Riparian woodrat, *Neotoma fuscipes riparia Paul W. Collins*

Description: This is a medium-sized (206-312 g, WT) rat-like rodent with grayish brown dorsum; pale to white venter; long (160--227 mm), faintly-bicolored, scantly-haired, tail; and relatively large (24-36 mm), naked ears (Ingles 1965, Jameson and Peeters, 1988, Carraway and Verts 1991). Riparian woodrats can be distinguished from adjacent subspecies by their larger overall size (434-452 mm, TL), lighter, more grayish dorsal coloration, distinctly bicolored tail (207-224 mm), larger (43-45 mm) hind feet with white rather than dusky colored upper surfaces, and larger more massive skull (40.0-44.7 mm, basilar length) (Hooper 1938).

Taxonomic Remarks: This taxon in one of 11 described subspecies of the dusky-footed woodrat (Hooper 1938). The morphological characters of *N. f. riparia* show considerable overlap with other races of *N. fuscipes*.

Distribution: Developing a clear picture of the historical range of this California endemic is difficult because much of the riparian forest habitat which this taxon inhabited was destroyed even before it was described by Hooper (1938), and because there are only a few woodrat specimens from the floor of the San Joaquin Valley available for study. According to Hooper (1938), the range of riparia encompassed the area in the vicinity of Kincaid's Ranch, about 3 km (2 mi) northeast of Vernalis, Stanislaus County (the type locality), and probably occurred historically along the west side of the San Joaquin River from southern Merced County or northern Fresno County north to the Suisun Straits region in Contra Costa County. Others list a more restricted historic range for this taxon which encompasses an area along the San Joaquin, Stanislaus, and Tuolumne rivers in Stanislaus and San Joaquin counties (Williams 1986, Williams and Kilburn 1992). Goldman (1910) listed a dusky-footed woodrat from El Nido in southern Merced County, which Hall and Kelson (1959) assigned to riparia. Williams (1986) suggests that this specimen may have originated from somewhere along the San Joaquin River west or south of El Nido. Three specimens assigned to riparia, one (CSUF) collected from 10 mi southwest of Los Banos, Merced County (Williams 1986), and the other two (MVZ 94769 and 128790) collected from Corral Hollow Creek in western San Joaquin County, are outside the accepted geographic range for *riparia*. If these outlying specimens turn out to be riparian woodrats, then the historic range of this taxa would have included an area of the San Joaquin Valley floor encompassed by the San Joaquin River and its tributaries, extending from southern Fresno County north to its confluence with the Sacramento-San Joaquin River Delta in Contra Costa County. Clarifying the historic range of riparia will have to wait until the taxonomic status of all available specimens collected from sites across the floor of the San Joaquin Valley in Merced, Fresno, Stanislaus, Contra Costa and San Joaquin counties is reevaluated.

Currently, a single population is known to exist on about 102 ha (250 acres) of riparian forest along the Stanislaus River in and immediately adjacent to Caswell Memorial State Park (Cook 1992, Williams 1993). Williams (1993) estimated that approximately 437 woodrats inhabited 91 ha of this 104 ha (258 acre) park. Riparian woodrats also may still be present along the San Joaquin River in the vicinity of the type locality near Vernalis, Stanislaus County; however, there are no reported sightings there since the 1970s (Williams and Kilburn 1992). Woodrats are also occasionally found in wood duck nest boxes along the lower San Joaquin and Tuolumne rivers which suggests the possible presence of additional extant populations of this taxon along these two rivers (Williams 1986). Intensive, range-wide surveys throughout the northern San Joaquin Valley floor of remnant stands of riparian forest habitat along the San Joaquin River and its larger tributaries are needed to clarify the current distribution and population status of this taxon.

Life History: No studies have been conducted on the life history of the riparian woodrat. This account is based on studies of other subspecies of dusky-footed woodrats (Linsdale and Tevis 1951, Carey 1991, Carraway and Verts 1991).

