Rice Rat (Lower Florida Keys Population) = Silver Rice Rat
(Oryzomys palustris natator) = (O. argentatus)

5-Year Review:
Summary and Evaluation

November 2021

U.S. Fish and Wildlife Service
South Atlantic–Gulf Region
Florida Ecological Services Field Office
Vero Beach, Florida

5-YEAR REVIEW
Silver Rice rat (*Oryzomys palustris natator*)

I. GENERAL INFORMATION

A. Methodology used to complete the review:

This review is based on monitoring reports, surveys, and other scientific and management information, augmented by communications with experts and biologists familiar with the species. The public notice for this review was published on August 6, 2018, with a 60-day public comment period (83 FR 38320). No public comments were received, however, new information received from outside the U.S. Fish and Wildlife Service (Service) was incorporated. Literature and documents used for this 5-year review are on file at the Florida Ecological Services Field Office (FESFO). Because new information is limited, a peer review was not conducted on this update. The review was conducted by the lead recovery biologist for the species with the FESFO, Vero Beach. No part of the review was contracted to an outside party.

In previous documents, such as the species' Recovery Plan and the 2008 5-Year Review, the silver rice rat (SRR) is referred to as the "rice rat" or the "Lower Keys population of the rice rat". As there are several subspecies of rice rats in the United States, including some in Florida, this document will consistently refer to the subspecies as it is in the listing rule, as the silver rice rat.

B. Reviewers

Lead Region: South Atlantic-Gulf Region, Carrie Straight, (404) 679-7226
Lead Field Office: FESFO, Sandra Sneckenberger, (772) 562-3909
Cooperating FWS program: Florida Keys National Wildlife Refuge Complex, Christian Eggleston, (305) 872-2239

C. Background

1. **Federal Register Notice citation announcing initiation of this review:**
   83 FR 38320 (August 6, 2018)

2. **Listing history:**
   Original Listing
   Federal Register Notice: 56 FR 19809
   Federal Register Notice date: April 30, 1991
   Effective listing date: May 30, 1991
   Entity listed: Subspecies
   Classification: Endangered

3. **Associated rulemakings:** Critical habitat was designated August 31, 1993 (58 FR 46030).

4. Review History:
Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as "Stable, Decreasing or Increasing" for this species. We continue to show that species status recommendation as part of our 5-year reviews. In our 2008 5-year review, the species' status was considered stable, and we found that no change to the SRR's listing classification as endangered was warranted.
Recovery Plan: 1999
Previous 5-year review: 2008

5. Species' Recovery Priority Number at start of review (48 FR 43098): 3C
Degree of Threat: High
Recovery Potential: Moderate to high recovery potential if threats are eliminated
Taxonomy: Subspecies
The "C" reflects a degree of conflict between the species recovery and economic development.

6. Recovery Plan
Name of plan: South Florida Multi-Species Recovery Plan (MSRP; Service 1999)
Date issued: May 18, 1999

Date of amendment to the original 1999 MSRP for the SRR, providing delisting criteria: November 7, 2019 (Service 2019).

II. REVIEW ANALYSIS

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

1. Is the species under review listed as a DPS? No.

2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy? No.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria?
Yes. The recovery plan (MSRP; Service 1999) does not include criteria for delisting. However, an amendment to the plan that included delisting criteria was recently finalized (Service 2019). These criteria are objective, measurable, and parallel the recovery strategy and goals outlined in the recovery plan. The delisting criteria address what is necessary to ensure resiliency, redundancy, and representation by addressing factors that threaten the SRR.

2. **Adequacy of recovery criteria.**

   a. **Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?**

   Yes. The newly amended recovery criteria (Service 2019) provide updated biology and include recovery actions within the entire range of the species.

   b. **Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?**

   The 5 listing factors are as follows: A) the present or threatened destruction, modification, or curtailment of its habitat or range; B) overutilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors affecting its survival. No immediate threats related to factor B are known at this time; this factor is not addressed in the recovery criteria.

