agencies are required to insure that their actions do not result in the destruction or adverse modification of critical habitat for the silver rice rat. Permitting actions that may affect the silver rice rat or areas within silver rice rat critical habitat require section 7 consultation with the FWS. Federal, State, and county agencies are currently working with Charles River Lab to minimize adverse effects at Raccoon Key, which may comprise the largest population of silver rice rats.

The persistence of the silver rice rat is dependent upon the amount of suitable habitat available. Some silver rice rats have been found to use areas with some residential construction nearby (Forys *et al.* 1996), but their long term persistence in these disturbed areas in not known. Much of the remaining wetland habitat suitable for rice rats is protected under local, State, and Federal law, but total protection in all areas is not assured. The presence of contiguous habitat has been suggested to be capable of supporting higher densities of *O. palustris,* and silver rice rats also require large areas of habitat (an average of 5.4 ha^2 of habitat required per rat) to persist. With the current limited amount of suitable habitat available, it is important to retain the integrity of the larger contiguous wetlands and prevent further fragmentation and destruction.

The GFC surveyed and monitored for silver rice rats in all occupied and unoccupied habitat. Suitable rice rat habitat includes habitat as identified in the survey by GFC (Forys *et al*. 1996) with a 500 m buffer around occupied habitat and all habitat on Raccoon and Water keys. At least 2,643 ha of suitable rat habitat are in private ownership and have the potential to be destroyed by construction activities. In a recent study of the population dynamics of the silver rice rat in suitable habitat throughout the Lower Keys, Forys *et al*. (1996) confirmed that this species still occurs at extremely low densities (mean = 2.29/ha during 24 trapping periods) and is extremely vulnerable to destruction of its habitat. Trapping and monitoring of this species was conducted in 1997 by the FWS and GFC with assistance from the Americorps program.

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Recovery for the Rice Rat

Oryzomys palustris natator

Recovery Objective: RECLASSIFY to threatened.

Recovery Criteria

The silver rice rat has a narrow geographic range, small local population, low reproductive rate, and large home range, causing it to be more susceptible to extinction. Information from recent surveys indicates that the silver rice rat is rare and may be threatened with extirpation due to the loss, fragmentation, and degradation of its habitat and anthropogenic factors. Consequently, the objective is to reclassify the silver rice rat from *endangered* to *threatened* by protecting, managing, and restoring its habitat in the Lower Keys; increasing the size of its population; and establishing populations on the periphery of its range. This objective will be achieved when further loss, fragmentation, or degradation of suitable, occupied habitat in the Lower Keys 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 for the Lower Keys is protected either through land acquisition or cooperative agreements; when the mangrove and saltmarsh habitat which forms the habitat for the silver rice rat are managed, restored, or rehabilitated on protected lands; when stable populations of the silver rice rat are distributed throughout its historic range; and when three additional, stable populations have been established along the periphery of the historic range of the silver rice rat. 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 silver rice rat.** Silver rice rat populations occur at extremely low densities on 12 islands in the Lower Keys, but additional surveys are still needed. Survey the current distribution of the silver rice rat and areas not previously recorded.

S1.1. **Conduct presence/absence surveys to determine the status of rice rats and refine definition of range.** Conduct presence/absence surveys on (a) the Big Pine Complex (including Big Pine, Little Pine, Annette, Porpoise, Water, Johnson, Horseshoe, and Howe Keys); (b) Saddlebunch Complex (Saddlebunch, Sugarloaf, Cudjoe, Big Torch, Howe); (c) Knockemdown complex; (d) Boca Chica and Big Coppit; and (e) Sawyer Key, Bud Key, and other backcountry islands.

S1.2. **Survey for the presence/absence of black rats simultaneously with rice rat trapping.** Interspecific competition between silver rice rats and black rats is evident (Goodyear 1992). Determine the number of black rats encountered during the rice rat surveys.

S1.3. Maintain and improve the GIS database for silver rice rats. Compile and maintain silver rice rat distribution information through the FWS and GFC Geographic Information System (GIS) databases.

S2. Protect and enhance existing populations.

S2.1. Assign a biologist responsibility for implementing recovery actions for the threatened or endangered species of the Lower Keys. Recovery actions for the silver rice rat will benefit the other threatened or endangered species in the Lower Florida Keys, including the Key deer, Lower Keys rabbit, Key tree-cactus and Stock Island tree snail. The number of actions that will be necessary to recover threatened or endangered species in the Lower Florida Keys will require the attention of a biologist or similarly-trained professional who is dedicated to specifically addressing the recovery needs of these species.

S2.2. Conduct silver rice rat reintroductions from natural wild populations.