The distribution of dusky-footed woodrats is apparently restricted by factors such as their limited dispersal abilities, daily water requirements, and the availability of dense, brushy habitat (Carey 1991). With a minimum daily requirement for water of 10.2% of their body mass (Carpenter 1966), dusky-footed woodrats tend to be restricted to habitats that are in close proximity to a year-round water supply. They are primarily nocturnal showing peak activity at dawn and dusk. They are equally proficient on the ground and in the foliage of trees and shrubs (Linsdale and Tevis 1951). In California, dusky-footed woodrats breed from December to September, with the majority of litters born in mid-spring (Carraway and Verts 1991). Following a 28-33 day gestation period (Carraway and Verts 1991), females give birth to one annual litter (Vestal 1938). Litter size averages 2.6 young per litter but ranges from one to four (Carraway and Verts 1991). Juveniles rarely disperse more than 50 ft to establish home ranges in or adjacent to the maternal range (Linsdale and Tevis 1951). The matrilineal social structure of dusky-footed woodrat societies results in populations that are female-biased and in which adjacent females are closely related. Unlike females, males disperse away from their birth den, and are highly territorial and aggressive during the breeding season.

The dusky-footed woodrat is a social animal which lives in colonies of conical stick houses constructed with sticks, bark, plant cuttings, and other objects (Carraway and Verts 1991). Individual colonies are relatively stable with the number of adults remaining fairly constant (Wallen 1982). Woodrat colonies are generally situated in flood-free areas. Colonies established in areas subject to flooding may be abandoned in favor of sites on higher ground (Cranford 1977). Woodrats generally construct their houses in locations which provide good cover, low to medium humidity, cool temperatures, and dark surroundings (Linsdale 1957). At Caswell Memorial Park, riparian woodrat houses were generally positioned over or next to logs in areas with a dense canopy cover, ground cover high in leaf litter and a light growth of sedges, and a moderate understory of vines, seedlings, and shrubs (Cook 1992). Each house represents the efforts of many generations of woodrats and can be occupied continuously for 13-25 years (Linsdale and Tevis 1956, Wallen 1982). Woodrat houses used as residences are generally occupied and vigorously defended by a single adult woodrat. Some houses are "common" houses which are used by many individuals and serve as places where males and females meet (Wallen 1982). Houses are used for nurseries, protection from predation and temperature extremes, resting, self care, food storage, and social communication (Vestal 1938, Wallen 1982). In California, woodrat stick houses occur in densities of 7.4-37.1/ha (Vogl 1967, Cranford 1977) with an average of 1.8 houses/home range (M'Closkey 1972). The number of houses is typically greater than the number of woodrats present in a given area. At Caswell Memorial Park, riparian woodrat houses have been recorded at a mean density of 6.6 to 8.3 houses/ha for a park-wide estimate of 673-847 houses (Cook 1992, Williams 1993). Although dusky footed woodrats can occur at densities ranging from 3.2-7.3/ha (Cranford 1977, Wallen 1982), they have relatively small home ranges. Riparian woodrats have been recorded at a mean density of 4.8 woodrats/ha, for an estimated population size of 437 woodrats in 91 ha of Caswell Memorial State Park (Williams 1993). Based on a density of 6.6 woodrat houses/ha, Cook (1992) extrapolated a population estimate of 673 woodrats for Caswell Memorial Park. In California, dusky-footed woodrat home ranges averaged 0.23 ha (0.58 acres) for males, 0.19 ha (0.48 acres) for females, and 0.17 ha (0.43 acres) for juveniles (Cranford 1977). On average, females travel 837 meters and males 949 m from initial points of capture (Smith 1965).

Habitat: Historically, riparian woodrats probably inhabited the riparian forests in the floodplain along the San Joaquin River and its tributaries. The riparian woodrat occurs in riparian woodland

with an overstory canopy of trees and moderate to dense shrub understory, with abundant dead branches and downed woody material (Williams 1993). Low-growing woody vegetation provides important protection from predators, shade, food sources, suitable limbs for runways between houses, sufficient woody materials for constructing nests and houses, and vertical woody support required for stabilizing a large house (Linsdale and Tevis 1951, Carey 1991). Nest sites are also located in tree cavities, logs, and talus slopes. At Caswell Memorial Park, *N. f. riparia* occurred in dense understory shrubs under a closed canopy of riparian forest trees (Cook 1992, Williams 1993).

Status: Class I. This taxon appears to meet CESA criteria for listing as Endangered because of its restricted distribution in a single small population, and ongoing threats of continued loss and degradation of its riparian forest habitat to urban and agricultural development and flood control activities. Because of its small population size, the single population is at risk of extinction from genetic (inbreeding depression), demographic (disease), and environmental (flooding, wildfire) variability.