3. **List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been achieved.**

   The SRR will be considered for delisting when:

   1. SRR populations on at least twelve (12) islands of the Lower Keys exhibit a stable or increasing trend, as evidenced by natural recruitment for multiple generations;
   This criterion has not been met. SRR populations were known to inhabit 12 islands as recently as 2004-2005 (Perry et al. 2005) but are currently known on 10 islands (Big, Middle, Little Torches, Summerland, Knockemdown, Cudjoe, Howe, Sugarloaf, Lower Sugarloaf, and Saddlebunch Keys; McCleery and Taillie 2020; Taillie 2021) (see C.1.e).

   Population demographic data have not been collected to evaluate trends; however, the distribution of the SRR appears to have remained relatively stable over the last 30 years (Perry 2006; McCleery and Taillie 2020). Not all islands have been recently surveyed, but there is no evidence of significant curtailment of range (see C.1.e).

   Survey efforts have transitioned to questions of occupancy rather than measures of abundance. Therefore, data needed to determine population trends are not available and we do not know whether the quantitative measures for this criterion have been attained. Overall, it appears that the SRR has exhibited general stability in distribution over at least the last decade.

2. the SRR populations are connected to the extent that genetic diversity of the three genetic groups can be naturally maintained without translocations or captive breeding;
The current level of connectivity and genetic diversity between SRR populations is unknown.

3. predation and competition from non-native species (e.g., Burmese pythons, black rats, and free-roaming pets) are low enough for SRRs to remain viable for the foreseeable future; and
Domestic cats (*Felis catus*) and burmese pythons (*Python bivittatus*) remain potential threats to rice rats in portions of the range, and neither threat has been reduced (see C.2.c). The Florida Keys National Wildlife Refuge Complex (FKNWRC) now has an Integrated Predator Management Plan (Service 2012) (see C.2.c) but resources have not been available to implement it fully. Black rats (*Rattus rattus*) have been described as a probable competitor (Goodyear 1992). Their populations have not been reduced; however, recent research suggests that while the two species may share a niche, temporal partitioning alleviates competition (Taillie et al. 2020).

4. in addition to the above criteria, it can be demonstrated that habitat loss associated with development, lack of natural disturbance, and other factors particularly affecting tidal mangrove and salt marsh habitat, are diminished or reversed such that enough suitable habitat remains for SRRs to remain viable for the foreseeable future despite anticipated sea level rise.
Habitat degradation and loss continues to occur in the Lower Keys, primarily due to sea level rise and development. Development may be more of an impact to SRRs, especially in past and present decades, than sea level rise (Taillie et al. 2020). Sea level rise appears to be the main driver of terrestrial habitat loss in this area in the last 40 to 50 years, but development and human population growth has continued to impact SRR habitat both directly and indirectly through reducing habitat quality, discouraging habitat management, enabling invasive predators (e.g., feral cats), and the interaction of both sea level rise and development (known as "coastal squeeze") (Schmidt et al. 2012). Due to the species' aquatic tendencies, development currently appears to be the main threat to the SRR (Taillie et al. 2020).

Despite restoration projects and ordinances on development (see C.2.a, C.2.d), habitat loss still threatens SRR populations. Furthermore, it is not currently known whether enough suitable habitat will remain to support a viable SRR population with the projected levels of sea level rise.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Summary of New Information of Species Biology and Life History:
Since the last 5-year review (Service 2008) new information regarding the species is centered on three main topics: genetics and taxonomy (see C.1.c and C.1.d), assessing threats (e.g., black rats, development, sea level rise; see C.2), and species distribution (see C.1.e). A Species Status Assessment has not been conducted for this species.

b. Abundance, population trends, demography:
SRR population size appears to have decreased, possibly by at least half, during the 1980s to mid- 1990s on four of five keys (Numi Mitchell, unpub. data; Smith and Vrieze 1979; U.S. Fish and Wildlife Service 1999; Wang et al. 2005). Due to lapses in systematic trapping surveys, information does not exist to determine trends prior to the 1980s or during the 1980s to mid-1990s.