S2.2.1. Develop a standard protocol for conducting, monitoring, and evaluating all reintroduction, translocation, and supplementation efforts of silver rice rats using the IUCN/SSC Guidelines for Reintroductions. Ensure release sites are free of threats, especially cats and feral hogs, prior to any release of rice rats.

S2.2.2. Reintroduce silver rice rats on islands on the periphery of the silver rice rat's range. Suitable habitat exists on the periphery of its range, but silver rice rats have not be found there recently.

S2.2.3. Reintroduce silver rice rats on Little Pine Key or other remote backcountry islands. There are 16.6 ha of suitable habitat available on Little Pine Key, which is within the FWS NWR boundaries. Reintroduce rice rats to this area and other suitable habitat.

S2.2.4. Conduct reinforcement/supplementation of silver rice rats. Translocate silver rice rats to existing populations on Sugarloaf and Big Pine Key in protected areas.

S2.3. Utilize Federal regulatory mechanisms for protection. Conduct section 7 consultations on Federal activities. Federal agencies whose actions may affect the rice rat include, COE, FEMA, Federal Housing Administration, and the Rural Electrification Administration. Determine jeopardy thresholds for the rice rat. Estimate and evaluate the type of Federal activities over the next 20 years that are likely to cause jeopardy and determine threshold levels for the total population. Coordinate with law enforcement to prevent take under section 9. Identify what activities could result in take of silver rice rats, such as habitat loss, cat predation, and vehicular traffic.

S2.4. Provide information about silver rice rats to Federal, State, county, and city agencies. Distribute information regarding the presence of silver rice rats, their protection under the ESA, and ways to minimize impacts. Non-federal agencies that may influence the silver rice rat include DEP, DCA, GFC, Department of Agriculture and Consumer Services, Monroe County Mosquito Control, Florida Keys Aqueduct Authority, and Monroe County Government.

S2.5. Minimize and eliminate disturbance or mortality to the silver rice rat. Silver rice rats are preyed upon by cats, black rats, raccoons, and fire ants. Predation by

these species is increased near areas of urbanization. Eliminate or reduce mortality from these sources.

S2.5.1. Minimize cat predation on silver rice rats. Cats are known predators of silver rice rats. Establish a program to license domestic cats, implement leash laws, eliminate cat-feeding stations, implement spay and neuter programs, increase awareness through educational material, test diseases, and remove nuisance free-roaming cats.

S2.5.2. Minimize competition and predation by black rats. Black rats may be able to outcompete silver rice rats for food and habitat resources and prey on young rice rats. Eliminate black rat food shelters and sources. Enforce proper disposal of refuse around residences and in silver rice rat habitat.

S2.5.3. Minimize raccoon impacts on silver rice rats. Raccoon populations are unnaturally high in some areas of the Lower Keys. Raccoons are capable of killing both adult and juvenile rats. Eliminate supplemental food sources, feeding by humans, outdoor cat-feeding stations, and open dumpsters to reduce raccoon populations.

S2.5.4. Eliminate fire ant colonies near rice rat habitat. Fire ant colonies have been found in silver rice rat habitat. Fire ants can prey on young rats. Eliminate fire ant colonies in silver rice rat habitat.

S2.5.5. Control blatant killing and prevent poisoning. Rice rats may be intentionally killed by humans in an effort to get rid of black rats. Develop a program to educate homeowners to prevent blatant killing. Pesticides used to control black rats also pose a threat to the silver rice rat. Develop methods to reduce poisoning of silver rice rats from black rat poisoning.

S2.6. Investigate captive propagation options. Although captive propagation is not necessary for the silver rice rat at this time, guidelines and protocol should be established to guide captive propagation efforts, if deemed necessary. Any captive propagation efforts should be conducted in the Lower Keys in as similar to natural conditions as possible, continued only when necessary, and all propagation efforts should be strictly monitored. DOI guidelines should be followed.

S3. Conduct research on the life history and population ecology of the silver rice rat. Some baseline information on the life history of rice rats has been gathered (*e.g.,* Spitzer 1983, Goodyear 1992, Forys *et al*. 1996, Mitchell 1996). In order to develop reclassification criteria for the silver rice rat, additional information is still needed. Research should focus on gaining information that will assist in the recovery of the silver rice rat, specifically information lending to reclassification criteria.

S3.1. Determine if the total population size is large enough to prevent functional extinction and genetic extinction. Populations of silver rice rats are at much lower densities than the mainland rice rat populations. Estimated population sizes for silver rice rats from nine islands range from 0 to 16 individuals present, with an average of approximately five per island (Mitchell 1996). Determine the persistence of this species and the effective population size necessary to prevent inbreeding depression.

S3.2. Examine the effects of resource limitation on the persistence of the silver rice rat. The rarity of the silver rice rat appears to be attributed to resource limitation. A

low proportion of juveniles in the population may be a result of limited food and freshwater resources. Investigate whether the persistence of the silver rice rat is being affected by limitations of resources (*e.g.,* food, water, shelter).