The principal reason for the decline of riparian woodrats in California has been the destruction, fragmentation, and degradation of the San Joaquin Valley native riparian forest community, due in part to the construction of dams and canals which diverted water for irrigation of farm lands and permanently altered the hydrology of Valley streams. During pre-settlement times, San Joaquin Valley riparian forest was distributed as stringers or corridors along water courses and over much of the riverine floodplains on the floor of the northern San Joaquin Valley (Katibah 1984). Historically the northern San Joaquin Valley from the Merced River north to confluence of the San Joaquin and Sacramento rivers in Contra Costa County contained approximately 75,100 ha (185,600 acres) of riparian forest habitat (Katibah 1984). By the mid-1980s only about 11.1% (8,336 ha) of this habitat remained, and the majority continues to be impacted by human activities (Katibah 1984). Today, San Joaquin Valley riparian forest habitat is only a vestige of what was present 100 years ago and is confined to a few disjunct patches and narrow ribbons along the San Joaquin River and a few of its larger tributaries. Gone are the broad expanses of this woodland habitat that once covered large areas of the valley floor in the northern San Joaquin Valley. Caswell Memorial State Park provides one of the largest remaining patches (104.5 ha) of San Joaquin Valley riparian forest habitat and is the only locale within the historic range with a surviving population of riparian woodrats (Williams 1993). Other threats include: continued loss of riparian and native floodplain habitats to cultivation and ongoing flood control projects; regulation of stream flow; stream channelization and levee maintenance: removal and burning of undergrowth (brush, trees, and snags) from riverside habitat which reduces the available cover critical to this species: and use of rodenticide treated grain within the range of this species to control California ground squirrel populations (Williams 1986, Williams and Kilburn 1992). Cattle grazing may adversely impact *riparia* habitat by removing available brushy cover (Linsdale and Tevis 1956). Wildfires and prescribed burning are also detrimental.

Management Recommendations: If listed, the riparian woodrat would be eligible for the allocation of funds and resources for its protection and recovery, and would receive protection from proposed developments that could alter its habitat by requiring pre-project biological consultation in accordance with CEQA and CESA. Such a consultation would ensure that mitigation measures and project alternatives developed during the CEQA environmental review process would be implemented as terms of project approval.

The draft recovery plan for upland species of the San Joaquin Valley (Williams et al. 1997) provides detailed recommendations for the management and conservation of the riparian woodrat. A summary of these is as follows: *i*) establish linkage corridors to reduce the effects of population fragmentation, *ii*) survey and map all riparian areas along the San Joaquin River and its major

tributaries, *iii*) collaborate with owners of riparian land and local levee-maintenance districts to develop an incentive program for preserving cover and riparian vegetation, *iv*) develop a plan for the restoration of riparian habitat, establishement of riparian corridors, and reintroduction (if necessary) of riparian woodrats to suitable habitat, *v*) initiate genetic studies of existing populations, *vi*) establish conservation agreements with willing landowners, *viii*) restore and link riparian habitat and reintroduce woodrats, *viii*) reevaluate the status of the riparian woodrat within three years of recovery plan approval. [Editor's note: The final Recovery Plan for Upland Species of the San Joaquin Valley, California was approved September 30, 1998.]

A trapping survey of remaining riparian forest habitat along all river corridors throughout the historic range of the riparian woodrat is needed to clarify the distribution and abundance of extant woodrat populations. Threats to remaining populations should be identified. Basic life history data that are needed to develop recovery and habitat conservation plans include habitat requirements, dispersal characteristics, and minimum viable population size. Genetic and morphologic studies are needed to clarify the taxonomic status and phylogenetic relationship of dusky-footed woodrats on the floor of the San Joaquin Valley from southern Fresno County north to the Delta in Contra Costa County; to clarify the systematic status of woodrats at Corral Hollow Creek, along the San Joaquin River near El Nido, and from areas south of Los Banos; and to determine levels of genetic diversity and inbreeding in the woodrat population at Caswell Memorial State Park.

Riparian woodrats are afforded some protection because they co-occur with the State-listed riparian brush rabbit (*Sylvilagus bachmani riparius*), and because the only know population occurs in Caswell Memorial State Park. However, the conservation needs of these species may differ in important respects. Listing this taxon as Endangered would lead to recovery and management actions that address its specific needs. In developing recovery and management strategies, measures recommended to protect and enhance San Joaquin Valley riparian forest habitat for the Endangered riparian brush rabbit (Larsen 1993) should be reviewed and modified where appropriate to ensure that habitat for the riparian woodrat is also being enhanced.