SRR populations appeared to be stable from 1997 to 2006, and densities were comparable to those of marsh rice rats on the mainland (Perry 2006). Since the last 5-year review (Service 2008), surveys designed to estimate population sizes or determine abundance, trends, and demographic rates have not been conducted. Instead, efforts have transitioned to questions of occupancy rather than measures of abundance.

c. Genetics:
Previous genetic analyses discussed in the 2008 5-year review indicated that SRRs exhibit lower levels of genetic variation than mainland (Everglades) populations of marsh rice rats (Wang et al. 2005) and presented the importance of maintaining the genetic diversity of the three identified genetically distinct populations of SRRs in the Lower Keys (eastern, central, and western.
No further genetic analyses regarding within-species differences have been attempted (but see C.1.d.) since the last 5-year review. However, there is concern that diversity has likely declined in recent decades, and/or may decline in the future due to the population bottlenecks associated with sustained habitat changes and fragmentation due to sea level rise.

d. Taxonomic classification or changes in nomenclature:
The SRR was first described as a new species (*Oryzomys argentatus)* based on pelage color and skull measurements (Spitzer and Lazell 1978). Classification of rice rat subspecies, historically based on morphologic characteristics, has undergone numerous revisions, but the SRR has remained distinct, even recognized as the "Lower Keys population of *O. p. natator*" (Service 1991). Since genetic techniques have been employed, the SRR has continued to be identified as a distinct taxon (Gaines et al. 1997; Wang et al. 2005; Crouse 2005; Indorf and Gaines 2013). Currently, there is insufficient evidence to classify the

SRR as a separate species (*Oryzomys argentatus*; reasserted in Goodyear 1991, but not accepted by the majority of the scientific community considered invalid (ITIS 2021)), however its geographic isolation, ecologic and morphologic differences, and level of genetic divergence support its classification as the subspecies *O. p. argentatus* (Indorf and Gaines 2013).

There have been no changes in the accepted taxonomy for the rice rat, *Oryzomys palustris,* which is verified (Integrated Taxonomic Information System [ITIS] 2021). ITIS does not validate any subspecies of *Oryzomys palustris.*

e. Distribution and trends in spatial distribution:
The range of this species is considered as the Lower Florida Keys, also described as the islands west of the Seven Mile Bridge. Specifically, SRRs have been detected on 14 of the Lower Keys: Little Pine, Big Pine, Big Torch, Cudjoe, Howe, Knockemdown, Lower Sugarloaf, Middle Torch, Raccoon, Ramrod, Saddlebunch, Summerland, Upper Sugarloaf, and Water (Goodyear 1984; Perry 2006; Taillie et al. 2020; McCleery and Taillie 2020). However, some of the detection records are old (historical) or are single occurrences and may reflect isolated dispersal events rather than a persisting population (Perry 2006). For example, SRRs have not been detected on Little Pine Key since the 1980s, and detections on Ramrod and Big Pine Keys were single instances. Big Coppit, Boca Chica, East Rockland, and Geiger Keys are also considered in the species' range, but surveys conducted detected no SRRs (Forys et al. 1996; Mitchell 1996; Perry 2006, Perry and Lopez 2010; Service 2016). Several other less accessible islands have not been surveyed or regularly surveyed.

Prior to the last status review, a rangewide survey conducted in 2004 and 2005 (Perry 2006) yielded captures on 12 keys (Big Pine, Big Torch, Cudjoe, Howe, Lower Sugarloaf Middle Torch, Raccoon, Ramrod, Saddlebunch, Summerland, Upper Sugarloaf, and Water). Trapping was conducted on 5 other keys (Little Pine, Big Coppit, Boca Chica, East Rockland, and Geiger) on which SRR were not detected. The most recent surveys (of 13 keys) documented SRRs on 10 keys: Big Torch, Middle Torch, Little Torch, Howe, Summerland, Saddlebunch, Cudjoe, Knockemdown, Lower and Upper Sugarloaf Keys (Taillie and McCleery 2020) (Table 1).