S3.3. Examine factors that affect the abundance and distribution of the silver rice rat. Investigate the relationships of silver rice rats to black rats, raccoons, fire ants, cats, or other animals that are nuisance competitors or predators and determine their effect on the silver rice rats' persistence.

S3.4. Determine the number of subpopulations necessary to maintain a stable or increasing population. The silver rice rat is known to occur on 12 islands. Populations have decreased at four of five saline wetland sites originally surveyed in the 1980s. Increases in habitat fragmentation will decrease the rats' ability to recolonize these areas.

S3.4.1. Identify subpopulations vulnerable to extinction. In 1984, Johnston Key had 0.83 individuals per ha and by 1996 the population declined to zero. Identify additional subpopulations vulnerable to habitat fragmentation, lost corridors, and reduced dispersal, and focus recovery actions on these sites.

S3.4.2. Determine the necessary number of subpopulations and level of exchange that will enable the silver rice rat to persist for 100 years.

S3.5. Determine a stable age structure, sex ratio, and group size for the silver rice rat. Investigate these parameters to determine what constitutes a stable population structure. Silver rice rats have a lower proportion of juveniles than mainland rice rat species, which may be affecting successful recruitment. The sex ratio is male biased, which may suggest female silver rice rats are more susceptible to predation or competition. Rice rats occur at very low densities, thus causing them to be more vulnerable to extinction.

S3.6. Conduct a silver rice rat reintroduction and evaluate its effectiveness in increasing the rats' persistence. Conduct a reintroduction and collect information on why this species exists in low numbers in some areas and is non-existent in other areas of suitable habitat. Determine factors for a stable population structure (*e.g.*, sex ratio, age structure, group size). Investigate these parameters to determine what constitutes a stable population structure.

S4. Monitor the status of the silver rice rat. Due to the rarity and secretive habits of the silver rice rat, population declines could go unnoticed unless a continuous monitoring program is established and implemented (Forys *et al*. 1996).

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

S4.2. Conduct long-term monitoring of the silver rice rat. Monitor presence/absence and degree of abundance every year until the rat is recovered.

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

S5.1 Prepare educational 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, and raccoon control program. Conduct workshops to educate residents about the necessity of controlling cat and raccoon predation on silver rice rats as well as minimizing the effects of black rats and fire ants.

S6. Establish reclassification criteria. Develop measurable reclassification criteria based on factors that result in a stable or increasing population, including total population size, number of subpopulations, sex ratio, age structure, habitat condition and availability, and level of threats. Evaluate and monitor the silver rice rat's status in relation to reclassification criteria.

Habitat-level Recovery Actions

H1. Prevent degradation of existing habitat. The main threat to the silver rice rat is degradation and loss of habitat due to urbanization. At least 2,643 hectares of suitable rat habitat are in private ownership and have the potential to be destroyed by construction activities.

H1.1. Determine the status of rice rat habitat, including critical habitat. Determine the condition of both occupied and unoccupied habitat of the silver rice rat. Characterize occupied habitat and determine why rats are present and characterize unoccupied habitat to determine why they are absent. Determine presence/absence of silver rice rats in freshwater marshes.

H1.2. Acquire silver rice rat habitat. Acquire habitat essential to the silver rice rat's survival. Develop a range-wide plan outlining priority acquisition areas for the silver rice rat that uses a reserve design approach to take such factors as connectivity, corridors, and fragmentation into consideration. Identify acquisition areas for occupied habitat (Priority 1) and unoccupied, suitable habitat (Priority 2).

H1.2.1. Continue Federal acquisition efforts. Continue acquisition efforts within the National Key Deer Refuge and Great White Heron NWR.

H1.2.2. Support State, local, and non-government organizations' acquisition efforts. Support efforts to acquire silver rice rat habitat by entities such as CARL, Monroe County Land Authority, Florida Community Trust, Florida Keys Land Trust, and The Nature Conservancy. Also support state conservation easements.

H1.3. Protect and manage silver rice rat habitat.

H1.3.1. Protect rice rats on public lands. Develop a habitat management plan that outlines priority habitat for acquisition and methods to protect, restore, and minimize impacts on rice rats and their habitat. Manage habitat for exotics, off-road vehicles, dumping, feral cats and other predators, and vehicular traffic.

H1.3.2. Protect rice rats on private lands. Protect rice rat populations on private land through acquisition, conservation easements or agreements, and education of land owners. Develop agreements (*e.g.*, Memorandum of Agreement) between the FWS and private land owners to minimize impacts such as feral cats and exotics.