Table 1. Silver rice rat survey locations and detections from recent efforts (2004-2005, 2020; Perry 2006; Taillie and McCleery 2020). (Historic locations bolded.)

Survey Locations	Silver Rice Rats Detected?	
	Perry 2006	***Taillie & McCleery 2020; Taillie 2021***
Big Coppit	No	Not surveyed
Big Pine	**Yes**	No
Big Torch	**Yes**	**Yes**
Boca Chica	No	Not surveyed
Cudjoe	**Yes**	**Yes**
East Rockland	No	Not surveyed
Geiger	No	Not surveyed
Howe	**Yes**	**Yes**
Little Pine	No	No
Little Torch	Not surveyed	**Yes**
Knockemdown	Not surveyed	**Yes**
Lower Sugarloaf	**Yes**	**Yes**
Middle Torch	**Yes**	**Yes**
Racoon	**Yes**	No
Ramrod	**Yes**	No
Saddlebunch	**Yes**	**Yes**
Summerland	**Yes**	**Yes**
Upper Sugarloaf	**Yes**	**Yes**
Water	**Yes**	Not surveyed

Because of seasonal changes in habitat use (Kruchek 2004), extensive dispersal/movement capabilities, and swimming abilities (Esher et al. 1978; Forys and Dueser 1993), changes in SRR distribution (and/or detection) between surveys is possible. More frequent range-wide monitoring would be necessary to evaluate trends in SRR distribution; however, the information available shows little change in the general range of the SRR since the 1980's.

f. Habitat or ecosystem conditions:

SRR occupy mangrove, saltmarsh, and saltmarsh transition plant communities (Goodyear 1987; Service 1999) and are occasionally reported from freshwater marshes (Mitchell 1996). Much of this habitat has been fragmented by roads, canals, and subdivision development (Forys and Humphrey 1999; Lopez 2001), with U.S. Highway 1 and adjacent development the primary cause of reduced connectivity (Lopez 2001; Faulhaber et al. 2007). Changes in wetland regulations and extensive acquisition of salt marsh and mangrove habitat for protection by government agencies has curtailed further impacts to some extent (Lopez 2001; Monroe County et al. 2006; Service 2006), but habitat loss from development continues to occur and may be a more pressing issue to the SRR than sea level rise (Taillie et al. 2020). (See C.2.e for discussion of sea level rise impacts on SRR habitat).

Hurricane Irma made landfall on Cudjoe Key, central to the species' range, as a Category 4 in 2017. This large and powerful storm impacted all habitats through its storm surge (over 2 meters [m] (6.5 feet [ft])), damaging vegetation, reforming coastlines, and overwashing lands (Radabaugh et al. 2019). Increased areas of inundation and loss of vegetation likely left SRRs more vulnerable to predators and with fewer resources (i.e., food and shelter). McCleery and Taillie (2020) noted a slight decline in the number of occupied grid cells in pre- and post-Hurricane Irma data (52 and 44 percent of grid cells occupied, respectively).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

Historically, habitat destruction due to development appeared to be the primary threat to the rice rat (56 FR 19809; Service 1999). Habitat loss and fragmentation resulted from the development of homes, businesses, roads, and canals. The area of impervious surfaces within the species' range doubled from 1959 to 2006 (Schmidt et al. 2012). This habitat loss has resulted in a reduction of the area of contiguous habitat, reduction in total habitat area, and degradation of dispersal corridors (Service 1999). Accordingly, the probability of demographic or genetic rescue by successful natural dispersal and recolonization among isolated and possibly extirpated habitats, has likely declined. These local habitat modifications also lead to systemic marsh degradation (i.e., changes in natural tidal flows, increased siltation) and other effects that can result in reduced prey availability and general habitat suitability.

Ditches, dug to facilitate mosquito control, were cut across large portions of the SRR's range. These ditches likely effect hydrological and plant community dynamics in SRR habitats. The effect of these ditches on mangrove and saltmarsh transition zones and/or the SRR has not been studied. The residual impact of mosquito control ditches is not known to be a significant threat to rice rats. A ditch inventory and small-scale remediation project was completed in the Lower Keys in 2000 (Hobbs et al. 2006). Ditches were plugged at 11 sites on Big Pine Key, which benefited approximately 13.5 acres (5.5 ha), including some SRR habitat. However, this is a small portion of the area that was historically impacted by the mosquito control ditches, and no current plans or projects are underway to plug additional mosquito ditches.

Land acquisitions by Monroe County have included mitigation parcels derived according to Rate of Growth Ordinances (ROGO) and anticipated under the Big Pine Key-No Name Key Habitat Conservation Plan (HCP) (Monroe County et al. 2006); this HCP is expected to be extended to 2026. Additionally, Monroe County ordinances virtually

preclude development in the supratidal habitats that SRRs inhabit.

Over the last 35 years, the Keys Environmental Restoration Fund and collaborators have undertaken a variety of significant projects on islands within the SRR's range (Hobbs et al. 2006). Few projects (e.g., removal of woody encroachment) include significant or direct benefits to SRR habitat due to the species' preference for tidal areas. Habitat conditions have gradually improved in some areas due to specific rehabilitation projects or simply the cessation of actions that cause disturbance. However, the significance of threats from lingering mosquito ditch canals, historical fragmentation, and hurricanes remains largely unknown.

A temporary building moratorium and the Big Pine – No Name Keys HCP reduced loss or fragmentation of rice rat habitat from development. Those protections extend to both saltwater and freshwater communities on Big Pine and No Name Keys (see C.2.d). The SRR is sensitive to development (Taillie et al. 2020), and loss of habitat due to development remains a threat, despite these protections.

b. Overutilization for commercial, recreational, scientific, or educational purposes:
We are not aware of take of SRRs due to commercial, recreational, or educational purposes. We do not have evidence that indicates this factor is a current threat.

c. Disease or predation:
We have no new information on disease in the SRR. Little is known about predation on this species. Free-ranging domestic cats occur widely throughout much of the Keys and potentially represent a threat to SRR survival (Mitchell 1996; Service 1999). Feral cat densities in Big Pine Key were found to be four times that found in Key Largo, where feral cats are a known predator of two endangered mammal species (Cove et al. 2018). Investigation of this threat and its potential impact on the SRR is needed.

Rice rats are a documented prey item of Burmese pythons in Everglades National Park (Harvey et al. 2008). Severe declines in mammal populations have been found to coincide temporally and spatially with the proliferation of pythons (Dorcas et al. 2012; McCleery et al. 2015). There have been five detections of these snakes within the SRR's range (EDDMapS 2021). If established in the Lower Keys, such snakes would likely become very effective predators of the SRR, and the species may have limited capacity to cope with such predators on the population level.

The Florida Keys National Wildlife Refuge Complex (FKNWRC) now has an Integrated Predator Management Plan (Service 2012) which

addresses several potential predators and competitors of the SRR, such as free-roaming cats, rats, large snakes and lizards, and raccoons.
The magnitude and imminence of predation threats from native predators is low. Regarding free-ranging domestic cats, the magnitude and imminence of threats remains unknown. The magnitude of potential threats from large exotic snakes, should they become established in the Lower Keys, is very high.

d. Inadequacy of existing regulatory mechanisms:
All impacts (i.e., residential and commercial development-related) to SRR habitat are regulated through either the Big Pine – No Name Key HCP or the FEMA BO (Service 2006). The mitigation plan for the HCP is still in place and will be until at least 2023, possibly through 2026. This extension would continue the current regulations and mitigation plan associated with the HCP, which includes land acquisition, implementation of recovery actions, and conservation measures that benefit the SRR.