H1.3.3. Coordinate with Federal, State and Monroe County agencies and private entities to develop management actions to protect silver rice rat habitat. Coordinate with these entities to ensure proposed construction activities that result in land clearing or alteration do not

impact the silver rice rat and its habitat. Habitat loss through construction activities, resource limitation, and domestic and non-native predators and competitors are all factors contributing to the low numbers of the silver rice rat in the Lower Keys.

H1.3.4. Establish and protect 500 m buffers around Priority 1 habitat. The necessity for a 500 m protection buffer is based on the likelihood that human influences (*e.g.,* increased habitat fragmentation, cat predation) encroach upon and impact the silver rice rat.

H1.3.5. Control free roaming horses on Cudjoe Key. Control roaming horses on Cudjoe Key to minimize destruction of silver rice rat habitat.

H1.3.6. Restrict access to silver rice rat habitat. Restrict access to remote habitat areas to prevent damage caused by camping, homesteading, trash dumping, and vehicular traffic.

H1.3.7. Eliminate exotic vegetation. Remove exotic vegetation in silver rice rat habitat and in adjacent upland buffers.

H2. Restore suitable silver rice rat habitat. Habitat degradation from road construction, mosquito ditching, fill excavation, illegal solid waste disposal, and invasive exotic vegetation have altered natural hydrology patterns and facilitated the ability of exotic plants and animals to invade silver rice rat habitat. As a result, habitat quality and availability has been reduced or eliminated. Identify areas in greatest need of restoration and initiate restoration efforts.

H2.1. Re-establish natural hydrology and water circulation in silver rice rat habitat. Maintain and manage mosquito ditches so they do not impact rice rat habitat. The alteration of the natural hydrologic regime by dredge and fill activity alters nesting behaviors by causing rice rats to nest in nearby spoil areas. Water level variations influence where rice rats can forage. Implement hydrological restoration efforts in other areas of need.

H2.2. Restore both occupied and unoccupied silver rice rat habitat. Restore habitat that has been degraded by road construction, mosquito ditching, fill excavation, illegal solid waste disposal, and exotic vegetation to historic, natural conditions.

H2.3. Improve water quality in freshwater sources and create freshwater sources. The availability of fresh water is important to the survival of silver rice rats since they cannot effectively concentrate urine to meet their metabolic needs (Dunson and Lazell 1982, Goodyear 1987). Improve water quality in other freshwater areas or create additional sources.

H2.4. Improve habitat by planting or encouraging native plant species. Plant native vegetation in areas that have been scarified or degraded.

H2.5. Create habitat by refilling and creating suitable habitat areas. Restore or create habitat in areas that have been dredged or altered. Mulch areas or regrade roads to create habitat.

H3. Conduct research on rice rat habitat and how it affects the rat's distribution and abundance. Silver rice rats depend on both freshwater wetlands and saline wetland habitat, especially large areas of adjacent or contiguous habitat.

H3.1. Investigate how rats use different habitat components for survival. In general, mangrove habitats are used primarily for foraging, while higher-elevation salt

marshes are used for nesting and foraging (Forys et al. 1996). Investigate other patterns of habitat use (*e.g.,* food, shelter, nesting, traveling).

H3.1.1. Investigate stable home range and minimum area requirements. Silver rice rat home ranges and average dispersal distances are much larger than rice rats in the Everglades. Conduct radio telemetry and other surveys on silver rice rats to determine the minimum habitat area requirements. Compare size of home range in freshwater habitat versus saltmarsh habitat.

H3.1.2. Investigate the effect of habitat change. Determine how the silver rice rat's distribution and abundance is affected by increased road mortality, habitat degradation, and hydrology changes.

H3.2. Determine an index of habitat fragmentation. The rice rat requires large, contiguous areas of mangrove and saltmarsh habitats to sustain viable populations. In general, islands located on the periphery of the silver rice rat's range do not support populations although suitable habitat is present. Fragmentation of habitat interferes with dispersal, foraging, and nesting. Areas of concern from urbanization include all mangrove habitat within 1 km of known silver rice rat habitat.

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 silver rice rats.

H4. Monitor the status of silver rice rat habitat, particularly critical habitat, and examine ecological processes. Conduct yearly monitoring evaluations of the status of the rice rat's habitat. Overlay habitat quality with GIS mapping of habitat locations, including what patches are being altered or lost each year. Monitor the availability of rice rat habitat by updating the loss or change of habitat due to residential or commercial construction through GIS.

H5. Increase public awareness of silver rice rat habitat, especially critical habitat, and instill stewardship. Conduct workshops with the public to inform private land owners of appropriate management practices to preserve rice rat habitat. Encourage private land owners to remove exotics, maintain natural hydrology, refrain from destroying rice rat habitat, and restore disturbed areas. Prepare literature to provide information regarding the rice rat's habitat and its preservation and conservation.