The protection provided by the Clean Water Act (62 Stat. 1155, as amended; 33 U.S.C. 1251-1376) (CWA) continues to help conserve the SRR and its habitat. Projects involving wetland impacts require permit application review by the U.S. Army Corps of Engineers pursuant to section 404 of the CWA and/or coordination among regulatory agencies pursuant to the Fish and Wildlife Coordination Act [48 Stat. 401, as amended; 16 U.S.C. 661 et seq.] and ESA. However, this process changed in 2020 when the Florida Department of Environmental Protection began administering this program. Generally, through consultation, impacts to the SRR and its habitat may be avoided or minimized, but the efficacy of this new regulatory process is unknown at this time.

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

Additionally, Monroe County adopted a Comprehensive Land Use Plan (Policy 204.2) that benefits SRR habitat. The policy states that the county shall eliminate the loss of undisturbed wetlands and the net loss of disturbed wetlands, including submerged lands, mangroves, salt ponds, freshwater wetlands, freshwater ponds, and undisturbed saltmarsh and buttonwood

wetlands. Furthermore, the policy states that that "no structures shall be permitted in submerged lands, mangroves, salt ponds, or wetlands except for elevated, pile-supported walkways, docks, piers and utility pilings".

Pressure to develop remaining residential and commercial land within the range of the silver rice rat continues. However, development is subject to regulatory oversight by Monroe County (e.g., ROGO and the Comprehensive Land Use Plan), the State of Florida (e.g., designated an Area of Critical State Concern), and the Service (e.g., the HCP; ESA consultation, presumably including continued consultation with FEMA regarding administration of the National Flood Insurance Program). Regulatory mechanisms have reduced habitat loss in the Lower Keys, particularly in the wetland habitat occupied by the SRR. Despite these protections and mechanisms, development remains a major threat, particularly considering its interaction with sea level rise (i.e., coastal squeeze) (Taillie et al. 2020).

e. Other natural or manmade factors affecting its continued existence:
Non-native competitor—The black rat *(Rattus rattus)*, an introduced Old World rat found throughout the Lower Keys, may compete with the SRR for space and food (56 FR 19809; Goodyear 1992; Forys et al. 1996; Perry 2006). Black rats are the suspected cause of decline for many species and have been considered a possible threat to the SRR, especially as they are often captured when trapping surveys are conducted to monitor SRR populations. Recent research suggests that while the two species use the same areas and habitat types, they appear to be unlikely competitors due to temporal partitioning (Taillie et al. 2020). The magnitude of the threat from black rats is considered low, but additional research, particularly on diet, is needed to confirm that these species are not competing for resources.

Hurricanes—Hurricanes frequently alter landscapes and flora due to storm surges and wind, which may impact low-lying SRR habitat. Hurricane Georges in 1998 resulted in extensive damage to pine rocklands and caused numerous waterholes to become saline for many months (Lopez 2001). Similarly, Hurricane Wilma (October 2005) resulted in a storm surge 5 to 8 ft (1.5 to 2.4 m) above mean sea level that displaced fresh water with sea water throughout Big Pine Key, killed slash pines throughout more than 15 percent of the pine rocklands, and resulted in an outbreak of bark beetles (add scientific name) (Carothers 2006). In some saltmarsh areas with poor tidal connection (drainage) and areas where roads and other developments resulted in the retention of sea water, hypersalinity followed recent storm surges. Additionally, in portions of the species' range, areas of black mangrove (*Avicennia germinans*) died off after Hurricane Wilma. Black mangrove communities are an important component of the upper edges of the low intertidal areas and among swales in saltmarsh areas, which together constitute much of the SRR's habitat (Goodyear 1987). (See C.1.f for specific details regarding Hurricane Irma impacts.)

In terms of silver rice rat habitat suitability, the impact of storm surges remains unknown. In both saltwater and freshwater systems, positive and negative effects are possible. In the more salt-tolerant plant communities inhabited by SRRs, the habitat-related effects of storm surges may often be negligible. For example, the saltmarsh areas inhabited by SRRs are normally flooded by spring tides and variously by storm tides (Goodyear 1987). The magnitude of threats from stochastic events such as hurricanes and associated storm surge may be exacerbated due to the characteristics of small populations and a small range. Also, previous studies showed other rice rat species abandoned Gulf Coast islands during Hurricane Katrina (Abuzeineh et al. 2007). However, there are no available data specifically regarding impacts to SRR populations due to hurricanes.

Sea level rise—
Sea level rise associated with global climate change is a serious concern for the Lower Florida Keys. The most recent projections, which factored in ice melt in Greenland and Antarctica, developed scenarios that range from less than 0.3 m to 3.2 m (1.0 ft to 10.4 ft) of SLR in South Florida and the Florida Keys by 2100 (University of Florida Geoplan 2015; The Nature Conservancy 2011; Zhang et al. 2011; Vargas-Moreno and Flaxman 2010; National Oceanic and Atmospheric Administration [NOAA] 2017). Recent analysis indicating an accelerated rate suggests that, of the NOAA SLR scenarios based on different greenhouse gas emission scenarios (NOAA 2017), the intermediate to extreme sea level rise scenarios are more likely to occur than the low and intermediate-low scenarios (scenarios), and NOAA is recommending the use of the higher end estimates for future projections. Regardless of scenario, all six are at or above the levels of SLR that LaFever et al. (2007) predicted would result in loss of coastal and upland vegetation in the Lower Florida Keys. Due to the low elevation of the Florida Keys (average 1 to 2 m (3 to 6 ft)) above sea level), substantial areas are predicted to be impacted by saltwater intrusion and inundation.

Sea level rise has been shown to affect conversions of upland communities with low soil and moisture salinities to communities comprised of more salt tolerant plant species and higher soil and groundwater salinities (Ross et al. 1994). As SRRs inhabit regularly inundated mangrove habitat, the species is likely capable of adapting to rising sea levels (Taillie et al. 2020). In fact, this phenomenon may result in the creation of suitable SRR habitat in areas where it did not previously exist. However, sea level rise may also result in total inundation of currently suitable SRR habitat or may initially or temporarily create additional habitat prior to increased and finally total inundation. The low-lying mangroves and buttonwood transition zones that the SRR predominantly occupies are most vulnerable to inundation (Goodyear 1987; Forys et al. 1996; Perry 2006).

The effects of sea level rise within the range of the SRR will depend upon the rate of rising seas, the landscape (on a small or microscale), tides, as well as how the coastal environment changes in response to sea level rise (e.g., migration of vegetative communities, sediment deposition) (Borchert et al. 2018). Additionally, human responses to sea level rise may have a significant impact on future SRR habitat. Based on models of the potential impacts of sea level rise on the Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), LaFever (2006) concluded that abandonment of human dominated areas (i.e., development and roads), as opposed to protecting them from ongoing sea level rise, may significantly ameliorate habitat impacts because it could allow for upslope migration of habitat. This may also be the case for SRR, if abandoned areas transition into mangrove and buttonwood tidal zones.

Beyond habitat changes, sea level rise is a threat to the SRR through the projected increased frequency and depth of high tide flooding (Ezer and Atkinson 2014; Sweet et al. 2014; Sweet and Park 2014, as cited in NOAA [2017]; NOAA 2019) and increased frequency and intensity of hurricanes in the Florida Keys (IPCC 2014). The imminence of sea level rise effects is high, the magnitude remains high, and may have different threat levels in the short-term and long-term.

D. Synthesis

Past surveys have documented SRRs on a total of 14 of the Lower Keys (Goodyear 1984; Perry 2006; Taillie et al. 2020; Taillie and McCleery 2020). A rangewide survey conducted in 2004 and 2005 yielded captures on 12 keys (Perry 2006). Recent surveys have documented SRR on 10 keys (Taillie and McCleery 2020). The level of survey effort has not been consistent between the various surveys and SRRs are known to have seasonal changes in habitat use (Kruchek 2004) and extensive dispersal/movement capabilities, including swimming (Esher et al. 1978; Forys and Dueser 1993). Therefore, changes in SRR distribution (and/or detection) between surveys is likely. In addition, some islands are thought to support only transient individuals (Perry 2006). Based on this data, we believe that the SRR's distribution has remained generally stable over the past decades; however, more surveys would be required to determine more precise distribution trends and if a range reduction has occurred since the 1980s. Trends in SRR abundance are unknown as recent surveys have provided distributional data only. In addition, data are lacking to adequately evaluate the genetic connectivity between populations, the effects of sea level rise and development, and the influence of predators and competitors on the SRR.

While some progress has been made to limit development in SRR habitat, none of the recovery criteria have been fully met. Threats to the SRR include invasive species, sea level rise, development, and coastal squeeze. Together, these threats have led to range-wide degradation of the species' tidal habitat which expected to continue. Although the SRR's distribution has remained generally stable over the past decades, many significant threats remain and are easily exacerbated by small population size in a restricted range. Additional populations have not been established or discovered at this time, and non-native species

continue to infiltrate the Florida Keys. Based on the best available data, the SRR continues to meet the definition of endangered.

III. RESULTS

A. Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

B. New Recovery Priority Number:

There is no recommendation to change the Recovery Priority Number.

C. If a reclassification is recommended, indicate the Listing and Reclassification Priority Number: n/a

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting Priority Number: ____

Recommended Classification:

_X_ No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Conduct intensive range-wide distribution surveys, including the 18 Keys within the SRR range, but focused on the 14 islands where SRR have historically been detected.
- Continue and expand research that increases our understanding of how SRR populations function (i.e., demographics, movement, dispersion).
- Research how vegetation communities and SRR populations respond to climate change and sea level rise, and predict future changes in SRR distribution under different sea level rise and climate change projections.
- Conduct genetic analyses using modern techniques to identify remaining population substructure, assess threat of loss of genetic diversity, and evaluate strategies to remedy, if needed.
- Determine need and feasibility for building a reference genome for SRR and develop protocols for bio-banking/crypto-preservation of SRR genetic material to inform management and future recovery strategies.
- Restore tidal communities within the SRR range and research how SRR, as well as vegetative, macroinvertebrate, and fish communities respond.
- Determine SRR food habits and preferences in order to better identify important habitats and potential threats.
- Continue to closely monitor for the presence of invasive snakes and feral cats. Continue efforts to develop and refine risk assessments, prevention and control techniques, and outreach. Support FKNWRC Integrated Predator Management Plan.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Silver Rice Rat (*Oryzomys palustris natator*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: n/a

Review Conducted By: Sandra Sneckenberger, Florida Ecological Services Field Office – Vero Beach.

FIELD OFFICE APPROVAL:

Division Manager, Classification and Recovery, Florida Ecological Services Field Office, Fish and Wildlife Service

Approve LOURDES MENA Digitally signed by LOURDES MENA Date: 2021.11.30 09:22:31 -05'00'

OTHER FIELD OFFICE APPROVAL:

This 5-year review was shared with the Florida Keys National Wildlife Refuge Complex for their concurrence prior to finalizing the document. We will retain any comments that we received, as well as verification of concurrence, in the administrative record for this 5-year review.

* In 2021, the Classification and Recovery Division Manager in the Florida Ecological Services Field Office was delegated authority to approve 5-year reviews that do not recommend a status change.